

Shell Programming for System Administrators

SA-245

Student Guide **With Instructor Notes**



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About This Course



Course Goal

The goal of the *Shell Programming for System Administrators* course is to provide you with the knowledge and skills necessary for shell script programming. In this course, you learn shell script syntax, as well as analysis and design procedures, to successfully create shell scripts. The course takes prerequisite knowledge and allows you to automate tasks that you would frequently perform on the job.

- ✓ *Use this module to get the students excited about this course.*
- ✓ *With regard to the overheads: To avoid confusion among the students, it is very important to tell them that the page numbers on the overheads have no relation to the page numbers in their course materials. They should use the title of each overhead as a reference.*
- ✓ *The strategy provided by the “About This Course” is to introduce students to the course before they introduce themselves to you and one another. By familiarizing them with the content of the course first, their introductions have more meaning in relation to the course prerequisites and objectives.*
- ✓ *Use this introduction to the course to determine how well students are equipped with the prerequisite knowledge and skills. The pacing chart on page xxii enables you to determine what adjustments you need to make to accommodate the learning needs of students.*



Course Overview

The course first briefly describes the different shells available in the operating system. Then the course covers the basics in analyzing a problem, designing a series of steps to solve the problem, and then organizing a series of operating system commands and shell built-in commands to perform the necessary steps to solve the problem. Good programming techniques and script debugging are also described.

The audience for this course are systems administrators who are familiar with basic administrative concepts and tasks, such as adding users and software and, using the system boot process, daemons, and device configurations. This is a follow-up course to SA-238: *Solaris™ 8 Operating Environment System Administration I*.

The course material shows example syntax of both the Bourne and Korn shell, and the module examples and exercise solutions were executed in the Solaris™ 8 Operating Environment. Most examples and solutions work in either the Bourne or Korn shell, although some topics are denoted as Korn shell only.



Course Map

Shell Basics and Script Analysis and Design

UNIX® Shells
and Shell
Scripts

Writing and
Debugging
Scripts

The Shell
Environment

Useful Utilities and Regular Expression Characters

Regular
Expressions
and grep

The sed Editor

The nawk
Programming
Language

Programming Constructs

Conditionals

Interactive
Scripts

Loops

Advanced Shell Programming

Advanced
Variables,
Parameters,
and Argument
Lists

Functions

Traps



Module-by-Module Overview

This course contains the following modules:

- Module 1 – “UNIX® Shells and Shell Scripts”

This module provides a review of the roles of a shell, an overview of the three standard operating system shells, and a brief description of all interactive shells. The module also introduces the concept and basic layout of a shell script.

Lab exercise – Answer brief questions about the shells available with the operating system, and write a brief shell script on paper.

- Module 2 – “Writing and Debugging Scripts”

This module explains the necessary components of a shell script, as well as good and poor practices. The processes of writing, executing, and debugging scripts are described.

Lab exercise – Add comments, white space, and an explicit call to a shell interpreter to the script written on paper in Lab 1. Type in and correctly execute the script. Follow directions to plant *bugs* in the scripts to practice debugging techniques.

- Module 3 – “The Shell Environment”

This module provides a review shell variables, aliases, and initialization files. This module defines many standard shell variables and aliases, and shows user-defined variables and aliases. Then the module describes how and where these may be placed in shell initialization files.

Lab exercise – Create new users and modify the system-wide and user-specific initialization files with shell variables and aliases.

- Module 4 – “Regular Expressions and grep”

This module defines and shows the use of specific regular expression characters utilized by the `grep` utility. This module explains and illustrates the benefit of the `grep` utility.

Lab exercise – Use the `grep` command to search for patterns in text files, and then print out the specified records from the file.



- Module 5 – “The sed Utility”

This module describe and illustrates the use of `sed`, the stream editor. The module shows how to perform non-interactive editing on a text file including adding, removing, and substituting text.

Lab exercise – Use the `sed` command to search for patterns in text files, and then modify the specified records from the file before printing the results to standard output.

- Module 6 – “The `nawk` Programming Language”

This module defines variables and parameters in `nawk`. This module describes and utilizes the extended regular expression characters used by `nawk`.

Lab exercise – Use the `nawk` command to process fields within records in a text data file. The `nawk` scripts processes both numeric and text variables.

- Module 7 – “Conditionals”

This module describes and illustrates shell programming constructs that perform conditional testing using the many forms of the `if` construct. This module also explains positional parameters, `case` constructs, Boolean logic, and the proper way to programmatically exit a script.

Lab exercise – Use the programming constructs to write scripts that test and validate input from the command line through the positional parameters. Scripts also validate path names to determine if the path is a directory or some type of file.

- Module 8 – “Interactive Scripts”

This module illustrates how to use the `read` command to obtain input from standard input, which, by default, is a user’s keyboard device. The module also shows the assignment of file descriptor numbers to text files to simplify file input and output operations.

Lab exercise – Use the `read` command in a script to obtain input from a user, have that input stored and verified before continuing, and ask the user for other information.



- Module 9 – “Loops”

This module describes and illustrates shell programming constructs to perform looping within a shell script. This module describes the `for`, `while`, and `until` loop constructs. Additionally the module describes the menu capability of the Korn shell.

Lab exercise – Write and modify scripts to implement loops so the same operations can be applied to a number of files or directories. Modify an existing lab to include a menu of choices for the user login shell.

- Module 10 – “Advanced Variables, Parameters, and Argument Lists”

This module describes manipulation of string variables, numeric variables, and array variables. This module also covers resetting the values of the positional parameters using the `set` command.

Lab exercise – Write a script that uses metacharacters to extract a substring from a string variable. The value in the string variable is a long path name.

- Module 11 – “Functions”

This module describes the purpose, benefits, and syntax of shell functions.

Lab exercise – Write a script that defines and calls a function. Additionally, write a script that calls a functions not contained within the script but the functions location is referenced within the script using a special shell variable.

- Module 12 – “Traps”

This module describes traps and signals, and shows how traps can be used within a script to selectively stop a user from interrupting the script.

Lab exercise – Write and modify scripts to create traps to catch the signal generated when the user attempts to interrupt the script.



Course Objectives

Upon completion of this course, you should be able to

- Develop and debug scripts
- Use local and environmental variables and shell metacharacters in scripts
- Customize system-wide shell initialization files
- Use regular expression characters with the `grep`, `sed`, and `nawk` utilities
- Write `sed` scripts to perform non-interactive editing tasks
- Write `nawk` scripts to manipulate individual fields within a record
- Write `nawk` scripts to write reports based upon an input file
- Use the exit status of a command to determine if the command succeeded or failed
- Access and process command-line arguments passed into a script
- Develop a USAGE message to display when a script is invoked incorrectly
- Use flow control constructs, such as branching and looping
- Develop interactive scripts
- Perform string manipulation and integer arithmetic on shell variables
- Write a script that uses functions
- Write a script that uses a trap to catch a signal

✓ *Ask the students how many signed up for this course because of the information in the Sun Educational Services course catalog, and what their knowledge and expectations of the objectives stated there are. Use this information as a tool to manage your time in covering the material in this course.*



Skills Gained by Module

The skills for *Shell Programming for System Administrators* are shown in Column 1 of the following matrix. The black boxes indicate the main coverage for a topic; the gray boxes indicate the topic is briefly discussed.

Skills Gained	Module											
	1	2	3	4	5	6	7	8	9	10	11	12
Develop and debug scripts												
Use local and environmental variables and shell metacharacters in scripts												
Customize system-wide shell initialization files												
Use regular expression characters with the grep, sed, and awk utilities												
Write sed scripts to perform non-interactive editing tasks												
Write awk scripts to manipulate individual fields within a record												
Write awk scripts to write reports based upon an input file												
Use the exit status of a command to determine if the command succeeded or failed												
Access and process command-line arguments passed into a script												
Develop a USAGE message to display when a script is invoked incorrectly												
Use flow control constructs, such as branching and looping												
Develop interactive scripts												
Perform string manipulation and integer arithmetic on shell variables												
Write a script that uses functions												
Write a script that uses a trap to catch a signal												



-
- ✓ *Refer students to this matrix as you progress through the course to show them the progress they are making in learning the skills advertised for this course.*



Guidelines for Module Pacing

The following table provides a rough estimate of pacing for this course:

Module	Day 1	Day 2	Day 3	Day 4	Day 5
"About This Course"	A.M.				
"UNIX Shells and Shell Scripts"	A.M.				
"Writing and Debugging Scripts"	A.M.				
"The Shell Environment"	P.M.				
"Regular Expressions and grep"	P.M.	A.M.			
"The sed Editor"		A.M.			
"The nawk Programming Language"		P.M.			
"Conditionals"			A.M.		
"Interactive Scripts"			P.M.		
"Loops"				A.M.	
"Advanced Variables, Parameters, and Argument Lists"				P.M.	
"Functions"					A.M.
"Traps"					A.M.



Topics Not Covered

This course does not describe the following topics. Many of the topics are described in other courses offered by Sun Educational Services:

- Basic UNIX® commands – Covered in SA-118: *Fundamentals of Solaris™ 8 Operating Environment*
- System startup and shutdown procedures – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I*
- How to add a user to the system – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I*
- Logical device names for disks – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I*
- Mounting and unmounting file systems – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I*
- Adding and removing software on the system – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I*
- The JumpStart™ facility – Covered in SA-238: *Solaris™ 8 Operating Environment System Administration I* and SA-381: *Solaris™ JumpStart™*

Refer to the Sun Educational Services catalog for specific information and registration.



How Prepared Are You?

To be sure you are prepared to take this course, can you answer yes to the following questions?

- Are you an experienced UNIX user who is familiar with basic commands, such as `rm`, `cp`, `man`, `more`, `mkdir`, `ps`, and `chmod`?
- Can you create and edit text files using `vi` or a text editor?
- Do you understand the system boot process and proper shutdown procedures?
- Can you create users and passwords and set file permissions?
- Do you understand device naming conventions to mount and unmount file systems?
- Do you know user software package commands, such as `pkgadd`, `pkgrm`, and `pkginfo`?

This course assumes that you have these prerequisite skills and knowledge:

- This is not an introductory course, so you must be comfortable with the operating system commands and must be able to read the online manual pages.
- To write and save scripts, you must be comfortable with some editor.
- You must be familiar with several boot scripts and system shutdown in regard to system backups.
- User creation is a typical system administration task, and it is used in the course as a scripting exercise.
- References to disk devices for the purposes of monitoring and reporting are typical system administration issues and are used in the course as a scripting exercise.
- Software installation of unbundled or third-party software is a typical system administration task, and it is used in the course as a scripting exercise.



- If you learn best from code examples and technical explanations, you will be able to program the lab exercises based on the explanations and examples presented in the lecture.
- ✓ *If any students indicate they cannot do these requirements, meet with them at the first break to decide how to proceed with the class. Do they want to take the class at a later date? Is there some way to get the extra help needed during the week?*
- ✓ *It might be appropriate here to recommend resources from the Sun Educational Services catalog that provide training for topics not covered in this course.*



Introductions

Now that you have been introduced to the course, introduce yourself to each other and the instructor, addressing the items shown on the overhead.



How to Use Course Materials

To enable you to succeed in this course, these course materials use a learning model that comprises the following components:

- **Course map** – An overview of the course content appears in the “About This Course” module so that you can see how each module fits into the overall course goal.
- **Objectives** - What you should be able to accomplish after completing this module is listed here.
- **Lecture** – The instructor will present information specific to the topic of the module. This information helps you learn the knowledge and skills necessary to succeed with the exercises.
- **Exercise** – Lab exercises gives you the opportunity to practice your skills and apply the concepts presented in the lecture.
- **Check your progress** – Module objectives are restated, sometimes in question format, so that before moving on to the next module you are sure that you can accomplish the objectives of the current module.
- **Think beyond** – Thought-provoking questions are posed to help you apply the content of the module or predict the content in the next module.



Course Icons and Typographical Conventions

The following icons and typographical conventions are used in this course to represent various training elements and alternative learning resources.

Icons

Additional resources – Indicates additional reference materials are available.



Demonstration - Indicates a demonstration of the current topic is recommended at this time.



Discussion – Indicates a small-group or class discussion on the current topic is recommended at this time.



Exercise objective – Indicates the objective for the lab exercises that follow. The exercises are appropriate for the material being described.

Note – Additional important, reinforcing, interesting, or special information.



Typographical Conventions

Courier is used for the names of commands, files, and directories, as well as on-screen computer output; for example:

```
Use ls -al to list all files.  
system% You have mail.
```

Courier bold is used for characters and numbers that you type; for example:

```
system% su  
Password:
```

It is also used for each code line that is referenced in text; for example:

```
1. import java.io.*;  
2. import javax.servlet.*;  
3. import javax.servlet.http.*;
```

Courier italic is used for variables and command-line placeholders that are replaced with a real name or value; for example:

To delete a file, type `rm filename`.

Palatino italics is used for book titles, new words or terms, or words that are emphasized; for example:

Read Chapter 6 in *User's Guide*.
These are called *class* options.
You *must* be root to do this.



Notes to the Instructor

Philosophy

The *Shell Programming for System Administrators* course has been created to allow for interactions between you and the student as well as between the students themselves. To enable you to accomplish the course objectives easily and in the time frame given, a series of tools has been developed and support materials created for your discretionary use.

A consistent structure has been used throughout this course. This structure is outlined in the “Course Goal” section. The suggested flow for each module is:

1. Module objectives
2. Context questions and module rationale
3. Lecture information with appropriate overheads
4. Lab exercises
5. Discussion: either as whole class or in small groups

To allow you flexibility and give time for meaningful discussions during the lectures and the small-group discussions, a timing table is included in the “Course Tools” section.

Course Tools

To enable you to follow this structure, the following supplementary materials are provided with this course:

- Course map

The course map allows the students to get a visual picture of the course. It also helps students know where they have been, where they are, and where they are going. The course map is presented in the “About This Course” in the student’s guide.



- Lecture overheads

Overheads for the course are provided in two formats:

You can copy the paper-based overheads onto standard transparencies and use them on a standard overhead projector. These overheads are not provided in the student's guide.

The web browser-based format is in HTML and can be projected using a projection system that displays from a workstation. This format gives the instructor the ability to allow the students to view the overhead information on individual workstations. It also allows better random access to the overheads.

- Small-group discussion

After the lab exercises, it is a good idea to debrief the students. Gather them in the classroom and have them discuss their discoveries, problems, and issues in programming the solution to the problem in small groups of four or five, one-on-one, or one-on-many.



Module	Lecture (Minutes)	Lab (Minutes)	Total Time (Minutes)
"About This Course"			
Module 1 – "UNIX® Shells and Shell Scripts"	45	30	75
Module 2 – "Writing and Debugging Scripts"	45	60	105
Module 3 – "The Shell Environment"	60	30	90
Module 4 – "Regular Expressions and grep"	75	60	135
Module 5 – "The sed Editor"	60	45	105
Module 6 – "The awk Programming Language"	90	120	210
Module 7 – "Conditionals"	120	120	240
Module 8 – "Interactive Scripts"	90	80	170
Module 9 – "Loops"	100	120	220
Module 10 – "Advanced Variables, Parameters, and Argument Lists"	90	90	180
Module 11 – "Functions"	60	75	135
Module 12 – "Traps"	60	30	90

- Module self-check

Each module contains a checklist for students in the "Check Your Progress" section. Give them a little time to read through this checklist before going on to the next lecture. Ask them to see you for items they do not feel comfortable checking off.



Instructor Setup Notes

Purpose of This Guide

This guide provides general information about setting up the classroom. Refer to the README_setup_Instructions file in the SA-245_IN directory for specific information about how to set up this course.

Projection System and Workstation

If you have a projection system for projecting HTML slides and are planning to use the HTML slides, you need to do the following:

- Install the HTML overheads on the workstation connected to the projection system so you can display them with a browser during lecture. To install the HTML overheads, copy the HTML and images subdirectories provided in the SA245_OH directory to any directory on the overhead workstation machine.

Display the overheads in the browser by choosing Open►File and typing the following in the Selection field of the pop-up window:

/location_of_HTML_directory/OH.Title.doc.html

- Set up an overhead-projection system that can project instructor workstation screens.

Note – This document does not describe the steps necessary to set up an overhead projection system because it is not known what will be available in each training center. This setup is the responsibility of each training center.



Course Files

All of the course files for this course are available from the `education.central` server. You can use `ftp` or the `education.central` web site, <http://education.central/Released.html>, to download the files from `education.central`. Either of these methods requires you to know the user ID and password for FTP access. See your manager for these if you have not done this before.

Course Components

This course consists of the following components:

- Instructor guide

The `SA-245_IG` directory contains the FrameMaker files for the instructor's guide (student's guide with instructor notes). The `ART` directory is *required* for printing this guide.

- Student guide

The `SA-245_SG` directory contains the FrameMaker files for the student's guide. The `ART` directory is not required for printing this guide.

- Art

There is no art required for this course.

- Instructor notes

The `SA-245_IN` directory contains the text file `README_setup_Instructions`.



- Overheads

The SA-245_OH directory contains the instructor overheads. There are both HTML and FrameMaker versions of the overheads.

- Lab files

The SA-245_LF directory contains the lab files for this course.

Objectives

Upon completion of this module, you will be able to:

- Describe the role of shells in the UNIX environment
- Describe the standard shells
- Define the components of a shell script
- Write a simple shell script

What Is a Shell?

A shell is a specialized, compiled program that provides an interface between the user and the operating system (kernel). The operating system starts a shell for each user when the user logs in or open a terminal or console window.

The kernel is a specialized program that controls all aspects of the computer's operation. One of the kernel's jobs is to coordinate all of the executing utilities, ensuring that they do not interfere with each other or consume all of the system's resources. Additionally, the kernel schedules and manages all processes on the system.

By interfacing with the kernel, the shell provides a way for the user to execute utilities and other programs.

What Are a Shell's Functions?

The shell has several functions.

Command-Line Interpreter

When you type a command on the command line, the shell interprets the command by parsing the line and handling metacharacters, redirection, and control. It then searches for the command and executes the command.

The shell analyzes each typed line and initiates execution of the requested program.

✓ **The shell takes the command:** `ps -ef | sort +1 | more`
and does the following:

1. The shell breaks up the command line into pieces called words: `ps`, `-ef`, `|`, `sort`, `+1`, `|`, and `more`.
2. The shell determines the purpose of the words: `ps`, `sort`, and `more` are commands, `-ef` and `+1` are arguments, and the `|` is an I/O operation.
3. Based upon the shell-parse order, which is described in Module 3, "The Shell Environment," the shell sets up the output of `ps` to be the input to `sort`, and the output of `sort` to be the input to `more`.
4. The shell locates the `ps`, `sort`, and `more` commands and then executes them in order, applying the arguments as specified.

Programming Language

You can type the commands directly into the shell at the prompt, or the shell can read commands from a file. A file containing shell commands is called a *shell program* or *shell script*. As you perform a task repetitively, you might type the same commands over and over. You can place these commands in a file and execute this script to automate your task.

A shell script can contain commands and programming constructs. In this way, the script can act based on conditions, loop through a series of commands, and test files.

Shell programs are interpreted, not compiled. This means that the shell reads and executes the commands one-by-one. A compiler reads and converts a program to a machine-readable form, called a compiled program, and then the kernel executes the compiled program all at once. This is the reason that even the fastest shell programs always run more slowly than an equivalent program written in a compiled language, such as the C programming language.

Note – A command placed in a shell script is referred to as a statement. For example, `cat` on the command line is a command, and `cat` in a script is a statement. You will see references to both the `cat` command and the `cat` statement.

User Environment

The shell also provides a user environment that can be supplemented using initialization files. These files contain settings for user environment characteristics, such as search paths for finding commands, default permissions on new files, values for variables that other programs use, and many more values that the users can customize to fit their needs.

Available Shells

- ✓ *Following is a list of all available shells in Solaris™ 8 Operating Environment. Only the Bourne and Korn shells need to be mentioned in the lecture.*
- ✓ *The other shells are mentioned because it is the role of the system administrator to choose a login shell for users.*
- ✓ *The default prompts are shown to remind the system administrators that a # is the preferred root prompt.*

Bourne Shell (sh)

The Bourne shell, written by Steve Bourne while he was at AT&T Bell Labs, is the original UNIX shell. It is the preferred shell for shell programming because of its compactness and speed. Its main drawback is that it lacks features for interactive use, such as the ability to recall previous commands (history). The Bourne shell also lacks built-in arithmetic and logical expression handling.

The default shell in the Solaris™ Operating Environment (Solaris 2.x) is the Bourne shell. The standard shell for Solaris system administrative scripts is the Bourne shell.

- ✓ *If the user entry in the /etc/passwd file does not have an entry in the shell field, the user gets a Bourne shell.*
- ✓ */bin/sh is dynamically linked, which means it does not have all the library routines linked into the executable. The output of the ldd command shows the libraries that must be linked at runtime to execute /bin/sh (# ldd /bin/sh).*
- ✓ */sbin/sh is statically linked, which means all the library routines are linked into the executable. The output of the ldd command shows /sbin/sh is not a dynamic executable or shared object (a file name with a .so extension).*
- ✓ *Another test is to verify this difference between /bin/sh and /sbin/sh is to execute the file command against both (# file /bin/sh /sbin/sh).*

You need to know the following about the Bourne shell:

- The full path name of the command is /bin/sh and /sbin/sh
- The default prompt for a non-root user is \$
- The default prompt for a root user is #

C Shell (csh)

The C shell was one of the enhancements to UNIX that was done at the University of California at Berkeley. The C shell was written by Bill Joy while he was at Berkeley. The C shell incorporated features for interactive use, such as *aliases* and *command history*. It also included more convenient programming features, such as an arithmetic, C-like expression syntax. The syntax of C shell programs is very reminiscent of the C programming language, hence the name. These added features make the C shell preferable for interactive use, but they also make it larger and slower than the Bourne shell.

You need to know the following about the C shell:

- The full path name of the command is `/bin/csh`
- The default prompt for a non-root user is `<hostname> %`
- The default prompt for a root user is `<hostname> #`

Korn Shell (ksh)

The Korn shell, written by David Korn at AT&T Bell Labs, is a superset of the Bourne shell; that is, it supports everything in the Bourne shell. In addition, it offers interactive features comparable to those in the C shell. The Korn shell also includes convenient programming features, such as built-in integer arithmetic, arrays, functions, and string-manipulation facilities. The Korn shell is faster than the C shell and runs scripts written for the Bourne shell.

You need to know the following about the Korn shell:

- The full path name of the command is `/bin/ksh`
- The default prompt for a non-root user is `$`
- The default prompt for a root user is `#`

✓ **These three shells, Bourne, Korn, and C, were always a part of the Solaris Operating Environment.**

Other Shells

There are several other shells available.

GNU Bourne-Again Shell (bash)

The GNU Bourne-Again shell is compatible with the Bourne shell. The GNU Bourne-Again shell also incorporates useful features from the Korn and C shells. The arrow keys are automatically mapped for command recall and editing.

You need to know the following about the GNU Bourne-Again shell:

- The full path name of the command is `/bin/bash`
- The default prompt for a non-root user is `bash-2.03$`
- The default prompt for a root user is `bash-2.03#`

Desktop Korn Shell (dtksh)

The Desktop Korn shell is a version of the Korn shell extended to support X, Xt, and Motif facilities from within a shell script. Therefore, you can open windows with text fields, buttons, labels, scroll bars, menus, and so on from within a Desktop Korn shell script. These windows are limited to a CDE windowing environment.

You need to know the following about the Korn shell:

- The full path name of the command is `/usr/dt/bin/dtksh`
- The default prompt for a non-root user is `$`
- The default prompt for a root user is `#`

Job Control Shell (jsh)

The Job Control shell is an interface to the Bourne shell that provides all of the functionality of `sh` and enables job control.

- ✓ *There are no differences between these two executables. To prove this, execute the following commands:*
- ✓ *# ls -i /bin/jsh /bin/sh*
- ✓ *# ls -i /sbin/jsh /sbin/sh*
- ✓ *Although the executables are identical, invoking the shell with the jsh command allows a user to not only to put jobs in the background with a &, but also to list the background processes with jobs, and remove them with kill %PID.*

You need to know the following about the Job Control shell:

- The full path name of the command is /bin/jsh and /sbin/jsh
- The default prompt for a non-root user is \$
- The default prompt for a root user is #

Restricted Shell Command Interpreter (rsh)

The Restricted shell is a limited version of the Bourne shell that restricts logins to user environments in which capabilities are controlled.

- ✓ *For example, in a "restricted shell," the user may not:*
 - *Change the directory from the present one*
 - *Change the value of \$PATH*
 - *Specify path or command names containing /*
 - *Redirect output*
- ✓ *For more information, refer to the specific man page:*

`man -s 1m rsh`

You need to know the following about the Restricted shell:

- The full path name of the command is /usr/lib/rsh
- The default prompt for a non-root user is \$
- The default prompt for a root user is #

Enhanced C Shell (tcsh)

The Enhanced C shell is compatible with the C shell. It also incorporates useful features, such as a command-line editor, programmable word completion, and spelling correction. The arrow keys are automatically mapped for command recall and editing.

You need to know the following about the Enhanced C shell:

- The full path name of the command is `/bin/tcsh`
- The default prompt for a non-root user is `>`
- The default prompt for a root user is `#`

Z Shell (zsh)

The Z shell most closely resembles Korn shell. The Z shell includes many enhancements, such as built-in spelling correction and programmable command completion.

You need to know the following about the Z shell:

- The full path name of the command is `/bin/zsh`
- The default prompt for a non-root user is `<hostname>%`
- The default prompt for a root user is `<hostname>#`

✓ **Question – How do you determine your current shell?**

✓ **Answer – Execute the `ps` command. If the student has stacked a series of shells, use:**

```
ps | sort
```

✓ **Question – How do you change your current shell?**

✓ **Answer – Type in an alternate shell (command) at the prompt; for example, `csh` or `bash`.**

Shells in This Course

This course limits the discussion of shells to the Bourne and Korn shells. The Korn shell is a superset of the Bourne shell, so all references to shell implies it is known to both. When a feature is a Korn addition, it is noted as such.

Subshells – Child Processes

The shell determines the type of program that was executed. It is either a compiled (executable) program or a script file for one of the available shells. If it is an executable program, a new process is created for the program by means of a *fork*, which makes a copy of the shell process. The new process is called a *child process* or *subshell*. The kernel loads the program into the child process (called *execing* the program). The program then begins running, and the shell process waits until the child process finishes.

When the program being executed is a shell script, the execution process is a little different. The shell creates a new shell process (also by *forking*). This new process (subshell) reads the lines from the shell script file one at a time. The subshell reads, interprets, and executes each line as if it had come from the keyboard. The entire execution process that is described in this module is repeated for each line of the shell script.

While the subshell processes the lines of the shell script, the parent shell waits for it to finish. When there are no more lines in the shell script file to read, the subshell terminates and the parent shell awakes, displaying a new prompt.

Figure 1-1 on page 1-11 shows the order of execution.

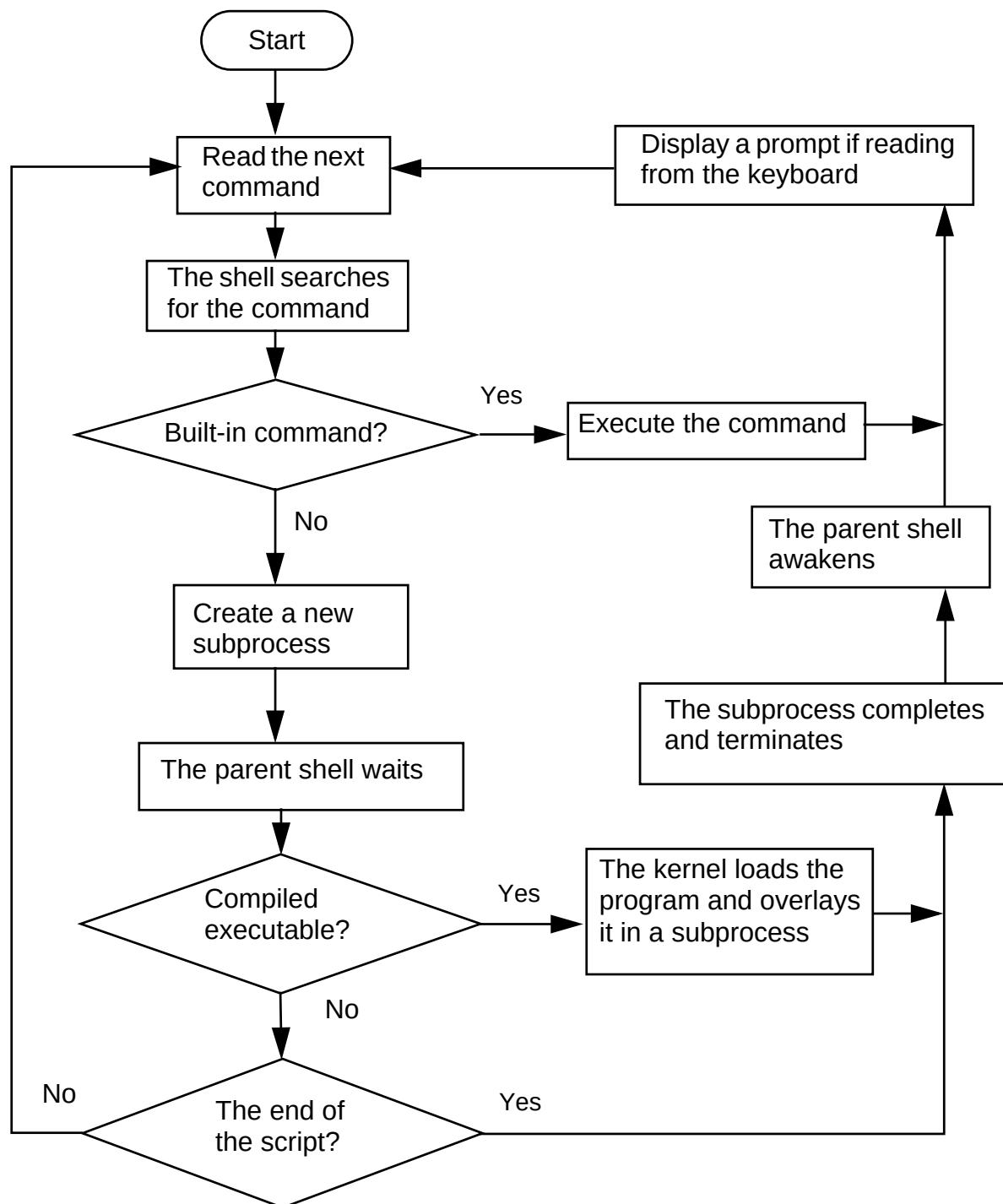


Figure 1-1 Shell Script Order of Execution

What Is a Shell Script?

A shell script is a file that contains shell and UNIX commands. Like compiled executable programs, the shell script has a specific purpose and is reusable. When the commands in the shell script are ordered and error-free, the tasks can be carried out efficiently and correctly by the user who executes the script.

All scripts, programs, and procedures use the following rules:

- They should execute without error
- They perform the task for which they are intended
- They ensure that the program logic is clearly defined or apparent
- They do not incorporate unnecessary work into the program or procedure

Procedures are common in every day work. For example, procedures are used when:

- The system boots up
- You create a user on the system
- You log in

All programs and procedures are a series of tasks that are organized into a logical sequence, sometimes with certain sequences being repeated.

Developing a Script

The structure of a shell script is flexible. You must ensure correct logic, flow control, and efficiency before the tasks can be carried out easily and correctly by the user who executes the script.

When you start to develop your script, determine the types of information needed before writing the script. For example, your script might:

- Prompt a user for a directory name
- Create an archive file representing the directory
- Compress the archive file

✓ *The script should:*

- *Prompt the user for the directory name*
- *Read and store the directory name in a variable*
- *Verify that the directory exists and that the user has permissions for the directory*
- *Execute the `tar` command and create the archive file (perhaps in a temporary directory)*
- *Compress the archive file (into the current directory)*
- *Notify the user of the name of the compressed file*

Name other script components and syntax. Use examples you have looked over, such as system boot scripts.

✓ *Discuss these components with the students; they form the answer to one of the lab questions:*

- *Comments*
- *Information displays*
- *Conditional testing*
- *Loops*
- *Arithmetic*
- *String manipulation*
- *Variable manipulation and testing*
- *Argument and option handling*

Programming Terminology

Table 1-1 describes terminology used when designing and writing programs or procedures.

Table 1-1 Terminology

Term	Meaning
Logic flow	The overall design of the program or procedure. The logic flow determines the logical sequence of the tasks that are involved in the program or procedure so that a successful and controlled outcome is achieved.
Loop	A portion of the procedure that is performed one or more times.
User input	Information that is provided by an external source, during the running of the program or procedure, that is used within the program or procedure. This information is stored so that it can be recalled when required.
Conditional branch	A logical point in the program or procedure when a condition determines the actions that are subsequently performed.
Command control	Testing the exit status of a command to control whether a portion of code should be performed.

Logic-Flow Design

A program must follow a logical order. When designing a program or procedure, start with the flow of logic for that program.

A number of standard methods are used in computing. One of the simplest methods of logic-flow design is itemized lists. By itemizing the list of processes involved in the program, you can describe each task, or process, and refer to each individual task by its associated number.

If you start by writing the tasks in a descriptive format using the English language, the program is in an understandable form. Later, you can transform the English-language statements into the appropriate computer-language statements.

Here is an example of a logic-flow design. This example procedure describes the process of adding new users to your system.

1. Do you want to add a user?
 - a. If Yes:
 1. Enter the user's name.
 2. Choose a shell for the user.
 3. Determine the user's home directory.
 4. Determine the group to which the user belongs.
 - b. If No, go to Step 3.
2. Do you want to add another user?
 - a. If Yes, go to Step 1.a.
 - b. If No, go to Step 3.
3. Exit.

This example shows a possible repetitive loop, that is controlled by the number of users, between Steps 1.a and 2.a.

The user must be provided with information, such as “These are the available shells (sh, ksh, csh). Which would the user prefer?”

Additionally, input from the user must be obtained and stored; for example, the choice for user name, shell, and group.

Example Bourne Script: echoscript1.sh

The echoscript1.sh script uses some familiar commands to display information about the workstation.

```
# cat echoscript1.sh
#!/bin/sh

clear
echo "SCRIPT BEGINS"

echo "Hello $LOGNAME"
echo

echo "Todays date is: \c"
date '+%m/%d/%y'

echo "and the current time is: \c"
date '+%H:%M:%S%n'

echo "Now a list of the processes in the current shell"
ps

echo "SCRIPT FINISHED!!"
```

- ✓ *The specification of full path names to commands is not necessary if you plan to be logged in when you execute the script and you are sure that your PATH variable uses the correct version of every command (/bin/ps instead of /usr/ucb/ps).*
- ✓ *If you are executing this script from cron, you must supply full path names and redirect output and errors.*

Example Korn Script: echoscript2.ksh

The echoscript2.ksh script uses some familiar commands to display information about the workstation. The Korn shell version uses the print command rather than the echo command.

```
$ cat echoscript2.ksh
```

```
#!/bin/ksh
```

```
clear
```

```
print "SCRIPT BEGINS"
```

```
print "Hello $LOGNAME"
```

```
print
```

```
print -n "Todays date is: "
```

```
date '+%m/%d/%y'
```

```
print -n "and the current time is: "
```

```
date '+%H:%M:%S%n'
```

```
print "Now a list of the processes in the current shell"
```

```
ps
```

```
print "SCRIPT FINISHED!!"
```

Example Boot Script: /etc/init.d/volmgt

This system script starts and stops the volume manager daemon (vold). Notice the system commands used. Module 7, “Conditionals,” revisits the script and looks at each line to define what is specifically being performed.

```
$ cat /etc/init.d/volmgt
#!/sbin/sh
#
# Copyright (c) 1997-1998 by Sun Microsystems, Inc.
# All rights reserved.
#
#ident  "@(#)volmgt      1.6      98/12/14 SMI"

case "$1" in
'start')
    if [ -f /etc/vold.conf -a -f /usr/sbin/vold ]; then
        echo 'volume management starting.'
        /usr/sbin/vold >/dev/msglog 2>&1 &
    fi
    ;;

'stop')
    /usr/bin/pkill -x -u 0 vold
    ;;

*)
    echo "Usage: $0 { start | stop }"
    exit 1
    ;;

esac
exit 0
```

✓ *Full path names are used in the UNIX commands. They are required because they are executed during system boot and no PATH variable is set.*

Exercise: UNIX Shells and Shell Scripts



Exercise objective – In this lab, you answer questions pertaining to the Solaris Operating Environment-supplied shells and write a simple shell script on paper based on the specified requirements.

Preparation

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

When writing the script on paper, you may want to execute commands on the system to ensure you have the correct command and option to obtain the prescribed output.

Tasks

1. Describe the functions of the UNIX shells.

2. Name and describe the three standard shells found in the Solaris Operating Environment.

3. Name three components of a shell script.

4. On paper, write an ordered list of shell commands to yield the following output:

▼ The system name (hint: use `uname`)

▼ The hardware platform (for example, SUNW, Ultra-5_10) (hint: use `uname`)

▼ Processor-specific information including clock speed (hint: use `psrinfo`)

▼ The total number of processes running on the system (hint: use `ps` and `wc`)

The output should resemble the following:

The name of the machine is ultrabear

The machine platform type is SUNW, Ultra-5_10

Specific processor information for this machine is
Status of processor 0 as of 05/03/00
Processor has been on-line since 05/03/00 08:40:20
The sparcv9 processor operates at 360 MHz
and has a sparcv9 floating point processor

Currently the total number of processes
running on this machine is 75

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Describe the functions of the UNIX shells.

They provide:

- ▼ *Command-line interpretation*
- ▼ *A programming language*
- ▼ *Interactive user environment*

2. Name and describe the three standard shells found in the Solaris Operating Environment.

- ▼ *Bourne shell – The original UNIX shell written at AT&T Bell Labs. The preferred shell for scripting because of its compactness and speed. It lacks features often expected by users for frequent interactive use.*
- ▼ *C shell – Written at the University of California at Berkeley. The programming constructs were borrowed from the C language, hence the name of the shell. It includes the history and alias capabilities frequently used by users and programmers.*
- ▼ *Korn shell – Written at AT&T Bell Labs. This shell uses the programming constructs of the Bourne shell and the history and alias capabilities of the C shell and then adds features, such as integer arithmetic, arrays, and string manipulation.*

3. Name three components of a shell script.

- ▼ *Comments*
- ▼ *Information displays (output)*
- ▼ *Conditional testing*
- ▼ *Loops*
- ▼ *Arithmetic*
- ▼ *String manipulation*
- ▼ *Variable manipulation and testing*
- ▼ *Argument and option handling*

4. On paper, write an ordered list of shell commands to yield the following output. (In Module 2, “Writing and Debugging Scripts,” the script will be modified, entered into the system using an editor, and tested.)
- ▼ The system name (hint: use `uname`)
 - ▼ The hardware platform (for example, `SUNW, Ultra-5_10`) (hint: use `uname`)
 - ▼ Processor-specific information including clock speed (hint: use `psrinfo`)
 - ▼ The total number of processes running on the system (hint: use `ps` and `wc`)

The output should resemble the following:

```
The name of the machine is ultrabear
```

```
The machine platform type is SUNW, Ultra-5_10
```

```
Specific processor information for this machine is
Status of processor 0 as of 05/03/00
Processor has been on-line since 05/03/00 08:40:20
The sparcv9 processor operates at 360 MHz
and has a sparcv9 floating point processor
```

```
Currently the total number of processes
  running on this machine is    75
```

The commands to produce the output should resemble the following:

```
echo
echo "The name of the machine is \c"
uname -n          # uname -n gives the hostname
echo

echo "The machine platform type is \c"
uname -i          # uname -i gives the hardware platform
echo

echo "Specific processor information for this machine is:"
psrinfo -v
echo

echo "Currently the total number of processes "
echo "  running on this machine is \c"
ps -ef | tail +2 | wc -l      # wc -l gives number of lines
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Describe the role of shells in the UNIX environment
- ☐ Describe the standard shells
- ☐ Define the components of a shell script
- ☐ Write a simple shell script

Objectives

Upon completion of this module, you will be able to:

- Start a script with #!
- Put comments in a script
- Put commands in a script
- Change permissions on the script
- Execute a script
- Debug a script

Creating Shell Scripts

A shell script is a text file that contains a sequence of UNIX commands. The shell script is often a command sequence for which you have a repeated use. Typically, you execute the sequence of commands in the shell script by entering the name of the shell script on the command line.

To create a shell script, create a file, and put UNIX commands into it. UNIX commands include standard utilities, user programs, and the names of other scripts that you need to accomplish your task.

Note – If you put the names of other scripts in your script, be sure they have *read* and *execute* permission so they will run.

A script file can have any name following the conventions of regular file names in the operating-system environment. Just as you would when creating a regular file, do not to use a name that is a UNIX command or a built-in command in the shell.

- ✓ *Suggest to the students that they give the script a descriptive name that does not conflict with existing commands or scripts.*
- ✓ *To best verify that the name will not be in conflict, try commands, such as:*
 - *which scriptname*
 - *whereis scriptname # note /usr/ucb/whereis*
 - *grep scriptname /var/sadm/install/contents*

The example script on the next page uses the `echo` command to inform the user the output to expect before the actual command creating this output is called. It is considered good practice in writing scripts to inform the user of what is happening so they have an idea of whether the script is running correctly.


```
$ vi firstscript.sh
#!/bin/sh

clear
echo "SCRIPT BEGINS"

echo "Hello $LOGNAME!"
echo

echo "Todays date and time: \c"
date
echo

mynum=21
myday="Monday"

echo "The value of mynum is $mynum"
echo "The value of myday is $myday"
echo

echo "SCRIPT FINISHED!!"
echo
```

- ✓ *Have the students create this script. On the next few pages, they will be asked to make the file executable and test it.*
- ✓ *Note: The shell prompt used throughout the course book is a "\$ " even though the students are assumed to be logged in as root. Depending on the shell the student uses, the prompt can be different. Tell students that the prompt can be changed and they should not depend on the prompt to tell them whether they are root.*

Executing a Shell Script

To execute a script, give it execute permission, and execute it as a command. This allows you to use it just like any other command; for example:

```
$ chmod 744 scriptname
$ scriptname
```

This is the preferred and most common method for executing a shell script. A subshell is created to execute the specified script. Give execute permission only to users who need to execute the script.

- ✓ **As an alternative to `chmod 744 scriptname`, the students could use:**
`chmod u+x scriptname`
- ✓ **Try to dissuade the students from using the typical `chmod a+x scriptname` as their scripts are often ones that only root should execute. (See permissions on `/etc/init.d` scripts in the example directory.)**

When a script is executed in a subshell, the variables, aliases, and functions created and used in the script are only known in the subshell. After the script finishes and control returns to the parent shell, the variables, functions, and other changes to the state of the shell made by the script are no longer known.

- Generally, you only execute a script using the shell command to invoke certain options on a script that you do not have permission to execute (*or do not want to*).

```
$ ksh scriptname
$ sh scriptname
```

Again, a subshell is created to execute the specified script. This is used in situations when you want the shell to start with specific options not explicitly specified in the script. The typical situation is when you want to turn on and off debugging for the entire script.

- To execute a script with debugging:

```
$ ksh -x scriptname
$ sh -x scriptname
```

- To run the script in the current shell:

```
$ . ./scriptname
```

To execute the shell script in the current shell, you do not need execute permission on the script. You are running the commands in the current shell, so any operations you perform on shell variables or aliases take affect in the current shell and is seen after the shell script terminates.

Executing firstscript.sh

The following is the firstscript.sh script.

```
$ cat firstscript.sh
#!/bin/sh

clear
echo "SCRIPT BEGINS"

echo "Hello $LOGNAME!"
echo

echo "Todays date and time: \c"
date
echo

mynum=21
myday="Monday"

echo "The value of mynum is $mynum"
echo "The value of myday is $myday"
echo

echo "SCRIPT FINISHED!!"
echo
```

Variables created by the script are not known to the shell that executed it. The script is executed in a subshell, and changes made there do not affect the parent shell.

```
$ chmod 744 firstscript.sh
```

```
$ ./firstscript.sh
SCRIPT BEGINS
Hello root!
```

```
Todays date and time: Fri May  5 11:38:13 MDT 2000
```

```
The value of mynum is 21
The value of myday is Monday
```

```
SCRIPT FINISHED!!
```

```
$ echo $mynum
```

```
$ echo $myday
```

```
$ sh firstscript.sh
```

```
SCRIPT BEGINS
```

```
Hello root!
```

```
Todays date and time: Fri May  5 11:38:57 MDT 2000
```

```
The value of mynum is 21
```

```
The value of myday is Monday
```

```
SCRIPT FINISHED!!
```

```
$ echo $mynum
```

```
$ echo $myday
```

Starting a Script With #!

When running a script that has *execute* permission by typing the script name on the command line, you should know the subshell (sh, csh, ksh, bash, or other subshell) that will run the script.

The first line of the script determines the shell that is created as the interpreter of the script. The first two characters on the first line in a script are `#!`. The current shell interprets what follows as the path name for the subshell to execute the script.

Note – *First characters of the file or the file begins with the characters,* means exactly that. There are no blank lines or spaces before these characters.

In the following examples, the specified shell is forked as the subshell to run the script.

```
#!/bin/sh
```

```
#!/bin/csh
```

```
#!/bin/ksh
```

Although the syntax `#! path for shell` allows the script writer to specify exactly in what shell the script should be run, not all operating systems recognize this syntax. Therefore, scripts written in this way might not run in exactly the same way on all operating systems.

✓ *Earlier, it was discussed what the subshell would be for a script that did not contain any special characters at the beginning of the file. In this example look at which subshell is invoked when the script file begins with any of the characters #, :, or #!.*

1. If the very first character in a script is #, and the second character is not !, then the subshell that runs the script is the same as the parent shell.
2. If the very first character in a script is :, then the subshell that runs the script is:
 - *A Bourne shell if the parent shell is a Bourne or C shell.*
 - *A Korn shell if the parent shell is a Korn shell.*
3. If the very first two characters in a script are #!, then the current shell interprets what follows as the path name for the subshell to run the script.

Base the shell you choose on two simple rules:

- For a system boot script, use the Bourne shell (/sbin/sh).

Because it is possible that only the root file system may be mounted, use the only shell that exists in the root file system, /sbin/sh. Remember the system library files are in /usr/lib.

✓ *Speed is the issue here, plus the syntax is then the same as the other boot scripts.*

✓ *Realize that if the boot script is executed from /etc/rc2.d or /etc/rc3.d, you can assume that /usr will be mounted; in that case, you can alternatively use /bin/sh.*

- For a typical script, use the shell that is most comfortable to you or the one that supports all the features you desire.

Hence, if you want to use the alias feature or true integer variables, use the Korn shell. If you know the C language, the C shell might be the most comfortable shell for you to use.

Putting Comments in a Script

The persons who write scripts usually are not the only persons who read them. Many persons run scripts written by others. If they view the contents of the script file to see what the script does, it is helpful if the author of the script included some explanations in comments.

It is a good practice to put comments into programs and shell scripts. The comments should explain the purpose of the script and should explain any specific lines that might be especially confusing.

The example script, `scriptwithcomments.sh`, has a comment at the beginning of the script explaining what the script does when it runs. The line with the `date` statement contains a comment explaining the output produced by the `date` statement.

```
$ cat scriptwithcomments.sh
#!/bin/sh

# This script clears the window, greets the user,
# and displays the current date and time.

clear                                # Clear the window
echo "SCRIPT BEGINS"

echo "Hello $LOGNAME!"              # Greet the user
echo

echo "Todays date and time: \c"
date                                # Display current date and time
echo

mynum=21                            # Set a local shell variable
myday="Monday"                      # Set a local shell variable

echo "The value of mynum is $mynum"
echo "The value of myday is $myday"
echo

echo "SCRIPT FINISHED!!"
echo
```



```
$ ./scriptwithcomments.sh
```

```
SCRIPT BEGINS
```

```
Hello user1!
```

```
Todays date and time: Fri May 5 13:44:48 MDT 2000
```

```
The value of mynum is 21
```

```
The value of myday is Monday
```

```
SCRIPT FINISHED!!
```

The addition of comments did not affect the execution of the script unless a syntactical error was introduced when the comments were added. Remember the comments are there for documentation purposes, so someone reading the script will have an idea of what will occur when the script is executed.

✓ *You might want to have the students:*

- `cp firstscript scriptwithcomments`
- `vi scriptwithcomments` *(and add comments)*
- `./scriptwithcomments`

✓ *You might want to wait until all have executed the script correctly before proceeding.*

Comments are sometimes the first lines entered in a shell script. The comments can list the step-by-step operations that need to take place. Once completed, you can follow each comment line by the operating system commands to carry out the operation.

Adding the Debugging Statement

When a script does not work properly, you need to determine the location of the problem. The shell provides a debugging mode. You can run either the entire script in debug mode or just a portion of the script.

To run an entire script in debug mode, add `-x` after the `#!/bin/ksh` on the first line:

```
#!/bin/ksh -x
```

To run an entire script in debug mode from the command line, add a `-x` to the `ksh` command used to execute the script:

```
$ ksh -x script_name
```

You can run several portions of a script in debug mode by placing a `set -x` at the point where debugging is to begin and a `set +x` where you want it to stop. This can be done as many times in the script as you want.

The debug options are shown in Table 2-1.

Table 2-1 Debug Statement Options

Option	Meaning
<code>set -x</code>	Prints the statements after interpreting metacharacters and variables
<code>set -v</code>	Prints the statements before interpreting metacharacters and variables
<code>set -f</code>	Disables file name generation (using metacharacters)

The `set -x` option allows you to see the statement line after the shell has interpreted any metacharacters and performed any statement, variable, or file name substitutions. For the portion of the script file running in this debug mode, each statement is output, preceded by `+`, before the statement itself is executed.

```
cmd1
set -x
cmd2
.
.
set +x
```

✓ *Explain why the students might want to use the debug controls.*

Debug Mode Controls

The `set -v` statement is similar to `set -x`, except it shows the statement line *before* the shell performs any interpretation or substitution. When you use these two options, with `set -xv`, the shell displays the statement lines both before and after interpretation and substitution, so that you can see how the shell has used the statement line in the script.

For the following statement in a shell script:

```
echo $HOME      # echo the HOME directory path
```

The statement line, before interpretation (`set -v`) is:

```
echo $HOME      # echo the HOME directory path
```

The statement line, after interpretation (`set -x`) is:

```
+ echo /export/home/user200
```

If both options are turned on, the `-v` line is always displayed before the `-x` line. Also, the `+` character does not precede the `-v` line.

The `set -f` option turns off the shell's file name substitution (globbing) capability. This, in effect, disables the special meaning of characters, such as `*` and `?`, when used as part of a file or directory name.

To turn on the option, you must give the statement `set -option`, where *option* is one, or a combination, of the letters `x`, `v`, and `f`.

To turn off the option, you must give the statement, `set +option`, where *option* is one, or a combination, of the letters `x`, `v` and `f`.

You can use the options on the first line of the script by adding them to the end of the shell's path name; for example:

```
#!/bin/ksh -xvf
```

Example: Debug Mode Specified on the #! Line

The following examples show the `debug1.sh` script being run once with no debugging turned on, and then in debug mode. In debug mode, each command is displayed with a `+` in front of it, and then it is executed. If you remove all lines with a `+` at the beginning, the remainder is the output from the normal running of the script.

```
$ cat debug1.sh
```

```
#!/bin/sh
```

```
echo "Your terminal type is set to: $TERM"
echo
```

```
echo "Your Timezone is set to: $TZ"
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc2.d"
ls /etc/rc2.d/*nfs*
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc3.d"
ls /etc/rc3.d/*nfs*
echo
```

```
$ ./debug1.sh
```

```
Your terminal type is set to: dtterm
```

```
Your Timezone is set to: US/Mountain
```

```
Now we will list all the nfs scripts in /etc/rc2.d
/etc/rc2.d/K28nfs.server  /etc/rc2.d/S73nfs.client
```

```
Now we will list all the nfs scripts in /etc/rc3.d
/etc/rc3.d/S15nfs.server
```

```
$ vi debug1.sh
```

```
< append a "-x" to the first line >
```

```
< write and save the file >
```

```
$
```

```
$ cat debug1.sh
```

```
#!/bin/sh -x
```

```
echo "Your terminal type is set to: $TERM"
echo
```

```
echo "Your Timezone is set to: $TZ"
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc2.d"
ls /etc/rc2.d/*nfs*
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc3.d"
ls /etc/rc3.d/*nfs*
echo
```

```
$ ./debug1.sh
```

```
+ echo Your terminal type is set to: dtterm
Your terminal type is set to: dtterm
+ echo
```

```
+ echo Your Timezone is set to: US/Mountain
Your Timezone is set to: US/Mountain
+ echo
```

```
+ echo Now we will list all the nfs scripts in /etc/rc2.d
Now we will list all the nfs scripts in /etc/rc2.d
+ ls /etc/rc2.d/K28nfs.server /etc/rc2.d/S73nfs.client
/etc/rc2.d/K28nfs.server /etc/rc2.d/S73nfs.client
+ echo
```

```
+ echo Now we will list all the nfs scripts in /etc/rc3.d
Now we will list all the nfs scripts in /etc/rc3.d
+ ls /etc/rc3.d/S15nfs.server
/etc/rc3.d/S15nfs.server
+ echo
```

Example: Debug Mode With set -x

The following example shows the debug mode turned on for only a portion of the script.

```
$ cat debug2.sh
#!/bin/sh

set -x
echo "Your terminal type is set to: $TERM"
echo
set +x

echo "Your Timezone is set to: $TZ"
echo

echo "Now we will list all the nfs scripts in /etc/rc2.d"
ls /etc/rc2.d/*nfs*
echo

echo "Now we will list all the nfs scripts in /etc/rc3.d"
ls /etc/rc3.d/*nfs*
echo

$ ./debug2.sh
+ echo Your terminal type is set to: dtterm
Your terminal type is set to: dtterm
+ echo

Your Timezone is set to: US/Mountain

Now we will list all the nfs scripts in /etc/rc2.d
/etc/rc2.d/K28nfs.server  /etc/rc2.d/S73nfs.client

Now we will list all the nfs scripts in /etc/rc3.d
/etc/rc3.d/S15nfs.server
```

Example: Debug Mode With set -v

The following example shows the `-v` debug mode turned on for the entire script. This option:

- Prints the statement prior to executing but without a leading `+` (as the `-x` displays)
- Does not translate metacharacters; therefore, it prints the statement exactly as it is in the script
- Prints comment lines

✓ *The following example is a Korn shell script using Bourne syntax.*

```
$ cat debug3.ksh
#!/bin/ksh

set -v
echo "Your terminal type is set to: $TERM"
echo

echo "Your Timezone is set to: $TZ"
echo

echo "Now we will list all the nfs scripts in /etc/rc2.d"
ls /etc/rc2.d/*nfs*
echo

echo "Now we will list all the nfs scripts in /etc/rc3.d"
ls /etc/rc3.d/*nfs*
echo
```



```
$ ./debug3.ksh
```

```
echo "Your terminal type is set to: $TERM"
Your terminal type is set to: dtterm
echo
```

```
echo "Your Timezone is set to: $TZ"
Your Timezone is set to: US/Mountain
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc2.d"
Now we will list all the nfs scripts in /etc/rc2.d
ls /etc/rc2.d/*nfs*
/etc/rc2.d/K28nfs.server  /etc/rc2.d/S73nfs.client
echo
```

```
echo "Now we will list all the nfs scripts in /etc/rc3.d"
Now we will list all the nfs scripts in /etc/rc3.d
ls /etc/rc3.d/*nfs*
/etc/rc3.d/S15nfs.server
echo
```

Example: Debug Mode With `set -o noglob`

The following example shows the Korn-specific syntax using debug option names rather than the debug flags. In this example, you turn on the debug option for only a portion of the script.

Table 2-2 Comparison of Equivalent Syntax

Bourne and Korn Options	Korn Shell-Specific Options
<code>set -x</code>	<code>set -o xtrace</code>
<code>set +x</code>	<code>set +o xtrace</code>
<code>set -v</code>	<code>set -o verbose</code>
<code>set +v</code>	<code>set +o verbose</code>
<code>set -f</code>	<code>set -o noglob</code>
<code>set +f</code>	<code>set +o noglob</code>

```
$ cat debug4.ksh
#!/bin/ksh

echo "Your terminal type is set to: $TERM"
echo

echo "Your Timezone is set to: $TZ"
echo

set -o noglob
echo "Now we will list all the nfs scripts in /etc/rc2.d"
ls /etc/rc2.d/*nfs*
echo
set +o noglob

echo "Now we will list all the nfs scripts in /etc/rc3.d"
ls /etc/rc3.d/*nfs*
echo
```

```
$ ./debug4.ksh
```

```
Your terminal type is set to: dtterm
```

```
Your Timezone is set to: US/Mountain
```

```
Now we will list all the nfs scripts in /etc/rc2.d  
/etc/rc2.d/*nfs*: No such file or directory
```

```
Now we will list all the nfs scripts in /etc/rc3.d  
/etc/rc3.d/S15nfs.server
```

Exercise: Writing Shell Scripts

Exercise objective – In this lab, you type in and correctly execute the script you wrote in the previous module exercise. You also execute modified versions of the scripts from this module. The modifications are based on specified errors you are directed to enter. Doing this exercise helps to show the benefit of the different debug options (`-x`, `-v`, and `-f`).

Preparation

Locate the script you wrote for the exercise in the last module.

Refer to the lecture notes as necessary to perform the following tasks.

Change the directory to `mod2/lab` prior to beginning the exercise.

Tasks

1. Type the script you wrote for the end-of-module exercise in Module 1, “UNIX® Shells and Shell Scripts.” Name the script `echoscript`. Given the topics of the current module, make sure you:
 - ▼ Include a first line that calls the Bourne shell as the interpreter
 - ▼ Add a comment to state the script’s purpose
 - ▼ Add any other comments that you deem necessary
2. Change the permissions on `echoscript` so you can execute the script as a command.
3. Execute the `echoscript` script. If this script does not execute correctly, determine the problem, reedit, and execute again. If debug options would help in fixing the error, add debugging commands.
4. Copy the `debugscript.sh` script to `debug1.sh`. Read `debug1.sh` and note the different debug options entered in comment statements. This makes it easier to execute the script and test the option that gives you the most useful information.

5. Execute `debug1.sh`. Does it appear to execute correctly?
6. Misspell one of the `echo` statements near the middle of the script. Re-execute the script, and record the error message given. Then correct the spelling.
7. Change the statement in `debug1.sh` that prints out the value of the `timezone` variable. Therefore, change:

```
echo "Your Timezone is set to: $TZ"
```

to:

```
echo "Your Timezone is set to: $tz"
```

8. Re-execute `debug1.sh`, and write down the output given for the modified line.
9. Now re-execute the `debug1.sh` script after turning on each of the three different debug options one at a time. Record if that option gives you any help in determining the problem.

```
set -v _____
```

```
set -x _____
```

```
set -f _____
```

10. Which debug options gave you information to help point to the variable name problem?

-
11. Copy the `debug1.sh` script to `debug2.sh`.

12. Modify the `debug2.sh` script to:

- ▼ Run the Korn shell interpreter rather than the Bourne shell
- ▼ Turn on the verbose debug mode with the Korn shell-specific syntax (not `set -v`) just before the first `echo` statement

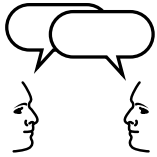
13. Execute the `debug2.sh` script, and compare the output to the output of `debug1.sh` executing with the `-v` option. Are the two script outputs the same?
-

14. Write a template shell script that contains basic information that should be included for each script that you write to provide documentation, in the form of comments, for each script you write in the future. Later when creating a new script, copy the template, fill in the information, and proceed to enter the statements into the script.

The template should include:

- ▼ The shell interpreter
- ▼ The name of the script
- ▼ The author of the script
- ▼ The date the script was written
- ▼ A brief description of the purpose of the script

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Type the script you wrote for the end-of-module exercise in Module 1, “UNIX® Shells and Shell Scripts.” Name the script `echoscript`. Given the topics of the current module, make sure you:
 - ▼ Include a first line that calls the Bourne shell as the interpreter
 - ▼ Add a comment to state the scripts purpose
 - ▼ Add any other comments that you deem necessary

```
$ vi echoscript.sh
```

```
#!/bin/sh
```

```
# This script will print useful information about the current machine.
# It will print the machine name, model type, specific processor
# information, and the current number of processes running.
```

```
echo
echo "The name of the machine is \c"
uname -n          # uname -n gives the hostname
echo
```

```
echo "The machine platform type is \c"
uname -i          # uname -i gives the hardware platform
echo
```

```
echo "Specific processor information for this machine is:"
psrinfo -v
echo
```

```
echo "Currently the total number of processes "
echo "  running on this machine is \c"
ps -ef | tail +2 | wc -l      # wc -l gives number of lines
```

2. Change the permissions on `echoscript` so you can execute the script as a command.

```
$ chmod 744 echoscript.sh
```


3. Execute the `echoscript` script. If this script does not execute correctly, determine the problem, reedit, and execute again. If debug options would help in fixing the error, add debugging statements.

```
$ ./echoscript.sh
```

4. Copy the `debugscript.sh` script to `debug1.sh`. Read `debug1.sh` and note the different debug options entered in comment statements. This makes it easier to execute the script and test the option that gives you the most useful information.

```
$ cp debugscript.sh debug1.sh
```

```
$ cat debug1.sh
```

5. Execute `debug1.sh`. Does it appear to execute correctly?

```
$ ./debug1.sh
```

Yes, it executes correctly.

6. Misspell one of the `echo` statements near the middle of the script. Re-execute the script, and record the error message given. Then correct the spelling.

```
$ ./debug1.sh
```

```
Your terminal type is set to: dtterm
```

```
Your Timezone is set to: US/Mountain
```

```
./debug1.sh: ehco: not found      <-- NOTE: ERROR MESSAGE
```

To list all the NFS scripts in /etc/rc2.d:

```
/etc/rc2.d/K28nfs.server  /etc/rc2.d/S73nfs.client
```

To list all the NFS scripts in /etc/rc3.d:

```
/etc/rc3.d/S15nfs.server
```

7. Change the statement in `debug1.sh` that prints out the value of the `timezone` variable. Therefore, change:

```
echo "Your Timezone is set to: $TZ"
```

```
to:
```

```
echo "Your Timezone is set to: $tz"
```

8. Re-execute `debug1.sh`, and write down the output given for the modified line.

Your Timezone is set to:

9. Now re-execute the `debug1.sh` script after turning on each of the three different debug options one at a time. Record if that option gives you any help in determining the problem.

`set -v`

Output:

```
echo "Your Timezone is set to: $tz"
```

Your Timezone is set to:

You can see the misspelled variable in the `echo` statement.

`set -x`

Output:

```
+ echo Your Timezone is set to:
```

```
Your Timezone is set to:
```

```
+ echo
```

You cannot see the name of the variable as it is was interpreted and replaced by its value (the default value is a null string).

`set -f`

Output:

Your Timezone is set to:

You cannot see the name of the variable as it is was interpreted and replaced by its value (the default value is a null string).

10. Which debug options gave you information to help point to the variable name problem?

The `-v` option was best because it showed the misspelling of the variable as part of the debug output.

11. Copy the `debug1.sh` script to `debug2.sh`.

```
$ cp debug1.sh debug2.sh
```

12. Modify the `debug2.sh` script to:

- ▼ Run the Korn shell interpreter rather than the Bourne shell

Change `#!/bin/sh` to `#!/bin/ksh`

- ▼ Turn on the verbose debug mode with the Korn shell-specific syntax (not `set -v`) just before the first `echo` statement

Add the statement `set -o verbose` before to the first `echo` statement.

13. Execute the `debug2.sh` script, and compare the output to the output of `debug1.sh` executing with the `-v` option. Are the two script outputs the same?

In one window:

```
$ ./debug1.sh
```

In another window:

```
$ ./debug2.sh
```

The two scripts have the same output.

14. Write a template shell script that contains basic information that should be included for each script that you write to provide documentation, in the form of comments, for each script you write in the future. Later when creating a new script, copy the template, fill in the information, and proceed to enter the statements into the script.

The template should include:

- ▼ The shell interpreter
- ▼ The name of the script
- ▼ The author of the script
- ▼ The date the script was written
- ▼ A brief description of the purpose of the script

\$ cat template.sh

#!/bin/ksh

Script name: template

Author: Student name

Date written: xx/xx/xx

#

**# Purpose: This script serves as a documentation template for future
scripts.**

#

\$ cat template.ksh

#!/bin/ksh

Script name: template

Author: Student name

Date written: xx/xx/xx

#

**# Purpose: This script serves as a documentation template for future
scripts.**

#

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Start a script with #!
- ☐ Put comments in a script
- ☐ Put commands in a script
- ☐ Change permissions on the script
- ☐ Execute a script
- ☐ Debug a script

Objectives

Upon completion of this module, you will be able to:

- Use Bourne and Korn shell variables
- Assign values to shell variables
- Display the value of shell variables
- Make variables available to subprocesses using `export`
- Display the value of environment variables
- Unset shell and environment variables
- Customize the user environment using the `.profile` file
- Perform arithmetic operations
- Create and use aliases
- Display aliases and the values assigned to them
- Define the built-in aliases
- Customize the Bourne and Korn shell environments
- Use the tilde expansion and command substitution features of the Korn shell

Reviewing User Startup Scripts

When the user logs in using `sh` or `ksh`, several configuration scripts run:

- `/etc/profile` runs first when a user logs in.
- `$HOME/.profile` runs second when a user logs in.
- `$HOME/.kshrc` runs third for Korn shell users if the `ENV` variable is set.

The `/etc/profile` Script

The first script to run is `/etc/profile`. The system administrator sets up this file. This is the same file for all users of the system. Generally, this file contains only a few commands, such as setting a default `umask` and printing the message of the day.

The `$HOME/.profile` Script

The second script to run is the user's `.profile`. This file resides in the user's home directory. This file is run each time the user logs in. The file does not exist by default. Generally the file contains environment variables, such as the user's preferred editor, the default printer, and the location of application software.

An Example `$HOME/.profile` Script

The example `.profile` file sets and then exports variables. The `MANPATH` variable is set to the directories in which the `man` utility should search for the online manual pages. The `ENV` variable is set to the full path name of the file that is read each time a new Korn shell is started. The `EDITOR` variable is set to the `vi` editor. Applications, such as `cron` and `edquota`, use this variable. Exporting the variables makes them part of the environment, which is inherited by all subshells and subprocesses.

Note – Variables are described later in this module.

```
$ cat /.profile
# This file initially did NOT exist for root
MANPATH=$MANPATH:/usr/share/man:/usr/dt/share/man:/usr/java1.2/man
ENV=$HOME/.kshrc
EDITOR=vi
export MANPATH ENV EDITOR
```

- ✓ *The ENV variable only has special meaning to the Korn shell.*
- ✓ *You might want to ask the students about what they typically have in their .profile files. Often, there will be variables to support software, such as environment variables required by database software that specify the location of the software or the software libraries.*

The following three lines are special because they allow root to change the shell from Bourne to Korn after the initial login. This benefits a root user who wants the default to be Bourne in case of a system catastrophe when only the root file system is available. If there is no failure, the shell then changes to Korn, in which the history, alias, or other features of the Korn shell are available.

Therefore, you refine the .profile to test for the existence of /usr/bin/ksh, and only then execute these lines if the file exists.

```
SHELL=/usr/bin/ksh    # This variable sets the default shell
                      # for subshells
export SHELL
/usr/bin/ksh          # Invokes a Korn shell as a child of the login shell
```

The \$HOME/.kshrc Script

The Korn shell executes the \$HOME/.kshrc file if the ENV variable is set. This happens each time a Korn shell is spawned, either at the request of the user or when a shell spawns a Korn subshell.

An Example \$HOME/.kshrc Script

The following .kshrc script first sets the PS1 variable, which is the prompt. The exclamation point within the string expands to the current command number in the history file.

Setting the trackall option causes the Korn shell to execute commands faster by creating aliases for commands for which it has to search.

Lastly, aliases are established to save keystrokes.

Note – The `set` command and aliases are described later in this module.

```
$ cat .kshrc
PS1="HOSTNAME ! $ "
set -o trackall
alias l='ls -laF'
alias ll='ls -aF'
alias hi='fc -l'
alias c=clear
```

- ✓ *For your information, the 1988 version of `ksh` in the Solaris 8 Operating Environment automatically tracks some commands to aliases when `trackall` is off. For example, `date` and `vi` get tracked but not `cal`. Is this a bug?*
- ✓ *It is recommended you avoid talking about the `$HOME/.dtprofile` file unless you are extremely sure you understand how this works with the common desktop environment (CDE). It is known that the `$HOME/.dtprofile` has a variable named `DTSOURCEPROFILE` that, when set to true (the default), allows the shell file (`$HOME/.kshrc`) to be read by the windows opening in CDE. The behavior of `.dtprofile` might change in a subsequent release of the Solaris Operating Environment.*
- ✓ *Currently, if a `dtterm` is started with the `-ls` option, both the `$HOME/.profile` and `$HOME/.kshrc` are read after the `/etc/profile` file. This is the default for a console window.*

Modifying a Configuration File

If you make changes to the `/etc/profile` or `$HOME/.profile` file, the shell does not read the changes until the next time you log in. To avoid having to re-log in, use the `dot` command to tell the shell to reread the `.profile` file:

```
$ . /.profile
```

By invoking a script with the `dot` command, you tell the shell (parent) to read the commands in the *script_name* file and execute them without spawning a child process. Any definitions in the script then becomes part of the present environment.

Most shell scripts execute in a private environment. Any variables they set are not available to other scripts. The shell (or script) that invokes a script is called a *parent*, and the script that is being invoked is called the *child*. Variables are not inherited unless they are exported with the `export` command.

A Review of Variables

Shell variables are capitalized by convention. The shell maintains two lists of variables—those local to the current shell and those global to all shells (environment variables). You can use the `set` and `env` statements to display local and environmental variables, respectively.

The following is a partial output of the `set` and `env` statements. Many of the same variables appear in both the local and environment variable list.

```
$ set
AB2_DEFAULTSERVER=http://docs.sun.com/
CUE_HOSTNAME=sunray10
DISPLAY=:46.0
DOMAIN=renegades.Central.Sun.COM
DOMAIN_COUNT=1
DTSOURCEPROFILE=true
DTUSERSESSION=milner-sunray10-46
DTXSERVERLOCATION=local
EDITOR=vi
ERRNO=25
FCEDIT=/bin/ed
LANG=C
LOGNAME=milner
LPDEST=hutchence
MAIL=/var/mail/milner
MAILCHECK=600
MANPATH=/usr/dt/man:/usr/man:/usr/openwin/share/man:/usr/man:/usr/openwin
/share/man:/usr/dt/man:/usr/dist/local/man/5.7
PRINTER=hutchence
PS1='$ '
PS2='> '
PS3='#? '
PS4='+ '
PWD=/home/milner/K-Shell-Course/InstructorGuide/Examples
SHELL=/bin/ksh
TZ=US/Mountain
```

```
$ env
DTSOURCEPROFILE=true
DOMAIN=renegades.Central.Sun.COM
DTUSERSESSION=milner-sunray10-46
EDITOR=vi
LOGNAME=milner
MAIL=/var/mail/milner
CUE_HOSTNAME=sunray10
PRINTER=hutchence
DISPLAY=:46.0
TERM=dtterm
TZ=US/Mountain
LPDEST=hutchence
DOMAIN_COUNT=1
```

Note – Variables are case-sensitive so, once defined, they must be spelled with the exact uppercase and lowercase letters. Variable names have a limit of 255 characters.

- ✓ *Variable names can contain uppercase or lowercase letters, digits, and underscores. Variable names cannot begin with a digit. Some of the boot scripts show mixed-case variable names. Be sure to use meaningful variable names.*

Special Shell Variables

Several special shell variables are available to users of the shell. The shell sets the value of the variable upon creation or termination of a process.

Process Identification

One of these variables is the \$, which contains the process identification number of the current process. Use this variable to create file names that are unlikely to already exist.

```
$ echo $$  
8873  
$ sh  
$ echo $$  
17716  
$ exit  
$ echo $$  
8873
```

Exit Status

This integer value is referred to as the *exit status* of the last executed command (program, script, or shell statement).

The ? variable provides the exit status of the most recent foreground process. The command determines if it ran successfully, and it sets this variable to 0 if it succeeded and to a nonzero value if it did not succeed. You can think of this as equating success with zero errors occurring and equating failure with one or more errors occurring or the command could not do what was requested.

```
$ grep "root" /etc/passwd  
root:x:0:1:Super-User:/:/sbin/sh  
$ echo $?  
0
```

```
$ grep "rot" /etc/passwd  
$ echo $?  
1
```

The `exit` statement terminates execution of the entire script. It is most often used if the input requested from the user is incorrect, a command ran unsuccessfully, or some other error occurred.

The `exit` statement in a shell script takes an optional argument, which is an integer. This number is passed back to the parent shell, where it is stored in the shell reserved variable `?`.

Background Process Identification

The shell allows you to run a command in the background using the `&` operator. To find the process identification number (PID) of the last background job started, you can echo the `!` variable.

```
$ date &
[1]      17983
$ Fri Feb 18 12:06:44 MST 2000

[1] +   Done                  date &
$ echo $!
17983
```

Creating Variables in the Shell

To set a variable in the shell, use the syntax:

var=value

Do not place spaces around the = sign. If the value contains spaces or special characters, use single or double quotes; for example:

`name="Susan B. Anthony"`

To display the value of a shell variable, use the `echo` command and place a `$` immediately in front of the variable name.

When you have finished with a variable, you can unset the value and release the resources with the `unset` command; for example:

```
$ MYNUM=21
$ MACHTYPE=sparc
$ echo $MYNUM
21
$ echo $MYNUM $MACHTYPE
21 sparc
$ unset MYNUM
$ echo $MYNUM $MACHTYPE
sparc
$ echo $EDITOR
vi
```

Exporting Variables to Subshells

Variables that are created in a particular shell are not known outside that shell. These variables are referred to as *local* variables, in that they are “local to” (known only in) the current shell.

Subshells of a shell do not automatically inherit the variables of their parent shell. Only the variables that are *exported* are passed onto subshells of the parent shell. Variables that are exported are referred to as *environment* variables.

To export a variable (with its current value) to subshells of a shell, use the following command:

```
export variable_name1 variable_name2 ...
```

Note – A subshell can change the value of a variable it inherits from its parent; however, the change does not affect the value of the variable in the parent shell. Thus, subshells cannot alter values of variables in the parent shell.

The following example creates two variables in the current shell, *x* and *name*. The *name* variable is then exported to be inherited by any subshells of the parent.

```
$ x=25
$ name="Marion Morrison"
$ echo $x $name
25 Marion Morrison
$ echo $$
429
$ export name
```


A subshell is created by invoking a new Korn shell using the `ksh` command. You can see that a new shell is started because of the change in the value of the `$` shell variable. This variable always holds the PID of the current process (shell).

```
$ ksh
$ print $$
430
$ print $x

$ print $name
Marion Morrison
$ export name="Marlena Dietrich"
$ print $name
Marlena Dietrich
$ exit
```

When you try to access the value of the variable `x` using the `echo` command, no output is shown because the child shell does not know the variable `x`. When you access the value of the variable `name`, however, the value of the variable is output because this variable was exported in the parent shell.

Changing the contents of `name` in the subshell has no effect on the value of the `name` variable in the parent.

```
$ echo $$
429
$ echo $name
Marion Morrison
```

Reserved Variables

The shell knows about and uses several variables. Use care when modifying the values for any of these variables. Before modifying the value, you should know how the shell uses the variable and how you might affect your interaction with the shell.

To learn about variables not listed in this module, you might want to read the man pages for `sh` or `ksh`, depending on your choice for an interactive shell.

Table 3-1 Shell Variables

Variable	Meaning
HOME	The path of user's login directory.
IFS	Inter-field separators, which hold a string of characters that are used as inter-field separators. By default, this string includes a space, a tab, and a newline. Do not change this string.
LOGNAME	The user's login name.
MAILCHECK	How often, in seconds, the <code>mail</code> daemon checks for mail.
OPTIND	The <code>getopts</code> statement uses this variable during parsing of options on command line.
PATH	The search path for commands.
PS1	The prompt. It defaults to <code>\$</code> .
PS2	The prompt used when there is a continuation of a command line. It defaults to <code>></code> .
PS3	The prompt used within a <code>select</code> statement. It defaults to <code>#?</code> .
PS4	The prompt used by the shell debug utility. It defaults to <code>+</code> .
PWD	The present working directory.
SHELL	The shell defined for the user in the <code>passwd</code> file.
TERM	The terminal type, which is used by the <code>vi</code> editor and other commands.

Review of Quoting Characters

With the exception of the letters and the digits, practically every key on the keyboard is a *metacharacter* in some context or other (including the space, the tab, and the newline). A metacharacter is a character that represents something other than its literal self.

When you want a metacharacter to be taken literally, you must tell the shell to leave it alone (rather than interpreting it) by using one of the three following mechanisms:

- Backslash – Turns off the special meaning of the following character
- Single quotes – Turns off the special meaning of all characters
- Double quotes – Turns off the special meaning of characters except \$, ', ", and \

Backslash

If you need to have the special meaning of any character *turned off* and the character to have its literal value, precede it with the backslash (\) character, which is often called an *escape* character. You can use the backslash to turn off the special meaning of any shell metacharacter.

```
$ name=jessica
$ echo "Hello \ $name. \
> Where are you going?"
Hello $name. Where are you going?
```

A Pair of Single Quotes

A pair of single quotes, '...', turns off the special meaning of *all* characters enclosed by the single quotes, including the \ character.

Note – A single quote character is not allowed to appear within a pair of single quotes.

```
$ echo a          b
a b
$ echo 'a          b'
a          b

$ num=25
$ echo 'The value of num is $num'
The value of num is $num
```

A Pair of Double Quotes

A pair of double quotes "... " turns off the special meaning of all characters enclosed by the double quotes, except for the four characters \$, ', ", and \. Within double quotes, you can use the backslash to selectively turn off the special meaning of these four characters.

Note – A double quote character is not allowed to appear within a pair of double quotes.

```
$ num=25
$ echo "The value of num is $num"
The value of num is 25

$ name=Roger
$ echo "Hi $name, I'm glad to meet you!"
Hi Roger, I'm glad to meet you!

$ echo "Hey $name, the time is 'date'"
Hey Roger, the time is Fri Jul  9 16:52:50 PDT 1993
```

Shell Command Substitution

Command substitution allows the output of one command to be used as an argument to another command.

- The Bourne shell uses `' '` (back quotes)
- The Korn shell supports the older Bourne shell syntax
- The Korn shell uses the `$(command)` syntax

```
$ ksh
```

```
$ date +%H:%M
```

```
12:50
```

```
$ print "The time is now $(date +%H:%M)."
```

```
The time is now 12:50.
```

```
$ cat currentinfo.ksh
```

```
#!/bin/ksh
```

```
# outputs the day, time, & current month.
```

```
day=$(date +%D)
```

```
time=$(date +%T)
```

```
print "Today is $day."
```

```
print
```

```
print "The time is $time."
```

```
print
```

```
print "This month's calendar:"
```

```
cal
```

```
$ ksh currentinfo.ksh
```

```
Today is 07/08/00.
```

```
The time is 12:15:03.
```

```
This month's calendar:
```

```
July 2000
```

```
S M Tu W Th F S
```

```
1
```

```
2 3 4 5 6 7 8
```

```
9 10 11 12 13 14 15
```

```
16 17 18 19 20 21 22
```

```
23 24 25 26 27 28 29
```

```
30 31
```

Korn Shell Tilde Expansion

You can use the tilde character (~) at the beginning of words. Five possible interpretations exist:

~/	The full path name of current user's home directory
~ <i>username</i>	The full path name of <i>username</i> 's home directory
~+	The full path name of the working directory
~-	The previous working directory
-	The previous working directory

Examples

The `cd` command accepts a hyphen to change the working directory to the previous working directory.

```
$ pwd
/users/milner/examples
$ cd ../course_notes/mod1
$ pwd
/users/milner/course_notes/mod1
$ cd -
$ pwd
/users/milner/examples
```

Arithmetic Operations on Bourne Shell Variables

The Bourne shell only assigns string values to variables in the assignment statement. The Bourne shell has no built-in ability to perform arithmetic; therefore, the external statement `expr` treats the variables as numbers and performs the arithmetic operation.

Note – The `expr` statement is space-sensitive and expects each operand and operator to be separated by white spaces.

The `expr` statement recognizes the operators shown in Table 3-2.

Table 3-2 `expr` Operators

Operator	Example
+ Addition	<code>num2='expr "\$num1" + 25'</code>
- Subtraction	<code>num3='expr "\$num1" - "\$num2"'</code>
* Multiplication	<code>num3='expr "\$num1" * "\$num2"'</code>
/ Division	<code>num4='expr "\$num2" / "\$num1"'</code>
% Integer remainder	<code>num5='expr "\$num1" % 3'</code>

Note – You must precede the multiplication operator with a backslash because it is a metacharacter of the shell.

✓ *Confirm the previous note by turning on debugging in the shell or (`set -x`) before executing the multiplication statement.*

The following example shows that the Bourne shell has no built-in arithmetic capability.

```
$ num1=5
$ echo $num1
5

$ num2=$num1+10
$ echo $num2
5+10
```

The following example shows that the `expr` statement must have white space around operators and operands. Also notice the `expr` statement automatically sends the value to standard output.

```
$ echo $num1
5

$ expr $num1 + 7
12

$ expr $num1+7
5+7

$ echo $num1
5
```

The following example shows the need for properly quoting the multiplication operator.

```
$ expr $num1 * 2
expr: syntax error

$ expr "$num1 * 2"
5 * 2

$ expr $num1 \* 2
10
```

When performing arithmetic, the result of the operation is stored into a variable. This is accomplished in the Bourne shell by placing the `expr` statement on the right side of a variable assignment statement, as shown in the following examples.

```
$ echo $num1
5

$ num2='expr $num1 + 25'
$ echo $num2
30

$ num3='expr $num1 + $num2'
$ echo $num3
35
```



```
$ num4='expr $num1 \* $num2'
$ echo $num4
150
```

```
$ num5='expr $num2 / $num1'
$ echo $num5
6
```

```
$ num6='expr $num1 % 3'
$ echo $num6
2
```

Arithmetic Operations on Korn Shell Variables

Arithmetic evaluation is invoked by placing an integer expression within two pairs of parentheses: `(( . . . ))`.

For readability, place a space before and after any arithmetic operator within the double pair of parentheses.

Table 3-3 summarizes the math operators.

Table 3-3 Arithmetic Operations on Integers

Operator	Operations	Example	Result
+	Addition	<code>((x = 24 + 25))</code>	49
-	Subtraction	<code>((x = 100 - 25))</code>	75
*	Multiplication	<code>((x = 4 * 5))</code>	20
/	Division	<code>((x = 10 / 3))</code>	3
%	Modulo (remainder)	<code>((x = 10 % 3))</code>	1

All calculations are performed using integer arithmetic, which can sometimes cause minor surprises; for example:

```
$ x=15.38
$ y=15.72

$ ((z = x + y))
$ echo $z
30
```

Note – Do not put a \$ in front of a variable reference within a calculation. Expansion is automatically performed on all variable references made within the double parentheses.

Everything is integer arithmetic, so you need to be aware of what happens when division is performed in a calculation. For example, in computing the percentage of the eligible voters who actually voted, the following statement would most likely assign 0 to *prct*:

```
((prct = voted / eligible_voters * 100))
```

The following algebraically equivalent statement is the correct way to do this in the Korn shell:

```
((prct = voted * 100 / eligible_voters))
```

None of the variables use \$ within the double pair of parentheses when doing the calculations, which insures that integer arithmetic is performed (not arithmetic on strings).

Arithmetic Precedence

Operations within parentheses are performed first, so you can use a single pair of parentheses around an expression to force it to be evaluated first. Multiplication and division take precedence over addition and subtraction. Beyond that, arithmetic expressions are evaluated from left to right.

1. Expressions within parentheses are evaluated first.
2. *, %, and / have greater precedence than + and -.
3. Everything else is evaluated left-to-right.

The simplest rule to follow is: When there is even the slightest doubt, put in parentheses to force the evaluation order.

The Korn Shell let Statement

The `let` statement is an alternative to the `((...))` statement. It is only used with integer variables.

Type the arithmetic formula with no spaces unless the formula is enclosed in double-quote (") characters. It is also possible to assign a numeric value, using the formula syntax, without using the `let` statement.

It is more common to use the Korn shell's `((...))` syntax instead of the `let` statement; for example:

```
$ let a=a+1
$ echo $a
1
$ let "a = a + 1"
$ echo $a
2
$ let a=b+c
$ echo $a
7
$ ((a = b + c))
$ echo $a
7
$ a=b+c
$ echo $a
7
```

Math in a Script

This script assigns the value 99 to the variable *y*. It then computes the cube of the number entered, the quotient of the number entered divided by 4, and the remainder of the number entered divided by 4. The results then prints with an appropriate message.

Lastly, the script computes the number that was input using the quotient, the divisor 4, and the remainder. That result is then multiplied by 2 and the result saved in the variable *z*. A message involving the value of *z* then prints.

```
$ cat math.ksh
#!/bin/ksh

# Script name: math.ksh

# This script finds the cube of a number, and the
# quotient and remainder of the number divided by 4.

y=99

(( cube = y * y * y ))
(( quotient = y / 4 ))
(( rmdr = y % 4 ))

print "The cube of $y is $cube."
print "The quotient of $y divided by 4 is $quotient."
print "The remainder of $y divided by 4 is $rmdr."

# Notice the use of parenthesis to
# control the order of evaluating.
(( z = 2 * (quotient * 4 + rmdr) ))
print "Two times $y is $z."

$ ./math.ksh
The cube of 99 is 970299.
The quotient of 99 divided by 4 is 24.
The remainder of 99 divided by 4 is 3.
Two times 99 is 198.
```

Korn Shell Aliases

You can create an alias within the Korn shell. Aliases are not available with the Bourne shell.

An alias is a name that you give to a command. Reasons for using aliases include:

- Several versions of a command might exist on the system, and you might want to use a particular one by default. You create an alias that lists the entire path name to that command; for example:

```
alias mycommand=/fullpathname/cmd
```

- You might spell a command incorrectly frequently, so you can make an alias of the incorrect spelling; for example:

```
alias mroe=more
```

- You might want to set up default options to a command; for example:

```
alias dk='df -k'
```

Commands, scripts, or programs that require a user to perform a considerable amount of typing on the command line to execute them are good candidates for aliases.

Removing Aliases

If you do not want to use a particular alias that you have set up, you can delete it using the `unalias` command. The syntax is:

```
unalias aliasname
```

Alias Inheritance

Aliases are not inherited by subshells. Placing the aliases in the `$HOME/.kshrc` file and having the value of `ENV` set to `$HOME/.kshrc` allows new Korn shells to know about the aliases.

Note – Aliases created on the command line are known only in the current shell.

```
$ alias lpgut='lp -d guttenberg'
$ alias lpgut
lpgut='lp -d guttenberg'
```

```
$ ksh
$
$ alias lpgut
lpgut alias not found
$
$ exit
```

```
$ alias lpgut
lpgut='lp -d guttenberg'
```

```
$ unalias lpgut
```

```
$ alias lpgut
lpgut alias not found
```

Automatic (Tracked) Aliases

Once enabled, the Korn shell automatically makes an alias to the full path name of the command whenever you use a UNIX command. If you use the command later, the alias is used instead of searching \$PATH.

To turn on this Korn shell feature, use the following syntax:

```
$ set -o trackall
```

```
$ date
Thur Mar 14 12:10:00 EST 1991
$ alias
date=/usr/bin/date
.
.
.
$
```


- ✓ *The aliases are listed alphabetically, so you might need to search through the list to find the alias you want.*
- ✓ *If a Bourne shell user types “alias,” the user executes /bin/alias, which lists the Korn shell-predefined aliases. This happens because /bin/alias is a shell script that:*
 - *Executes in a Korn subshell; therefore, it knows all predefined ksh aliases*
 - *Sets a variable named cmd to “alias”*
 - *Executes the value of the variable cmd, passing to it all arguments passed to /bin/alias*

Built-in Aliases

Table 3-4 lists some of the predefined aliases in the Korn shell.

In addition to the alias *functions*, you can use the alias *autoload* with function names.

You use the alias *r* to re-execute the previous given command. If followed by a number, it re-executes the command from the history file that has that number as its command number. If it is followed by a string, it re-executes the most recent command that begins with the string given.

Table 3-4 Built-In Aliases

Command	Meaning
<code>functions='typeset -f'</code>	Use this alias to list the names of all functions, with their definitions, that are known in the current shell.
<code>history='fc -l'</code>	This alias displays a list of the 16 most recently given commands. Each command is preceded by its command number.
<code>integer='typeset -i'</code>	Use the <code>integer</code> alias to declare a variable as an integer data type.
<code>nohup='nohup'</code>	Run a command that is immune to the hangup (HUP) and terminate (TERM) signals. If standard output is a terminal, it is redirected to the file <code>nohup.out</code> . Standard error is redirected to follow standard output.
<code>r='fc -e -'</code>	Use this alias to re-execute a previous command.
<code>suspend='kill -STOP \$\$'</code>	This alias issues the <code>kill</code> command with the STOP (SIGSTOP) signal, Signal 23, on the current shell (\$\$). The shell process is placed on the jobs list and might be restarted later with the <code>fg</code> command.

Shell Parse Order

Parsing describes how the shell processes a command line before the execution of the command. The shell has a predefined order in which it interprets or evaluates the different tokens (metacharacters, spaces, keywords, and so on) on the command line.

Based upon the rules built into the shell, it interprets these different tokens in a specific order, the parse order, and then executes the command. The following list shows the parse order for the Bourne and Korn shells. Given that the Korn shell has extra features, ignore any Korn shell-specific features if you are reading this specifically for the Bourne shell.

1. Read command
2. Keywords

✓ **For example:** *if, else, fi, do, done, and time. You can verify these with "whence -v".*

3. Alias
4. Built-in commands

✓ **For example:** *alias, bg, cd, echo, and let. You can verify these with "whence -v".*

5. Functions
6. Tilde expansion
7. Command substitution
8. Arithmetic expression substitution
9. Metacharacters for expansion of filenames
10. Command or script lookup
11. Execute the command

✓ **If students are unfamiliar with the metacharacters for expansion of file names, see Appendix E, "Shell Metacharacters for Pattern Matching for File Names."**

✓ **If you have a group of students that are unfamiliar with metacharacters, you might want to teach the information in the appendix. It not only has a description of the metacharacter, it has examples for each that list (existing) files from standard system directories.**

Exercise: Shell Environment



Exercise objective – In this lab, you set and unset variables. Also you edit the `/etc/skel/local.profile` file to add a variable because this file is copied to `$HOME/.profile` for each new Bourne or Korn shell user created with `admintool`. You may also choose to modify your `root.profile` to invoke a Korn shell.

Preparation

Refer to the lecture notes as necessary to perform the following tasks.

In the first part of the exercise, you create and manipulate variables. Whenever you are asked to display a list of variables, guess whether your variable will be in the specific shell or environmental list.

You need to execute `admintool` and bring up the graphical user interface (GUI) prior to creating the new users.

Tasks

1. Create the `var1` shell variable, and initialize it to `twenty`.
2. Create the `var2` shell variable, and initialize it to `21`.
3. Create the `var3` shell variable, and initialize it to `temp`.
4. Display the values of all three variables.
5. Display the list of local shell variables, and determine if either `var1`, `var2`, or `var3` is in the listing.
6. Display the list of environmental variables, and determine if either `var1`, `var2`, or `var3` is in the listing.
7. Use the `export` command to make `var1` and `var3` environmental variables.
8. Display the list of environmental variables, and determine if either `var1` or `var3` is in the listing.
9. Remove the `var3` variable with the `unset` command.

10. Display the list of local shell variables, and determine if either `var1`, `var2`, or `var3` is in the listing.
 11. Display the list of environmental variables, and determine if either `var1`, `var2`, or `var3` is in the listing.
 12. Create a new *terminal* window by executing the `dtterm` command. If necessary, you can execute the command using the absolute path name, `/usr/dt/bin/dtterm`.
 13. In the new terminal window, display the list of local shell variables, and determine if either `var1` or `var2` is in the listing.
-

14. In the new terminal window, display the list of environmental variables, and determine if either `var1` or `var2` is in the listing.
-

15. For the benefit of all your Bourne and Korn shell users, add the following to `/etc/profile`:

```
ENV=$HOME/.kshrc
EDITOR=vi
export ENV EDITOR
```

16. For `root`, set the prompt to the *hostname* followed by a `#`.
17. Modify your `/.profile` to make the Korn shell your login shell.
18. Create a `/.kshrc`. Add some Korn shell commands that you would find useful; for example:

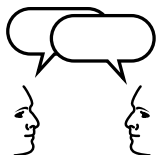
```
set -o vi
alias ll='ls -l'
alias pss='ps -ef | sort +1n | more'
```

19. Edit the `/etc/skel/local.profile` file to make the following change. This is the file that `admintool` copies to a new Bourne or Korn shell users' home directory and renames it `.profile`.
 - a. Append the `/usr/dt/bin` directory onto the `PATH` variable.
 - b. Create a Bourne and a Korn shell user with `admintool`. Use the information in the following table:

User Name:	user1	user2
User ID:	<next available>	<next available>
Primary Group:	10	10
Login Shell:	Bourne	Korn
Password:	cangetin	cangetin
Home Dir Path:	/export/home/user1	/export/home/user2

20. Log out and login as either user, and verify that the changes made to `/etc/skel/local.profile` were copied into the users' `$HOME/.profile`.
21. Log out and log back in as `root`.
22. Write a script to which you can pass an integer number. The output from the script should be the number and the value of that number multiplied by itself.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Create the `var1` shell variable, and initialize it to twenty.

```
$ var1=twenty
```

2. Create the `var2` shell variable, and initialize it to 21.

```
$ var2=21
```

3. Create the `var3` shell variable, and initialize it to temp.

```
$ var3=temp
```

4. Display the value of all three variables.

```
$ echo $var1 $var2 $var3  
twenty 21 temp
```

5. Display the list of local shell variables, and determine if either `var1`, `var2`, or `var3` is in the listing.

```
$ set | grep var  
var1=twenty  
var2=21  
var3=temp
```

6. Display the list of environmental variables, and determine if either `var1`, `var2`, or `var3` is in the listing.

```
$ env | grep var
```

7. Use the `export` command to make `var1` and `var3` environmental variables.

```
$ export var1 var3
```

8. Display the list of environmental variables, and determine if either `var1` or `var3` is in the listing.

```
$ env | grep var  
var1=twenty  
var3=temp
```

9. Remove the `var3` variable with the `unset` command.

```
$ unset var3
```


10. Display the list of local shell variables, and determine if either `var1`, `var2`, or `var3` is in the listing.

```
$ set | grep var
var1=twenty
var2=21
```

11. Display the list of environmental variables, and determine if either `var1`, `var2`, or `var3` is in the listing.

```
$ env | grep var
var1=twenty
```

12. Create a new *terminal* window by executing the `dtterm` command. If necessary, you can execute the command using the absolute path name, `/usr/dt/bin/dtterm`.

```
$ dtterm
```

13. In the new terminal window, display the list of local shell variables, and determine if either `var1` or `var2` is in the listing.

```
$ set | grep var
var1=twenty
```

14. In the new terminal window, display the list of environmental variables, and determine if either `var1` or `var2` is in the listing.

```
$ env | grep var
var1=twenty
```

15. For the benefit of all your Bourne and Korn shell users, add the following to `/etc/profile`:

```
ENV=$HOME/.kshrc
EDITOR=vi
export ENV EDITOR
```

16. For `root`, set the prompt to the *hostname* followed by a `#`.

```
<vi /.profile>
PS1="'uname -n'# "
export PS1
```

17. Modify your `/.profile` to make the Korn shell your login shell.

```
<vi and append to the end of /.profile>
SHELL=/usr/bin/ksh
export SHELL
/usr/bin/ksh
```

18. Create a `/.kshrc`. Add some Korn shell commands that you would find useful; for example:

```
set -o vi
alias ll='ls -l'
alias pss='ps -ef | sort +1n | more'
```

19. Edit the `/etc/skel/local.profile` file to make the following change. This is the file that `admintool` copies to a new Bourne or Korn shell users' home directory and renames it `.profile`.

- a. Append the `/usr/dt/bin` directory onto the `PATH` variable.

```
PATH=/usr/bin:/usr/ucb:/etc:/usr/dt/bin:.
```

- b. Create a Bourne and a Korn shell user with `admintool`. Use the information in the following table.

User Name:	user1	user2
User ID:	<next available>	<next available>
Primary Group:	10	10
Login Shell:	Bourne	Korn
Password:	cangetin	cangetin
Home Dir Path:	/export/home/user1	/export/home/user2

20. Log out and login as either user, and verify that the changes made to `/etc/skel/local.profile` were copied into the users' `$HOME/.profile`.

21. Log out and log back in as `root`.

22. Write a script to which you can pass an integer number. The output from the script should be the number and the value of that number multiplied by itself.

```
#!/bin/ksh

# Purpose: To take a value from the parameter list and multiple it by
itself.
#
# Name: multiply

if [ $# -ne 1 ]; then
    echo "Usage: multiply num_value"
    exit 1
fi

integer num
num=$1

print
print "The number is: $num"
(( result = num * num ))
print "The number multiplied by itself is: $result"

print
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use Bourne and Korn shell variables
- ☐ Assign values to shell variables
- ☐ Display the value of shell variables
- ☐ Make variables available to subprocesses using `export`
- ☐ Display the value of environment variables
- ☐ Unset shell and environment variables
- ☐ Customize the user environment using the `.profile` file
- ☐ Perform arithmetic operations
- ☐ Create and use aliases
- ☐ Display aliases and the values assigned to them
- ☐ Define the built-in aliases
- ☐ Customize the Bourne and Korn shell environments
- ☐ Use the tilde expansion and command substitution features of the Korn shell

Objectives

Upon completion of this module, you will be able to:

- Use and describe regular expressions
 - Describe the `grep` command
 - Use the `grep` command to find patterns in a file
 - Use regular expression characters with the `grep` command
-
- ✓ *The `grep`, `sed`, and `nawk` utilities are included at this point in the course to give the student practice and assimilation time, and so that more interesting labs can be undertaken later in the course.*
 - ✓ *Point out to students that `grep`, `sed`, and `nawk` are not necessary utilities to know from a shell programming perspective, but they are essential tools with which administrators should be totally and intimately familiar.*
 - ✓ *These modules form a sojourn into the `grep`, `sed`, and `nawk` utilities, and the course returns to shell programming in Module 7, “Conditionals,” in which these skills will be required for successful completion of the labs.*
 - ✓ *Additional functionality of `grep` is in Appendix C, “Additional `grep` Functionality.”*

What Is grep?

As with most UNIX commands, the word **grep** is a shorthand version of a longer word or phrase. The shorthand version comes from commands in the **ex** editor. The meaning is **g** (globally) search for a **re** (regular expression) and **p** (print) the results; thus, **grep**.

The **grep** utility searches text files for the specified pattern and prints all lines that contain that pattern. If no files are specified, **grep** assumes it will receive text from standard input.

Consider the following scenario. A user comes to you and says that the **msxyz** program on their machine has locked up their machine, and the user cannot get the program to halt. It is your job to find the process and stop it.

The **ps -ef** command gives you a long list of processes that are running. The output is probably too long to find this user's process. What you want is a single line or just a specific list of processes.

```
$ ps -ef | grep 'msxyz'
```

The **grep** command takes the output of the **ps -ef** command as its input. The **grep** command performs a search for the string **msxyz** and prints the results, which gives you specific lines to review.

Currently, you likely have multiple terminal and console windows open. To see those specific processes, you can execute a **ps** command and search for the **dtterm** command.

```
$ ps -ef | grep 'dtterm'
 352 ??      0:00 dtterm
 353 ??      0:13 dtterm
 354 ??      0:11 dtterm
1766 pts/5   0:00 dtterm
```

grep Options

grep has options that modify the behavior of the command, as shown in Table 4-1.

Table 4-1 grep Options

Option	Meaning
-i	Ignores uppercase and lowercase
-c	Prints the count of lines that match
-l	Prints the names of the files in which the lines match
-v	Prints the lines that do not contain the search pattern
-n	Prints the line numbers

The -i option specifies that grep ignores the case of the letters in the search pattern. In the following example, grep does a case-insensitive search for the pattern the.

```
$ grep -i 'the' /etc/default/login
# Set the TZ environment variable of the shell.
# ULIMIT sets the file size limit for the login. Units are disk blocks.
# The default of zero means no limit.
# ALTShell determines if the SHELL environment variable should be set
# PATH sets the initial shell PATH variable
<output truncated>
```

Compare this to the output of the following command, which only prints the lines of text that match the pattern The.

```
$ grep 'The' /etc/default/login
# The default of zero means no limit.
# bad password is provided. The range is limited from
# The SYSLOG_FAILED_LOGINS variable is used to determine how many failed
```

The -c option counts the number of lines that match the pattern. It then prints the count and not the actual lines that matched the pattern.

```
$ grep -ci 'the' /etc/default/login
17
```

```
$ grep -c 'The' /etc/default/login
3
```

To search for a string in many files and to have the output only list the file in which the string is found, use the `-l` option. This is often useful when you want to feed the output of `grep` to another utility to process the list.

```
$ grep -l 'grep' /etc/init.d/*
/etc/init.d/ab2mgr
/etc/init.d/afbinit
/etc/init.d/cacheefs.daemon
/etc/init.d/cron
/etc/init.d/dtlogin
```

To find a search pattern in a large file, print the line number before each match using the `-n` option. This is useful when you are editing files.

```
$ grep -n 'share' /etc/init.d/nfs.server
14:      # Clean up old /etc/dfs/sharetab - remove all nfs entries
16:      if [ -f /etc/dfs/sharetab ] ; then
17:          >/tmp/sharetab.$$
21:          >>/tmp/sharetab.$$
22:      done </etc/dfs/sharetab
<output truncated>
```

The `-v` option prints lines that do not contain the search pattern.

```
$ grep -v 'root' /etc/group
other::1:
staff::10:
sysadmin::14:
nobody::60001:
noaccess::60002:
nogroup::65534:
```


Regular Expression Metacharacters

A regular expression (RE) is a pattern of characters that match the same characters in a search. Regular expressions allow you to specify patterns for which to search in text. Metacharacters give additional meaning to the patterns as shown in Table 4-2.

Table 4-2 grep Metacharacters

Metacharacter	Function
\	Escapes the special meaning of an RE character
^	Matches the beginning of the line
\$	Matches the end of the line
\<	Matches the beginning of word anchor
\>	Matches the end of word anchor
[]	Matches any one character from the specified set
[-]	Matches any one character in the specified range
*	Matches zero or more of the preceding character
.	Matches any single character

Note – When using any of these regular expression characters with the `grep` command, it is safest to use quotes around the entire pattern. This is recommended as some of the regular expression characters used by `grep` are also metacharacters to one or more shells, and the shell might use the metacharacter as a file name metacharacter.

These metacharacters provide a powerful way of searching files for specific occurrences of a pattern.

- ✓ *You might want to recommend the students use single (') quotes around the pattern because it hides more of the metacharacters from the shell.*

Regular Expressions

Using a regular expression, you can search the current process table for any process that contains a capital letter, which is accomplished by using the following range as the pattern to the `grep` command:

```
$ ps -ef | grep '[A-Z]'
  UID    PID  PPID  C    STIME TTY          TIME CMD
  root    259    254   1 08:31:41 ?           0:52 /usr/openwin/bin/Xsun :0
-nobanner -auth /var/dt/A:0-o9aWfa
  root    248      1   0 08:31:34 console  0:00 /usr/lib/saf/ttymon -g -h
-p ultrabear console login: -T sun -d /dev/console -
  root    278    260   0 08:32:13 ?           0:00 /bin/ksh
/usr/dt/bin/Xsession
  root    349    341   0 08:32:26 ?           0:01 dtfile -session dtreaWva
  root    327    324   0 08:32:15 pts/3    0:00 -sh -c      unset DT;
DISPLAY=:0;          /usr/dt/bin/dtsession_res -merge
  root    324    278   0 08:32:15 pts/3    0:00 /usr/dt/bin/sdt_shell -c
unset DT;            DISPLAY=:0;          /usr/dt/bin/dt
<output truncated>
```

If you were only interested in current processes that contained the capital letter A, you could limit the pattern to specifically that character.

```
$ ps -ef | grep 'A'
  root    259    254   1 08:31:41 ?           0:52 /usr/openwin/bin/Xsun :0 -
nobanner -auth /var/dt/A:0-o9aWfa
  root    327    324   0 08:32:15 pts/3    0:00 -sh -c      unset DT;
DISPLAY=:0;          /usr/dt/bin/dtsession_res -merge
  root    324    278   0 08:32:15 pts/3    0:00 /usr/dt/bin/sdt_shell -c
unset DT;            DISPLAY=:0;          /usr/dt/bin/dt
```

Escaping a Regular Expression

A `\` (backslash) followed by a single character matches that character. Thus, a `\$` matches a dollar sign and a `\.` matches a period. The purpose is to divest a metacharacter of its special meaning.

Consider that the `$` is a regular expression character that matches the end of a line.

```
$ grep '$' /etc/init.d/nfs.server
#!/sbin/sh
#
# Copyright (c) 1997-1999 by Sun Microsystems, Inc.
# All rights reserved.
#
#pragma ident  "@(#)nfs.server 1.30    99/06/10  SMI"

[ ! -d /usr/bin ] && exit

# Start/stop processes required for server NFS
<output truncated>
```

The output contains all the lines from the script as the `$` matches the end line for each line in the script. You can verify this with the `wc` command.

```
$ grep '$' /etc/init.d/nfs.server | wc -l
128

$ wc -l /etc/init.d/nfs.server
128 /etc/init.d/nfs.server
```

To display only the lines from the `nfs.server` boot script that contain the literal character `$`, you must hide its special meaning by preceding the character with the `\` regular expression character.

```
$ grep '\$' /etc/init.d/nfs.server
case "$1" in
    >/tmp/sharetab.$$
        [ "$fstype" != nfs ] && \
        echo "$path\t$res\tfstype\topts\t$desc" \
        >>/tmp/sharetab.$$
        /usr/bin/touch -r /etc/dfs/sharetab /tmp/sharetab.$$
        /usr/bin/mv -f /tmp/sharetab.$$ /etc/dfs/sharetab
<output truncated>

$ grep '\$' /etc/init.d/nfs.server | wc -l
15
```

Line Anchors

An anchor is a symbol that matches a character's position on the line.

The `^` and `$` anchors match text patterns relative to the beginning `^` or ending `$` of a line of text. For example, the following command finds all lines that contain the pattern `root` in the `/etc/group` file.

```
$ grep 'root' /etc/group
root::0:root
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
adm::4:root,adm,daemon
uucp::5:root,uucp
<output truncated>
```

If the intent is to display only the one entry for the `root` group in the `/etc/group` file, then the pattern must specify that the line begins with the pattern (given the syntax of the file).

```
$ grep '^root' /etc/group
root::0:root
```

Therefore, the regular expression character allows you to anchor the pattern match to the beginning of the line.

Similarly the `$` regular expression character allows you to anchor the pattern match to the end of the line. Lines only print if the specified pattern represents the characters preceding the end-of-line character.

```
$ grep 'mount$' /etc/vfstab
#device      device      mount      FS      fsck      mount      mount
```

Word Anchors

Backslashed angle brackets are word anchors. The less-than bracket (<) marks the beginning of a word. Any text that follows this bracket is matched only when it occurs at the beginning of a word. The greater-than bracket (>) marks the end of a word. Text that precedes this bracket is only matched when it occurs at the end of a word. Words are delimited by spaces, tabs, beginnings of line, ends of line, and punctuation.

For example, if you wanted to print the group file entry for the uucp group, issuing the **grep** command without regular expression characters gives you the uucp and nuucp group entries. Using the following command; however, should give only the single group entry for uucp.

```
$ grep '\<uucp' /etc/group
uucp: :5:root,uucp
```

You can use both word anchors at the same time to ensure your pattern is a complete word by itself, rather than a sub-string of another word. Note the output if you search for the pattern the in the `nfs.server` script.

```
$ grep 'the' /etc/init.d/nfs.server
if [ -f /etc/dfs/sharetab ] ; then
# Retain the last modification time so that it can be truncated
# by the share command when it is called first time after boot.
# lines, then run shareall to export them, and then start up mountd
<output truncated>
```

The output includes lines with the as a sub-string of words, such as then, either, and their. If you were searching for the specific word the, you should use both word anchors (or the `-w` option).

```
$ grep '\<the\>' /etc/init.d/nfs.server
# Retain the last modification time so that it can be truncated
# by the share command when it is called first time after boot.
# logging enabled, or they were shared in the previous session
# When the system comes up umask is not set; so set the mode now
# the grace period
```

Character Classes

A string enclosed in square brackets specifies a character class. Any single character in the string is matched.

For example, the `grep '[abc]' frisbee` command displays every line that contains an `a`, `b`, or `c` in the `frisbee` file.

The following command prints the lines from `/etc/group` that contain either the letter `i` or the letter `u`.

```
$ grep '[iu]' /etc/group
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
uucp::5:root,uucp
mail::6:root
nuucp::9:root,nuucp
sysadmin::14:
nogroup::65534:
```

You might also specify a range of characters, which results in printing lines that contain at least one of the specified characters in the range.

```
$ grep '[u-y]' /etc/group
sys::3:root,bin,sys,adm
uucp::5:root,uucp
tty::7:root,tty,adm
nuucp::9:root,nuucp
sysadmin::14:
nobody::60001:
nogroup::65534:
```

The following command finds the word the or The at the beginning of the line in the `teams` file.

```
$ grep '\<[Tt]he\>' teams
```

```
The teams are chosen randomly.
```

```
$ cat teams
```

```
Team one consists of
```

```
Tom
```

```
Team two consists of
```

```
Fred
```

```
The teams are chosen randomly.
```

```
Tea for two and Dom
```

```
Tea for two and Tom
```


Single Character Match

The `.` regular expression character matches any one character except the newline character.

What do you think the following three commands look for? Try these commands:



```
$ grep 'c...h' /usr/dict/words
$ grep '^c...h' /usr/dict/words
$ grep '^c...h$' /usr/dict/words
```

- ✓ *The first command looks for all lines containing `c`, followed by any three characters, followed by `h`.*
- ✓ *The second command looks for all lines that do not have a character before the `c`; that is, the `c` is the first character, followed by any three characters, followed by `h`.*
- ✓ *The third command looks for all lines that do not have a character before the `c`, followed by any three characters, followed by `h`, which is the end of the word; that is five-letter words that begin with `c` and end with `h`.*

Closure (*)

The *, when used in a regular expression, is termed a closure. The closure symbol matches the preceding symbol or character zero or more times.

```
$ grep 'Team*' teams
Team one consists of
Team two consists of
Tea for two and Dom
Tea for two and Tom
```

For example, to find all lines that contain a word beginning with T, and a word ending with m, use the following command:

```
$ grep '\<T.*m\>' teams
Team one consists of
Tom
Team two consists of
Tea for two and Dom
Tea for two and Tom
```

An asterisk (*) has special meaning only when it follows another character. If it is the first character in a regular expression or if it is by itself, it has no special meaning. The following example searches for lines containing a literal asterisk within the file called `teams`.

```
$ grep '*' teams
```

Also note that the asterisk has another meaning outside of the regular expression. The following command searches all files in the current directory for the string `abc`.

```
$ grep 'abc' *
data1:abcd
```

✓ *In the example, the * is a shell metacharacter rather than a grep metacharacter.*

Exercise: Regular Expressions and **grep**



Exercise objective – In this lab, you write **grep** commands to search for the specified strings within text files.

Preparation

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod4/lab` before beginning the exercise.

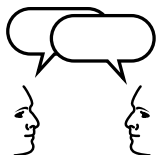
You might want to look at the `/var/sadm/install/contents` file to reacquaint yourself with the information contained in each entry, specifically the first and last fields.

Tasks

1. Print all the entries from `/etc/passwd` for users who have `ksh` as their login shell.
2. Print all the entries from `/etc/passwd` for users who have `sh` as their login shell.
3. Print the lines from `/etc/group` that contain the pattern `root` preceded by the line number.
4. Print the lines from `/etc/group` that do not contain the pattern `root`.
5. Print all the file and directory entries from the `/var/sadm/install/contents` file that are part of or dependent on the `SUNWjvman` package.
6. Print the number of files and directories that are part of the `SUNWjvman` package; use the `/var/sadm/install/contents` file.

7. Use two `grep` commands on a single command line to print only the man page entries for files that are part of the `SUNWjvman` package; use the `/var/sadm/install/contents` file.
8. Print all the man page entries from the `/usr/share/man` directory that are for commands that begin with `java`; use the `/var/sadm/install/contents` file.
9. List all entries of local disk devices from `/etc/vfstab`.
10. Place the previous two `grep` commands in a shell script, and then execute the script.
11. Start a script named `adduser` by copying one of the two template files in the `lab` directory. Add a single `grep` command into the script that allows you to determine if the user name (stored in the `name` variable) already exists in the `mypasswd` file. Test all values for `name` that appear in the template file. (You will build on this script in later modules as new concepts and constructs are encountered.)

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Print all the entries from `/etc/passwd` for users who have `ksh` as their login shell.

```
$ grep 'ksh$' /etc/passwd
```

2. Print all the entries from `/etc/passwd` for users who have `sh` as their login shell.

```
$ grep '/sh$' /etc/passwd
```

or

```
$ grep '\<sh\>$' /etc/passwd
```

3. Print the lines from `/etc/group` that contain the pattern `root` preceded by the line number.

```
$ grep -n 'root' /etc/group
```

4. Print the lines from `/etc/group` that do not contain the pattern `root`.

```
$ grep -v 'root' /etc/group
```

5. Print all the file and directory entries from the `/var/sadm/install/contents` file that are part of or dependent on the `SUNWjvman` package.

```
$ grep 'SUNWjvman' /var/sadm/install/contents
```

6. Print the number of files and directories that are part of the `SUNWjvman` package; use the `/var/sadm/install/contents` file.

```
$ grep -c 'SUNWjvman' /var/sadm/install/contents
```

7. Use two `grep` commands on a single command line to print only the man page entries for files that are part of the `SUNWjvman` package; use the `/var/sadm/install/contents` file.

```
$ grep 'SUNWjvman' /var/sadm/install/contents | grep 'man1/'
```

8. Print all the man page entries from the `/usr/share/man` directory that are for commands that begin with `java`; use the `/var/sadm/install/contents` file.

```
$ grep '/usr/share/man/.*/java' /var/sadm/install/contents
```

9. List all entries of local disk devices from /etc/vfstab.

```
$ grep '^/dev' /etc/vfstab
```

10. Place the previous two `grep` commands in a shell script, and then execute the script.

```
$ more twogreps.sh
#!/bin/sh
```

```
echo "Here are the /usr/share/man entries for java related commands"
grep '/usr/share/man/./java' /var/sadm/install/contents
```

```
echo
echo "Now a listing of local disk devices from /etc/vfstab"
grep '^/dev' /etc/vfstab
```

11. Start a script named `adduser` by copying one of the two template files in the lab directory. Add a single `grep` command into the script that allows you to determine if the user name (stored in the `name` variable) already exists in the `mypasswd` file. Test all values for `name` that appear in the template file. (You will build on this script in later modules as new concepts and constructs are encountered.)

```
$ cp adduser_sh.template adduser.sh
```

```
$ cat adduser.sh
#!/bin/sh
```

```
# Purpose: To write a script to add user to the system.
# Name: adduser.sh
```

```
### Set a shell variable to test the grep command.
name=nuucp      # Should match a single entry
#name=uucp      # Should match a single entry
#name=root      # Should match a single entry
#name=rot       # Should not match any entry
```

```
grep "^$name:" mypasswd
```

```
# End of lab 4
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use and describe regular expressions
- ☐ Describe the `grep` command
- ☐ Use the `grep` command to find patterns in a file
- ☐ Use regular expression characters with the `grep` command

Objectives

Upon completion of this module, you will be able to:

- Use the sed editor to perform noninteractive editing tasks
- Use regular expression characters with the sed command

✓ *Additional sed functionality is described in Appendix D, “Additional sed Functionality.”*

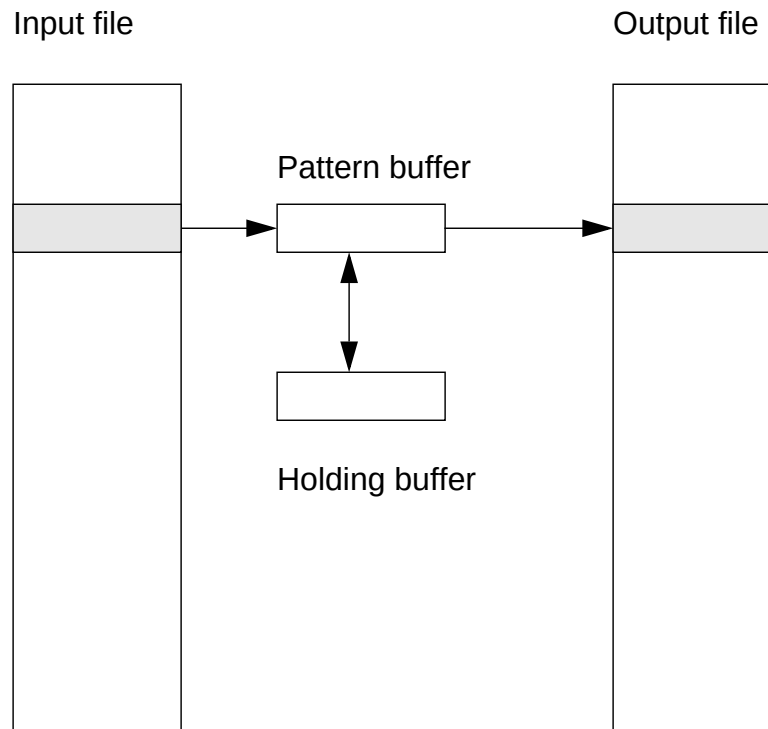
The sed Editor

`sed` stands for **s**tream **e**ditor.

A stream is a source or destination for bytes, which means `sed` can take its input from standard in, apply the requested edits on the stream, and automatically put the results to standard out. The `sed` syntax allows for an input file to be specified on the command line. The syntax does not allow an output-file specification; this can be accomplished through output redirection.

The `sed` editor edits a file by reading the file line-by-line into a pattern buffer, modifying the line, and then outputting the buffer to standard out, which can be redirected to another file. The original file is not modified.

The holding buffer is used for advanced operations. It is limited to a copy, append, compare, or retrieval command. You can use the holding buffer to find duplicate lines in a sorted input file or to concatenate multiple lines together for future output.



Command Format

```
sed [options] '[address(s)] action [args]' file(s)
    [ > outfile]
```

You do not need to interact with the `sed` editor while it is running; therefore, it has also been termed a batch editor. This is in contrast to such editors as `vi` and `ed`, which are interactive. Because `sed` does not require interaction, you can place `sed` commands in a script. You can call the script file and run it against the data file to perform repetitive editing operations.

The `sed` editor is capable of performing text-pattern substitutions and text-pattern deletions using regular expression syntax. These are the same regular expression characters used by `grep`.

`sed` offers capabilities that are an extension of interactive text editing. If you need to search and replace text strings in a large number of files, `sed` is most useful.

Editing Commands

The `sed` editor uses a set of editing commands similar to the ones for `vi` and `ed`. These commands are shown in Table 5-1.

Table 5-1 `sed` Commands

Command	Function
d	Deletes line(s)
p	Prints line(s)
r	Reads a file
s	Substitutes one string for another

The `sed` command has two options as shown in Table 5-2.

Table 5-2 `sed` Options

Option	Function
-n	Suppresses the default output
-f	Reads <code>sed</code> commands from a script file

Addressing

The `sed` editor processes all lines of the input file unless you specify an address. This address can be a range of line numbers, a regular expression, or a combination of both.

When specifying a line number or a range of line numbers, these represent lines from the input file against which the specified edit are applied. All other lines from the input file are displayed, unchanged, to standard out.

Similarly when a pattern, which may contain a regular expression, is used to select lines, only lines containing the pattern are edited. All other lines from the input file are displayed, unchanged, to standard out.

If two patterns are specified, this creates a range, beginning with the first line of the file containing the first pattern, including all subsequent lines of the file up to, and including, the one containing the second pattern or the end of the file.

A `$` (dollar sign) represents the last line of the file.

Using sed to Print Text

The following examples execute `sed` commands against the `data.file` file.

\$ cat data.file

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

The following example shows the use of the `p` (print) command, which prints a range of lines to stdout. The range is specified by a starting address followed by a comma and then the ending address.

\$ sed '3,5p' data.file

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18
southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

The default output of `sed` is each line that it reads. To suppress the default output, use the `-n` option.

\$ sed -n '3,5p' data.file

southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17

The following command prints all lines with the pattern `west` in it.
Use the forward slash (/) to delimit the regular expression.

✓ *While / is the most commonly used delimiter, you can use any character as a delimiter if the first occurrence of the character is preceded by a backslash; for example:*

```
$ sed -n '\?east?p' data.file
```

southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13

```
$ sed -n '/west/p' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18

The following command prints the first line containing the pattern `west`, up to and including the next line containing the pattern `southern`.

```
$ sed -n '/west/,/southern/p' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15

The following command prints the first line containing the pattern `Chris`, up through the last line of the file.

✓ *Remember, a \$ in the address means the last line of the file.*

```
$ sed -n '/Chris/, $p' data.file
```

southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

The pattern might contain the regular expression characters used by `grep`. The following example prints all lines that begin with an `s` and end with a `5`.

```
$ sed -n '/^s.*5$/p' data.file
```

southern	SO	May Chin	5.1	.95	4	15
----------	----	----------	-----	-----	---	----

Using sed to Substitute Text

The sed s command allows for a search and substitution operation to occur on the text. The command uses a pattern search and a literal string replacement. The replacement string characters are taken literally without metacharacter expansion. One exception to the literal replacement, shown in a later example, is the & (ampersand).

```
$ sed 's/3/X/' data.file
northwest    NW      Joel Craig      X.0 .98 3        4
western      WE      Sharon Kelly    5.X .97 5        23
southwest    SW      Chris Foster    2.7 .8  2        18
southern     SO      May Chin       5.1 .95 4        15
southeast    SE      Derek Johnson   5.0 .70 4        17
eastern      EA      Susan Beal      4.4 .8  5        20
northeast    NE      TJ Nichols      5.1 .94 X        13
north        NO      Val Shultz      4.5 .89 5        9
central      CT      Sheri Watson    5.7 .94 5        1X
```

The sed command checks each line of the file and substitutes the first occurrence of the old string with the new string. Subsequent occurrences of the old string within the same line are left unchanged.

The following example shows the g (global) command with the s (search and substitute), and it replaces all occurrences of the old string with the new string.

```
$ sed 's/3/X/g' data.file
northwest    NW      Joel Craig      X.0 .98 X        4
western      WE      Sharon Kelly    5.X .97 5        2X
southwest    SW      Chris Foster    2.7 .8  2        18
southern     SO      May Chin       5.1 .95 4        15
southeast    SE      Derek Johnson   5.0 .70 4        17
eastern      EA      Susan Beal      4.4 .8  5        20
northeast    NE      TJ Nichols      5.1 .94 X        1X
north        NO      Val Shultz      4.5 .89 5        9
central      CT      Sheri Watson    5.7 .94 5        1X
```

✓ **You can change a specific occurrence of the pattern by specifying the occurrence number after the search and substitute construct; for example:**

```
sed 's/./X/4' data.file
```


Occasionally with a search and substitute, the old string will be part of the new replacement string, which you can accomplish by placing an & (ampersand) in the replacement string. The location of the & determines the location of the old string in the replacement string.

The objective is to write a command that searches for all lines that end with a single digit in the last field and replaces it with the single digit number plus the string `Single Digit`.

To properly identify the lines with single digit numbers in the last field, consider the following `sed` command. Tabs separate the fields with each line.

```
$ sed -n '/[0-9]$/p' data.file
northwest NW      Joel Craig      3.0 .98 3      4
north      NO      Val Shultz     4.5 .89 5      9
```

The command searches for all lines that end with a single digit in the last field and replaces it with the single digit number plus the string `Single Digit`.

```
$ sed 's/[0-9]$/& Single Digit/' data.file
northwest NW      Joel Craig      3.0 .98 3      4 Single Digit
western    WE      Sharon Kelly   5.3 .97 5      23
southwest  SW      Chris Foster  2.7 .8  2      18
southern   SO      May Chin     5.1 .95 4      15
southeast  SE      Derek Johnson 5.0 .70 4      17
eastern    EA      Susan Beal    4.4 .8  5      20
northeast  NE      TJ Nichols    5.1 .94 3      13
north      NO      Val Shultz    4.5 .89 5      9 Single Digit
central    CT      Sheri Watson  5.7 .94 5      13
```

✓ *In the previous examples, the space between / and [0-9] is a tab.*

Reading From a File for New Text

Instead of inserting a line of text once, you might want to repeat the procedure several times, either in the same file or across multiple files. The `r` (read) command specifies a file name, and the contents of the file is inserted into the output after the lines specified by the address. The address may be a line number or pattern combination.

```
$ cat northmesg
```

```
*** The northern regions are the newest in the company ***
*** and the people are still being trained. *****
```

```
$ sed '/north/r northmesg' data.file
```

```
northwest      NW      Joel Craig      3.0 .98 3      4
*** The northern regions are the newest in the company ***
*** and the people are still being trained. *****
western        WE      Sharon Kelly    5.3 .97 5      23
southwest      SW      Chris Foster  2.7 .8  2      18
southern       SO      May Chin     5.1 .95 4      15
southeast      SE      Derek Johnson 5.0 .70 4      17
eastern        EA      Susan Beal   4.4 .8  5      20
northeast      NE      TJ Nichols   5.1 .94 3      13
*** The northern regions are the newest in the company ***
*** and the people are still being trained. *****
north          NO      Val Shultz   4.5 .89 5      9
*** The northern regions are the newest in the company ***
*** and the people are still being trained. *****
central        CT      Sheri Watson  5.7 .94 5      13
```

Note – The space following the `r` (read) command is required. You must also immediately follow the file name by the closing quote.

Using sed to Delete Text

The following command deletes Lines 4 through 8 from the output.

```
$ sed '4,8d' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18
central	CT	Sheri Watson	5.7	.94	5	13

The following command deletes any line containing the pattern west.

```
$ sed '/west/d' data.file
```

southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

The following command deletes any line beginning with the pattern west.

```
$ sed '/^west/d' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

The following command deletes the range of lines beginning with the first line containing the pattern south, up through the next line of the file containing north.

```
$ sed '/south/,/north/d' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

Reading sed Commands From a File

While you can put more than one edit command into a single `sed` command using the `-e` option, you can also put the edit commands into a file and call that file using the `-f` option.

When you place the commands in a file you:

- Do not use the `-e` option for each command
- Do not use quotes around the action and address
- Ensure that there is no trailing white space at the end of each line

```
$ cat script1.sed
1,4d
s/north/North/
s/^east/East/
```

These commands can then be applied to the `data.file` file with the following command:

```
$ sed -f script1.sed data.file
southeast      SE      Derek Johnson   5.0 .70 4      17
Eastern        EA      Susan Beal      4.4 .8  5      20
Northeast      NE      TJ Nichols      5.1 .94 3      13
North          NO      Val Shultz      4.5 .89 5       9
central        CT      Sheri Watson    5.7 .94 5      13
```

✓ *sed scripts are limited to 124 lines.*

Using sed to Write Output Files

The write command allows a specific `sed` command to write the output to a named file. Different `sed` commands can write to different files; for example:

```
$ cat script5.sed
/north/w northregions
s/9[0-9]/& Great job!/w topperformers
```

The previous script of `sed` commands writes to two different output files. The first file, `northregions`, contains all lines with the pattern `north`. The second file, `topperformers`, has all lines containing a `9` followed by another digit. This output contains the matched number, followed by the string `Great job!`.

```
$ sed -n -f script5.sed data.file
```

```
$ more northregions topperformers
```

```
::::::::::::
```

```
northregions
```

```
::::::::::::
```

northwest	NW	Joel Craig	3.0	.98	3	4
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9

```
::::::::::::
```

```
topperformers
```

```
::::::::::::
```

northwest	NW	Joel Craig	3.0	.98	Great job!	3	4
western	WE	Sharon Kelly	5.3	.97	Great job!	5	23
southern	SO	May Chin	5.1	.95	Great job!	4	15
northeast	NE	TJ Nichols	5.1	.94	Great job!	3	13
central	CT	Sheri Watson	5.7	.94	Great job!	5	13

Note – The space following the `w` (write) command is required. Also, follow the file name immediately by the end of line.

Exercise: The sed Editor



Exercise objective – In this lab, you write `sed` commands to delete, write, search, and substitute, as well as print lines from the input file to standard output or to a specified file.

Preparation

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod5/lab` before beginning the exercise.

You are asked to make a copy of the `/etc/passwd` file into your local directory. Display this file in a window that you can refer to as you are writing the `sed` commands to process the file.

Tasks

1. Copy the `/etc/passwd` file to the current directory, and name it `passwd2`. Use this local copy for the duration of this lab.
2. Print to standard out only the lines that end in the pattern `sh`.
3. Print to standard out only the lines that have the letter `o` as the second character.
4. Delete the first four characters of each line.
5. Delete each line that contains the pattern `uu`.
6. Print to standard out only the lines containing the pattern `oo`.

7. Create a file of `sed` commands to perform the previous two tasks.
 - ▼ In addition to these, add another command in the file to cause the `/etc/hosts` file to be displayed after the `passwd2` file in the output.
 - ▼ Remember to use the `-n` option.
8. The input to the `sed` command is a long listing of the `/` (root) directory. Send this to the `sed` command through a `|` (pipe).

Create a file of `sed` commands to do the following:

- ▼ If the first letter on the line is an `l`, print the entire line appended with `**** SYM LINK`.
 - ▼ If the first letter on the line is an `-`, print the entire line appended with `**** PLAIN FILE`.
9. Suppress default printing and have a `sed` script named `notrailingspaces.sed` to perform the following to input file `hostswithspaces`:
 - a. Delete trailing spaces at the end of the line.
 - b. Write all lines to an output file `hostsnospaces`.

Hint: You can use the `vi` `:set list` feature to view trailing spaces.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Copy the `/etc/passwd` file to the current directory, and name it `passwd2`. Use this local copy for the duration of this lab.

2. Print to standard out only the lines that end in the pattern `sh`.

```
$ sed -n '/sh$/p' passwd2
```

3. Print to standard out only the lines which have the letter `o` as the second character.

```
$ sed -n '/^..o/p' passwd2
```

4. Delete the first four characters of each line.

```
$ sed 's/^....//' passwd2
```

5. Delete each line that contains the pattern `uu`.

```
$ sed '/uu/d' passwd2
```

6. Print to standard out only the lines containing the pattern `oo`.

```
$ sed -n '/oo/p' passwd2
```

7. Create a file of `sed` commands to preform the previous two tasks.

▼ In addition to these, add another command in the file to cause the `/etc/hosts` file to be displayed after the `passwd2` file in the output.

▼ Remember to use the `-n` option.

```
$ cat labscript1.sed
```

```
/oo/p
```

```
/uu/d
```

```
$r /etc/hosts
```

To execute this `sed` script, type the following:

```
$ sed -f labscript1.sed passwd2
```

8. The input to the `sed` command is a long listing of the `/` (root) directory. Send this to the `sed` command through a `|` (pipe).

Create a file of `sed` commands to do the following:

- ▼ If the first letter on the line is an `l`, print the entire line appended with `**** SYM LINK`.
- ▼ If the first letter on the line is an `-`, print the entire line appended with `**** PLAIN FILE`.

```
$ more labscript2.sed
s/^l.*/& **** SYM LINK/
s/^-.*/& **** PLAIN FILE/
```

To execute this script, type the following:

```
$ ls -l / | sed -f labscript2.sed
```

9. Suppress default printing, and have a `sed` script named `notrailingspaces.sed` to perform the following to input file `hostswithspaces`:

- a. Delete trailing spaces at the end of the line.

```
s/ *$//
```

- b. Write all lines to an output file `hostsnospaces`.

```
w hostsnospaces
```

Hint: You can use the `vi :set list` feature to view trailing spaces.

```
$ cat notrailingspaces.sed
s/ *$//
w hostsnospaces
```

```
$ sed -nf notrailingspaces.sed hostswithspaces
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use the `sed` editor to perform noninteractive editing tasks
- ☐ Use regular expression characters with the `sed` command

Objectives

Upon completion of this module, you will be able to:

- Use **nawk** commands from the command line
- Write simple **nawk** programs to generate data reports from text files
- Write simple **nawk** programs to generate numeric and text reports from text files

Introduction to nawk

The `awk` programming language grew out of the recognition that many data processing problems are specialized applications of the concept of filtering, where the data is structured into records to which transformations are repetitively applied. `awk` is a record-oriented language that is named for its authors Aho, Weinberger, and Kernighan of AT&T Bell Labs.

New `awk`, `nawk`, added functionality to `awk`. This module looks at `nawk`.

Unlike `sed`, `nawk` looks at data by records and fields. By default, records are delimited by newline characters, and the fields within them by spaces or tabs, but these can be set to the delimiters that are built-in to your data, such as colons or commas.

`nawk` applications include:

- Filters
- Numerical processing on rows and columns of data
- Text processing to perform repetitive editing tasks
- Report generation

A Programming Language

`nawk` is considered a programming language because you can develop programs within a script. Many of the programming concepts, such as conditionals, looping, variables, and functions are included in `nawk`. This module focuses on the basic concepts of `nawk`, not including those programming concepts. Appendix B, “Advanced `nawk` Programming,” continues the description of `nawk` and programming.

nawk *Format*

The nawk command has the format:

```
nawk 'statement' input.file
```

The nawk *statement* is enclosed in single quotes and might be in one of three forms:

- *pattern* { *ACTION* }

The action is taken on those records that match the pattern.

- *pattern*

All records that match the pattern are printed.

- { *ACTION* }

The action is taken on all records in the input file

nawk *Scripts*

Execute nawk scripts using this format:

```
nawk -f scriptfile input.file
```

You can combine repetitive nawk commands into nawk scripts that consist of one or more lines of the form:

```
pattern { ACTION }
```

where *pattern* is commonly a regular expression (RE) enclosed in slashes (/RE/) and *ACTION* is one or more statements of the nawk language.

Using `nawk` to Print Selected Fields

The `print` statement outputs data from the file.

When `nawk` reads a record, it divides the record into fields based on the `FS` (input field separator) variable. This variable is predefined in `nawk` to be one or more spaces or tabs.

The variables `$1`, `$2`, `$3` hold the values of the first, second, and third fields. The variable `$0` holds the value of the entire line.

In the following example, Fields 3 (first name), 4 (last name), and 2 (office) are printed.

- ✓ *The data file uses tabs or spaces to separate the fields for readability. Spaces between the fields do not change the output because the `FS` is set to "space or tab."*
- ✓ *Have the students enter the `nawk print` command without using commas to see what the comma does.*

```
$ cat data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southwest	SW	Chris Foster	2.7	.8	2	18
southern	SO	May Chin	5.1	.95	4	15
southeast	SE	Derek Johnson	5.0	.70	4	17
eastern	EA	Susan Beal	4.4	.8	5	20
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13

```
$ nawk '{ print $3, $4, $2 }' data.file
```

```
Joel Craig NW
Sharon Kelly WE
Chris Foster SW
May Chin SO
Derek Johnson SE
Susan Beal EA
TJ Nichols NE
Val Shultz NO
Sheri Watson CT
```


Formatting With `print`

By adding tabs or other text inside double quotes, you can format the output more neatly.

In `nawk`, anything in double quotes is a string constant. You can use string constants in many places in `nawk`—in `print` statements and as values to be assigned to variables among other things.

Some format special characters use letters, such as `\t` for tab. You can also specify an octal value, such as `\011` for tab. Some of the formats you can use are shown in Table 6-1.

Table 6-1 Formatting Characters

Characters	Meaning
<code>\t</code>	Tab
<code>\n</code>	Newline
<code>\007</code>	Bell
<code>\011</code>	Tab
<code>\012</code>	Newline
<code>\042</code>	"
<code>\045</code>	%

If the fields in the `nawk print` statement are separated by commas (`,`), then the fields are separated by a space when they are printed. The comma is not a required part of the syntax. In a `print` statement, the comma actually represents the value of the `nawk` variable `OFS` (output field separator) that is described later in this module. The default value of the `OFS` variable is a single space.

The following example adds a single tab character between Field 4 and Field 2.

```
$ awk '{ print $3, $4 "\t" $2 }' data.file
```

Joel Craig	NW
Sharon Kelly	WE
Chris Foster	SW
May Chin	SO
Derek Johnson	SE
Susan Beal	EA
TJ Nichols	NE
Val Shultz	NO
Sheri Watson	CT

Notice that it was not necessary to use the comma before or after the tab (`\t`) in the previous `print` statement. The tab forces the output that follows to begin at the next tab position.

Using Regular Expressions

Regular expression metacharacters (egrep) can be used in the pattern.

✓ **egrep is discussed in SA-118, Fundamentals of Solaris™ 8 Operating Environment.**

In this example, `nawk` searches for the pattern `east`, and prints all lines containing that pattern.

```
$ nawk '/east/' data.file
southeast      SE      Derek Johnson    5.0 .70 4        17
eastern        EA      Susan Beal       4.4 .8  5        20
northeast      NE      TJ Nichols       5.1 .94 3        13
```

Next, print only Fields 1, 5, and 4 from lines containing the pattern `east`.

```
$ nawk '/east/ { print $1, $5, $4 }' data.file
southeast 5.0 Johnson
eastern 4.4 Beal
northeast 5.1 Nichols
```

This example prints Fields 1 and 5, and then a tab before Field 4, for all lines containing the pattern `east`.

```
$ nawk '/east/ { print $1, $5 "\t" $4 }' data.file
southeast 5.0   Johnson
eastern 4.4     Beal
northeast 5.1   Nichols
```

The string can contain regular expression characters. In this example, the pattern `east` must be at the beginning of the line.

```
$ nawk '/^east/' data.file
eastern      EA      Susan Beal       4.4 .8  5        20
```

When the search string contains a character that has special meaning as a regular expression character, the results can be unexpected. In this example, the `.` is used, which has a special meaning of *any character*.

```
$ nawk '/.9/' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southern	SO	May Chin	5.1	.95	4	15
northeast	NE	TJ Nichols	5.1	.94	3	13
north	NO	Val Shultz	4.5	.89	5	9
central	CT	Sheri Watson	5.7	.94	5	13



The arrow points to a line of output that you might not have anticipated as meeting the search criteria. To take away the special meaning of a regular expression character, precede it with a backslash (`\`).

```
$ nawk '/\..9/' data.file
```

northwest	NW	Joel Craig	3.0	.98	3	4
western	WE	Sharon Kelly	5.3	.97	5	23
southern	SO	May Chin	5.1	.95	4	15
northeast	NE	TJ Nichols	5.1	.94	3	13
central	CT	Sheri Watson	5.7	.94	5	13

Special Patterns – BEGIN and END

There are two special patterns that are not used to match text in a file. The **BEGIN** pattern (all letters must be uppercase) indicates an action that occurs before any of the input lines are read. It is commonly used for printing a heading or title line for the report before any data is processed and to assign values to built-in variables.

The **END** pattern (all uppercase) indicates an action occurs after all input records have been read and fully processed. It is commonly used to print summary statements or numeric totals.

BEGIN and **END** statements can occur multiple times each in any **nawk** program (and in any order). If there are multiple occurrences of either pattern, they are executed in the order in which they are found in the file.

The following example has a **BEGIN** statement to add a header to the output.

```
$ nawk 'BEGIN { print "Eastern Regions\n" }; /east/ { print $5, $4 }'  
data.file  
Eastern Regions  
  
5.0 Johnson  
4.4 Beal  
5.1 Nichol
```

While you can use multiple lines for the `nawk` command, the beginning brace of the action for the `BEGIN` and `END` patterns must appear on the same line as the keyword `BEGIN` or `END`.

The correct usage is:

```
$ nawk 'BEGIN {  
> print "Eastern Regions\n"; /east/ {print $5, $4}' data.file  
Eastern Regions  
  
5.0 Johnson  
4.4 Beal  
5.1 Nichols
```

The incorrect usage is:

```
$ nawk 'BEGIN  
> { print "Eastern Regions\n" }; /east/ { print $5, $4 }' data.file  
nawk: syntax error at source line 2  
context is  
    BEGIN >>>  
<<<  
nawk: bailing out at source line 2
```

The `END` pattern allows the action to occur at the end of the input file.

```
$ nawk 'BEGIN { print "Eastern Regions\n"; /east/ {print $5, $4}  
> END {print "Eastern Region Monthly Report"}}' data.file  
Eastern Regions  
  
5.0 Johnson  
4.4 Beal  
5.1 Nichols  
Eastern Region Monthly Report
```

Programming With `nawk`

A `nawk` script is a collection of `nawk` statements (patterns and actions) stored in a text file. A `nawk` script reduces the chance for errors because the commands are stored in a file and are read from the file each time they are needed.

Give the script file a descriptive name. To instruct `nawk` to read the script file, use the command:

```
nawk -f script_file data_file
```

For example:

```
$ cat report.nawk
BEGIN {print "Eastern Regions\n"}
/east/ {print $5, $4}
END {print "Eastern Region Monthly Report"}
```

```
$ nawk -f report.nawk data.file
Eastern Regions
```

```
5.0 Johnson
4.4 Beal
5.1 Nichols
Eastern Region Monthly Report
```

Using a `nawk` script makes it easy to make changes or additions. In this example, a second `BEGIN` statement is added to print an overall heading for the report. Remember, the `BEGIN` statements are executed in order.

```
$ cat report2.nawk
BEGIN {print "*** Acme Enterprises ***"}
BEGIN {print "Eastern Regions\n"}
/east/ {print $5, $4}
END {print "Eastern Region Monthly Report"}
$ nawk -f report2.nawk data.file
*** Acme Enterprises ***
Eastern Regions
```

```
5.0 Johnson
4.4 Beal
5.1 Nichols
Eastern Region Monthly Report
```

Using Built-in Variables

As `nawk` is processing the input file, it uses several variables. You can provide a value to some of these variables, while other variables are set by `nawk`. Table 6-2 lists some of the built-in variables.

Table 6-2 `nawk` Built-In Variables

Name	Default Value	Description
FS	Space or tab	The input field separator
OFS	Space	The output field separator
NR		The number of records from the beginning of the first input file

Working With Variables

A variable value can be a number, a string, or a set of values in an array. `nawk` uses several built-in variables. To assign a value to a variable, use the format:

variablename = value

Input Field Separator

The default input field separator (FS) is white space, either a space or a tab. Frequently, other characters can separate the input, such as a colon or comma. You can set the input field separator variable with the `-F` option or set the value with an assignment. The following two examples both set the input field separator to a colon:

```
nawk -F: 'statement' filename
nawk 'BEGIN { FS=":" } ; statement' filename
```

When using the `-F` or the `FS` variable, you can specify more than one field separator either by placing the value in square brackets (creating a character class), or by separating the values with a `|` (OR) within double quotes.

```
nawk -F"[ :]" 'statement' filename
nawk -F" |:" 'statement' filename
nawk 'BEGIN { FS="[ :]" } next_statement' filename
nawk 'BEGIN { FS=" |:" } next_statement' filename
```

For example, you need to set the default input field separator if you want to process the `/etc/group` file, which has fields separated by a colon. In this case, you set the `FS` variable before processing the first record of the file.

```
$ nawk 'BEGIN { FS=":" }; { print $1, $3 }' /etc/group
root 0
other 1
bin 2
sys 3
adm 4
uucp 5
mail 6
tty 7
lp 8
```

```
nuucp 9
staff 10
daemon 12
sysadmin 14
nobody 60001
noaccess 60002
nogroup 65534
```

You could save the previous command into a `nawk` script.

```
$ cat report3.nawk
BEGIN { FS=":" }
{ print $1, $3 }
```

```
$ nawk -f report3.nawk /etc/group
root 0
other 1
bin 2
sys 3
adm 4
uucp 5
mail 6
tty 7
lp 8
nuucp 9
staff 10
daemon 12
sysadmin 14
nobody 60001
noaccess 60002
nogroup 65534
```

Output Field Separator

The default output field separator is a space. In the `print` statement, a comma specifies using the output field separator. If you omit the comma, the fields run together. You can also specify a field separator directly in the `print` statement. Compare the following three lines:

```
$ nawk '{ print $3 $4 $2 }' data.file
$ nawk '{ print $3, $4, $2 }' data.file
$ nawk '{ print $3, $4 "\t" $2 }' data.file
```

To set the output field separator, place the assignment within a BEGIN statement.

```
$ nawk 'BEGIN { OFS="\t" } ; { print $3, $4, $2 }' data.file
Joel      Craig    NW
Sharon    Kelly    WE
Chris     Foster   SW
May       Chin     SO
Derek     Johnson  SE
Susan     Beal     EA
TJ        Nichols  NE
Val       Shultz   NO
Sheri     Watson   CT
```

Number of Records

The NR variable counts the number of input lines read from the beginning of the first input file. The variable's value updates each time another input line is read.

Given a single input file, NR is the number of lines in the file when the special pattern END is matched.

```
$ more report4.nawk
{ print $3, $4, $2 }
END { print "The number of employee records is " NR }
```

```
$ nawk -f report4.nawk data.file
Joel Craig NW
Sharon Kelly WE
Chris Foster SW
May Chin SO
Derek Johnson SE
Susan Beal EA
TJ Nichols NE
Val Shultz NO
Sheri Watson CT
The number of employee records is 9
```

Mid-Module Exercise: `nawk` and Regular Expressions



Exercise objective – In this lab, you write `nawk` commands to process text files and generate specified output or simple reports.

Preparation

Refer to the lecture notes as necessary to correctly compose the `nawk` commands.

Change the directory to `mod6/lab` before beginning the exercise.

For the multi-statement `nawk` commands, you might want to execute the individual statements on the system to ensure each gives the required output. After these individual statements prove correct, combine them into a multi-statement `nawk` command.

Tasks

Use the file named `data.file` for these exercises.

1. For every line of the file, print the string `Name:`, followed by the person's first then last name, followed by a tab, followed by the string `Region:`, and finally followed by the abbreviation for the region.
2. For every line that matches the pattern of an `W` followed or preceded by another capital letter, print Fields 2, 3, 4, and 1.
3. For the previous task, add a leading title to the report, `Developers in the Western Regions`.
4. For the previous task, add a trailing footer to the report, `End of Report on the Western Regions`.
5. For every line of the file, print a line number, followed by a colon, followed by a tab, and finally the entire record. (Hint: Check Table 6-2 on page 6-12.)

6. Set the output field separator to a tab, and make the initial heading for this report `***** Regional Report *****`. For every line of the file, print a line number, followed by the last name of the person, and finally the region name.

Task Solutions

Use the file named `data.file` for these exercises.

1. For every line of the file, print the string `Name:`, followed by the person's first then last name, followed by a tab, followed by the string `Region:`, and finally followed by the abbreviation for the region.

```
$ nawk '{ print "Name:", $3, $4, "\t" "Region:", $2 }' data.file
```

2. For every line that matches the pattern of an `W` followed or preceded by another capital letter, print Fields 2, 3, 4, and 1.

```
$ nawk '/[A-Z]W/ { print $2, $3, $4, $1 }
> /W[A-Z]/ { print $2, $3, $4, $1 }' data.file
```

3. For the previous task, add a leading title to the report, `Developers in the Western Regions`.

```
$ nawk 'BEGIN { print "Developers in the Western Regions" }
> /[A-Z]W/ { print $2, $3, $4, $1 }
> /W[A-Z]/ { print $2, $3, $4, $1 }' data.file
```

4. For the previous task, add a trailing footer to the report, `End of Report on the Western Regions`.

```
$ nawk 'BEGIN { print "Developers in the Western Regions" }
> /[A-Z]W/ { print $2, $3, $4, $1 }
> /W[A-Z]/ { print $2, $3, $4, $1 }
> END { print "End of Report on the Western Regions" }' data.file
```

5. For every line of the file, print a line number, followed by a colon, followed by a tab, and finally the entire record.

```
$ nawk '{ print NR, ":\t" $0 }' data.file
```

6. Set the output field separator to a tab, and make the initial heading for this report `***** Regional Report *****`. For every line of the file, print a line number, followed by the last name of the person, and finally the region name.

```
$ nawk 'BEGIN { OFS="\t" }
> BEGIN { print "***** Regional Report *****" }
> { print NR, $4, $1 }' data.file
```

User-Defined Variables

To create a variable, use a name that is not one of the `awk`-predefined variable or function names.

The first time `awk` encounters a reference to a given variable, the variable is created and initialized to a null string. (The null string evaluates to 0 if it is used in a numeric expression.) For all subsequent references, the value of the variable is whatever value was assigned last. The value assigned can be a string (string of characters) or numeric. It can be a literal value ("hello") or the contents from a field from the input file.

You can assign a value directly, or you can use the current value of the variable and use a combination operation on the variable; for example:

```
$ cat numexample.awk
{ counter = counter + 1 }
{ print $0 }
END { print "*** The number of records is " counter }
```

```
$ awk -f numexample.awk data.file
northwest      NW      Joel Craig    3.0 .98 3      4
western        WE      Sharon Kelly  5.3 .97 5      23
southwest      SW      Chris Foster  2.7 .8  2      18
southern       SO      May Chin     5.1 .95 4      15
southeast      SE      Derek Johnson 5.0 .70 4      17
eastern        EA      Susan Beal    4.4 .8  5      20
northeast      NE      TJ Nichols    5.1 .94 3      13
north          NO      Val Shultz    4.5 .89 5      9
central        CT      Sheri Watson  5.7 .94 5      13
*** The number of records is 9
```

Adding a Field of Numbers

Each field of a record has a variable assigned to it. `$1` is the first field, `$2` is the second field, and so forth. The value of this variable changes each time `awk` reads a new record. To add the values of a field, create a new variable, and add the value of the field to the variable each time a record is read.

The following example prints the value in Field 8 for each record, adds that value into the *total* variable. At the end of file, it prints the accumulated total of all values found in Field 8.

```
$ cat numexample2.nawk
{ total = total + $8 }
{ print "Field 8 = " $8 }
END { print "Total = " total }
```

```
$ nawk -f numexample2.nawk data.file
Field 8 = 4
Field 8 = 23
Field 8 = 18
Field 8 = 15
Field 8 = 17
Field 8 = 20
Field 8 = 13
Field 8 = 9
Field 8 = 13
Total = 132
```

A total can be written at the end of the file.

```
$ cat numexample3.nawk
{ total = total + $8 }
{ print $0 }
END { print "The total of field 8 is " total }
```

```
$ nawk -f numexample3.nawk data.file
northwest      NW      Joel Craig      3.0 .98 3      4
western        WE      Sharon Kelly    5.3 .97 5      23
southwest      SW      Chris Foster    2.7 .8 2       18
southern       SO      May Chin       5.1 .95 4      15
southeast      SE      Derek Johnson   5.0 .70 4      17
eastern        EA      Susan Beal      4.4 .8 5       20
northeast      NE      TJ Nichols      5.1 .94 3      13
north          NO      Val Shultz      4.5 .89 5       9
central        CT      Sheri Watson    5.7 .94 5      13
The total of field 8 is 132
```

✓ *If you feel the students can handle the shorthand += operator, you should mention that the code can also be written as:*

```
$ nawk '{ total += $8 }; { print "Field 8 =", $8 }
> END { print "Total =", total }' data.file
```


Variable Examples

The following example prints the record number followed by the entire record of any record containing a NE, NO, or NW:

```
$ nawk '/N/ { print NR, $0 }' data.file
1 northwest      NW      Joel Craig      3.0 .98 3      4
7 northeast      NE      TJ Nichols      5.1 .94 3      13
8 north          NO      Val Shultz      4.5 .89 5      9
```

The following example prints the record number followed by the entire record if it contains an N. In addition, at the end of the file, it prints the number of records that matched the specified pattern.

```
$ nawk 'BEGIN { count = 0 }
> /N[EOU]/ { print NR, $0; count = count + 1 }
> END { print "count of North regions is", count }' data.file
1 northwest      NW      Joel Craig      3.0 .98 3      4
7 northeast      NE      TJ Nichols      5.1 .94 3      13
8 north          NO      Val Shultz      4.5 .89 5      9
count of North regions is 3
```

The following example prints the record number and then the contents of the last field of the record.

```
$ nawk '{ print "Record:", NR, $NF }' data.file
Record: 1 4
Record: 2 23
Record: 3 18
Record: 4 15
Record: 5 17
Record: 6 20
Record: 7 13
Record: 8 9
Record: 9 13
```

✓ *The previous **nawk** command used **\$NF** rather than **\$8** to obtain the value for the last field in each record. This works because, in **nawk**, the variables are not preceded by a **\$** to obtain their value (as the shell requires).*

- *Because **NF == 8**
then **\$NF == \$8**
which is the value in Field 8.*

The `nawk` variable `NF` is set for each record to the number of fields in the record. Therefore, if your data file is not guaranteed to have the same number of fields per record, this variable always reports that unknown count.

\$cat raggeddata.file

```
northwest      NW      Joel Craig      3.0 .98 3      4
WE      Sharon Kelly  5.3 .97 23
southwest      SW      Chris Foster    2.7 .8  2      18
southern       SO      May Chin      5.1 .95 15
southeast      SE      Derek      5.0      17
eastern        Susan Beal  4.4 .8      20
NE      TJ Nichols    5.1 .94 3      13
Val Shultz     4.5      5      9
central       CT      Sheri Watson  .94      5
```

The following example prints the record number followed by the number of fields in the record, for each record in the input file `raggeddata.file`.

\$ nawk '{ print "Record:", NR, "has", NF, "fields." }' raggeddata.file

```
Record: 1 has 8 fields.
Record: 2 has 6 fields.
Record: 3 has 8 fields.
Record: 4 has 7 fields.
Record: 5 has 5 fields.
Record: 6 has 6 fields.
Record: 7 has 7 fields.
Record: 8 has 5 fields.
Record: 9 has 6 fields.
```

The `nawk` `length()` function returns the number of characters in a variable value. The following example prints the string `Field 1 has`, followed by the number of characters in `$1`, followed by the string `letters`.

\$ nawk '{ print "Field 1 has", length(\$1), "letters." }' raggeddata.file

```
Field 1 has 9 letters.
Field 1 has 2 letters.
Field 1 has 9 letters.
Field 1 has 8 letters.
Field 1 has 9 letters.
Field 1 has 7 letters.
Field 1 has 2 letters.
Field 1 has 3 letters.
Field 1 has 7 letters.
```

Writing Output to Files

In any statement that generates output, it is possible to have that output redirected to a file name instead, by using the UNIX redirection symbol (>) followed by a file name at the end of the output-generating statement. Enclose the file name in quotes if it is a string of characters. If the file name is stored in a variable or field, use the field number (preceded by the \$ character) or the variable name.

In the following example, the second and first fields are written to `textfile`.

```
$ nawk '{ print $2, $1 > "textfile" }' data.file
$ cat textfile
NW northwest
WE western
SW southwest
SO southern
SE southeast
EA eastern
NE northeast
NO north
CT central
```

- ✓ *The previous syntax using a single redirection symbol, >, overwrites the file if it already exists.*
- ✓ *If an append to an existing file is preferred, use two redirection symbols, such as >>.*

printf() Statement

The `printf()` statement allows you to print a character string. This string can contain place holders that represent other values. These place holders can represent integers, floating points, characters, and character strings. For every place holder in the character string of `printf()`, there must be a value following the character string. These values must be separated by a comma.

The syntax of `printf()` is:

```
printf ("string of characters" [, data_values ] )
```

where the *data_values* are used to fill in place holders in the "string of characters". Some of the place holders are:

%d	Integer value
%c	Character value
%s	String value

Examples:

```
printf( "Hello World\n" )  
printf( "The value is %d\n", num )  
printf( "My name is %-10s %20s\n", $3, $4 )
```

Note – Notice the use of `\n` in the preceding examples. `printf` does not generate a newline by default.

✓ *The use of the () after the function name is optional. Therefore, the following is allowed:*

```
printf "%d %c %s", 21, 'Q', "hello there\n"
```

Formatting options are available for each of the place holders. Some of them are:

<code>%<number>d</code>	Indicates a field width. The value is right-justified within the field.
<code>%<number>s</code>	
<code>%<number>c</code>	
<code>%-<number>d</code>	The value is left-justified within the indicated field width.
<code>%-<number>s</code>	
<code>%-<number>c</code>	

An example of formatting with the place holders:

```
printf( "%d, %20s\n", 54, "John Smith" )
```

prints:

```
54,    John Smith
```

The `printf` statement does not use the `OFS` variable because of its inherent ability to format the output line, so adjusting the fields to appear in column format is done by preceding the format specification with a digit. This digit refers to the number of spaces that value should consume.

```
$ nawk '{ printf "%10s %3d \n", $4,$7 }' data.file
    Craig      3
    Kelly      5
    Foster     2
    Chin       4
    Johnson    4
    Beal       5
    Nichols    3
    Shultz     5
    Watson     5
```

Guided `nawk` Script



- ✓ *The objective is to have the students determine a sequence of commands that produce the wanted report. The report is on the three top users of disk space in a file system. Given that disk configurations vary, this report is on the / (root) file system, because that one is always present.*
- ✓ *You can lead a discussion with the class to perform a group analysis and design of the commands you must execute to produce the wanted output.*
- ✓ *Have the students execute the individual commands to confirm whether they produce the wanted output. In some cases, the students can use more than one command to produce the output.*
- ✓ *After all the steps are determined, put the sequence of steps in a shell script and execute the script from the command line to ensure it does produce the correct output.*
- ✓ *For every step, the instructor guide provides a solution; remember that students can use alternative commands to produce the same output.*

The objective is to write a report on the top three users of disk space in a file system. `nawk` is only one of the commands you will use to obtain and manipulate the data. You can execute all the commands from the command line. Then, when you are certain of the commands and command sequence, you can place the commands in a shell script for execution.

1. Report on the root file system. Use the `quot` command to report on the number of blocks in the / file system currently owned by each user. The output is listed in descending order by the number of blocks.

✓ `quot /`

2. Strip off the first line of output that specifies the actual logical device name for that slice of the disk. Save the results in a file named `users1`.

✓ `quot / | grep -v "/dev" > users1`

3. Execute a command to list only the first three lines of the `users1` file.

✓ `head -3 users1`

4. Save the listing of the first three lines into the users2 file.

✓ `head -3 users1 > users2`

5. Write a `nawk` script to read the users2 file and produce the following output:

- ▼ Print a heading at the top of the report.
- ▼ Put in column headings the user name and the number of bytes.
- ▼ For each record in users2:
 - Print the user's name
 - Print the number of bytes reported for that user

The report should resemble the following:

Report on Top 3 Users in / Filesystem

Username	Number of Blocks
root	1647941
bin	804135
daemon	27009

✓ `$ cat users.nawk`
`BEGIN { print "Report on Top 3 Users in / Filesystem" }`
`BEGIN { printf "%10s %10s \n", "Username", "Number of Blocks" }`

`{ printf "%10s %10d \n", $2, $1 }`

6. Write a shell script that executes, in order, the commands identified to solve the preceding task.

✓ `$ cat filesystemscript.ksh`

✓ `#!/bin/ksh`

`quot / | grep -v "/dev" > users1`

`head -3 users1 > users2`

`nawk -f users.nawk users2`

✓ *This shows the students that virtually any task they can complete through a series of operating system commands can also be automated through a shell script.*

Exercise: *nawk* Scripts



Exercise objective – In this lab, you write *nawk* commands to process text files and generate specified output or simple reports.

Preparation

Refer to the lecture notes as necessary to correctly compose the *nawk* commands.

Change the directory to `mod6/lab` before beginning the exercise.

For the multi-statement *nawk* commands, you might want to execute the individual statements on the system to ensure each generates the required output. After these individual statements prove correct, combine them into a multi-statement *nawk* command.

Tasks

1. Write a *nawk* program that reads `data.file` and prints a report of all records that contain `north` or `south` in the region name. The program must count how many records are listed for both the north and south regions and should output that count at the end of the report.

Make the report look like the following.

Record #	Region Name	Employee	Region Count
1	northwest	Craig	1
3	southwest	Foster	1
4	southern	Chin	2
5	southeast	Johnson	3
7	northeast	Nichols	2
8	north	Shultz	3
Total of North region is:			3
Total of South region is:			3

2. Write a *nawk* script that counts the number of fields in the `raggeddata.file` file.

3. Copy `/etc/passwd` to `./mypasswd`.
4. Write a `nawk` script that counts and lists the Korn shell user entries in the `mypasswd` file.
5. Write a `nawk` script that counts and lists the Bourne shell user entries in the `mypasswd` file.
6. Write a shell script that calls both of the `nawk` scripts that count users in the `mypasswd` file based on their default shell. The output of the shell script should look like the following:

This is a report on default shells for the local machine

Here is the listing of Korn shell users

```
user2:x:1002:10:./export/home/user2:/bin/ksh
==> Total Korn shell users: 1
```

Here is the listing of Bourne shell users

```
root:x:0:1:Super-User:./sbin/sh
user1:x:1001:10:./export/home/user1:/bin/sh
==> Total Bourne shell users: 2
```

7. Copy the `adduser` script from the `mod4` lab.
 - a. Use `nawk` to extract all the user identification numbers (UIDs) out of the `mypasswd` file into a file called `currentuid`.
 - b. Use `sed` to remove all the “system UID numbers,” meaning all the one-, two-, and three-digit UIDs. You might want to put the remaining UIDs in a file named `currentuid2`.
 - c. Use `sed` to remove the `nobody` (60001), `noaccess` (60002), and `nobody4` (65534) UIDs. You might want to put the remaining UIDs in a file named `currentuid3`.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Write a `nawk` program that reads `data.file` and prints a report of all records that contain `north` or `south` in the region name. The program must count how many records are listed for both the north and south regions and should output that count at the end of the report.

Make the report look like the following.

Record #	Region Name	Employee	Region Count
1	northwest	Craig	1
3	southwest	Foster	1
4	southern	Chin	2
5	southeast	Johnson	3
7	northeast	Nichols	2
8	north	Shultz	3

Total of North region is: 3
Total of South region is: 3

```
$ cat northsouthreport.nawk
BEGIN { Ncount = 0; Scount=0 }
BEGIN { printf "%s %15s %15s %15s \n", "Record #", "Region Name",
"Employee",
"Region Count" }
/north/ { printf "%6d %15s %15s %15d \n", NR, $1, $4, Ncount = Ncount + 1
}
/south/ { printf "%6d %15s %15s %15d \n", NR, $1, $4, Scount = Scount + 1
}
END { print "Total of North region is:", Ncount }
END { print "Total of South region is:", Scount }
```

2. Write a `nawk` script that counts the number of fields in the `raggeddata.file` file.

```
$ cat raggedcount.nawk
BEGIN { print "This program is counting the number of fields in" }
BEGIN { print "the file raggeddata.file, please wait." }

{ totalfields = totalfields + NF }

END { print "==> The total number of fields is:", totalfields }
```

3. Copy /etc/passwd to ./mypasswd.

```
$ cp /etc/passwd ./mypasswd
```

4. Write a `nawk` script that counts and lists the Korn shell user entries in the `mypasswd` file.

```
$ cat korncounter.nawk
BEGIN { print "\nHere is the listing of Korn shell users \n" }

/\ksh$/ { print $0; korncounter = korncounter + 1 }

END { print "==> Total Korn shell users:", korncounter }
```

5. Write a `nawk` script that counts and lists the Bourne shell user entries in the `mypasswd` file.

```
$ cat bournecounter.nawk
BEGIN { print "\nHere is the listing of Bourne shell users \n" }

/\sh$/ { print $0; bournetotal = bournetotal + 1 }

END { print "==> Total Bourne shell users:", bournetotal }
```

6. Write a shell script that calls both of the `nawk` scripts that count users in the `mypasswd` file based on their default shell. The output of the shell script should look like the following:

This is a report on default shells for the local machine

Here is the listing of Korn shell users

```
user2:x:1002:10::/export/home/user2:/bin/ksh
==> Total Korn shell users: 1
```

Here is the listing of Bourne shell users

```
root:x:0:1:Super-User:/:/sbin/sh
user1:x:1001:10::/export/home/user1:/bin/sh
==> Total Bourne shell users: 2
```

```
$ cat kshshscript.ksh
#!/bin/ksh

print "This is a report on default shells for the local machine"

nawk -f korncounter.nawk mypasswd
```

```
nawk -f bournecounter.nawk mypasswd
```

7. Copy the adduser script from the mod4 lab.

```
$ cp ../../mod4/lab/adduser .
```

- a. Use nawk to extract all the UIDs out of the mypasswd file into a file called currentuid.

```
nawk -F: '{print $3}' ./mypasswd > ./currentuid
```

- b. Use sed to remove all the “system UID numbers,” meaning all the one-, two-, and three-digit UIDs. You might want to put the remaining UIDs in a file named currentuid2.

```
sed -e '/^.$$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2
```

- c. Use sed to remove the nobody (60001), noaccess (60002), and nobody4 (65534) UIDs. You might want to put the remaining UIDs in a file named currentuid3.

```
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3
```

```
$ cat adduser.sh
```

```
#!/bin/sh
```

```
# Purpose: To write a script to add user to the system.
```

```
# Name: adduser
```

```
#### Set a shell variable to test the grep command.
```

```
name=nuucp      # Should match a single entry
```

```
#name=uucp      # Should match a single entry
```

```
#name=root      # Should match a single entry
```

```
#name=rot       # Should not match any entry
```

```
grep "^$name:" ./mypasswd
```

```
# End of lab 4
```

```
# Use nawk to extract all the UIDs into the temp file currentuid
```

```
nawk -F: '{print $3}' ./mypasswd > ./currentuid
```

```
# Use sed to remove all 1, 2, and 3 digit UIDs from currentuid, and
```

```
# place the output in the temp file currentuid2
sed -e '/^.$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2

# Use sed to remove UIDs 60001, 60002, and 65534 from currentuid2,
# and place the output in the temp file currentuid3
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3

# End of lab 6
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use `nawk` commands from the command line
- ☐ Write simple `nawk` programs to generate data reports from text files
- ☐ Write simple `nawk` programs to generate numeric and text reports from text files

Objectives

Upon completion of this module, you will be able to:

- Use the exit status of a command as conditional control
- Use the `if` statement to test a condition
- Pass values using command-line arguments (positional parameters) into a script
- Create USAGE messages
- Place parameters on the command line
- Use conditional constructs `if`, `then`, `elif`, `else`, and `fi`
- Use `exit`, `let`, and test statements (`[[ ]]` , `(( ))`)
- Apply Boolean logic `&&`, `||`, and `!`
- Use the `case` statement

The if Statement

There are times when you need to specify different courses of action to be taken in a shell script, depending on the success or failure of some command. The `if` statement allows you to do this.

The `if` statement is a conditional statement that allows a test before performing another statement. The `if` statement has several forms (the more complicated forms are described later in this module). The syntax for the simplest form is:

```
if command
then
    block of statements
fi
```

For example:

```
$ cat snoopy.sh
#!/bin/sh

# Script name: snoopy.sh

name=snoopy

if [ "$name" = "snoopy" ]
then
    echo "It was a dark and stormy night."
fi
```

Note – Whenever you compare a variable in a condition test, always use double quotes around the variable to ensure it is evaluated properly. Without the double quotes, problems will arise if a string value has a space or if the value of the variable is null.

The previous example uses the single brackets so the code works for both the Bourne and Korn shells.

In regard to the double quotes around the variable in the `if` statement, if the variable had been null and the quotes were not present, the error message would be `test: argument expected`.

When every statement executes, it returns a numeric value called an exit status. A statement that executes successfully, returns an exit status of 0, meaning 0 errors. A statement that executes unsuccessfully returns an exit status of nonzero, meaning errors.

Therefore, when the statement following the `if` keyword executes successfully and returns a 0 exit status, the statements following the `then` statement are executed. However, when the statement following the `if` keyword executes unsuccessfully and returns a nonzero exit status, the statements following the `fi` statement are executed.

It is important to remember that the `then` is considered a separate statement in the shell. Therefore, it must appear on a separate line unless preceded by a `;` (semicolon). This is similar to the way several operating system commands can be provided on one line as long as a `;` separates each command.

For example, the statement:

```
if command; then
```

is treated as being the same as:

```
if command
then
```

Parts of the if Statement

The `if` statement contains three parts.

Command

The *command* in the `if` statement often involves a numerical or string test comparison, but it can also be any command that returns a status of 0 when it succeeds and some nonzero status when it fails.

Some of the conditions frequently used within an `if` are:

- The `((...))` command performs arithmetic comparisons (Korn shell).
- The `[[ ... ]]` command is primarily used to compare strings (Korn shell).
- The `[ ... ]` command performs arithmetic or string comparisons (Bourne or Korn shells).

Block of Statements

The statements that follow the `then` statement can be any valid UNIX command, any executable user program, any executable shell script, or any shell statement with the exception of `fi`.

End of the if

End every `if` statement with the `fi` statement.

Exit Status

The shell's reserved variable `?` holds the integer representing the exit status of the previously executed statement, script, or shell statement. This is the most recently completed foreground process.

By convention, the exit status is 0 if the statement ran successfully and nonzero otherwise.

The following example uses `grep` to search `/etc/passwd` for the string `root`. Then, the success or failure of the statement is tested by echoing `$?`.

```
$ grep root /etc/passwd
root:x:0:1:Super-User:/:/sbin/sh
$ echo $?
0
```

The following example sends the output to the `/dev/null` file, and then tests for successful completion.

```
$ grep root /etc/passwd > /dev/null
$ echo $?
0
```

Next, place the condition testing within the `if` statement:

```
$ grep root /etc/passwd
root:x:0:1:Super-User:/:/sbin/sh
$ if [ $? -eq 0 ]
> then
>     echo "Found root!"
> fi
Found root!
```

Instead of executing a statement, and then testing if it completed successfully, place the statement itself in the condition:

```
$ if grep root /etc/passwd
> then
>     echo "Found root!"
> fi
root:x:0:1:Super-User:/:/sbin/sh
Found root!
```

Additionally, you may redirect or pipe `stdout` as part of the output.

```
$ if grep root /etc/passwd > /dev/null
> then
>     echo "Found root!"
> fi
Found root!
```

Numeric and String Comparison

When comparing numbers in the Korn shell, use double parentheses `((...))`. There is no requirement about white space around any of the components. Use white space around variables and operators for improved readability.

The `((...))` is an abbreviation of the `let` statement.

Variables can be preceded by a `$` within `((...))`, but the `$` character is not required.

When using square brackets `[ ]`, the shell requires a space after the opening `[` and before the closing `]`. For example, `[$a -eq $b]` is invalid. `[ $a -eq $b ]` is the correct usage.

Table 7-1 shows numeric comparisons.

Table 7-1 Numeric Comparison

Bourne and Korn Shells	Korn Shell	Returns True if:
<code>[\$num1 -eq \$num2]</code>	<code>((num1 == num2))</code>	<i>num1</i> equals <i>num2</i> .
<code>[\$num1 -ne \$num2]</code>	<code>((num1 != num2))</code>	<i>num1</i> does not equal <i>num2</i> .
<code>[\$num1 -lt \$num2]</code>	<code>((num1 < num2))</code>	<i>num1</i> is less than <i>num2</i> .
<code>[\$num1 -gt \$num2]</code>	<code>((num1 > num2))</code>	<i>num1</i> is greater than <i>num2</i> .
<code>[\$num1 -le \$num2]</code>	<code>((num1 <= num2))</code>	<i>num1</i> is less than or equal to <i>num2</i> .
<code>[\$num1 -ge \$num2]</code>	<code>((num1 >= num2))</code>	<i>num1</i> is greater than or equal to <i>num2</i> .

The following example sets a variable and then tests the value of the variable using the double parenthesis in an `if` statement. The `then` statement is placed on the same line with the `if`.

```
$ num=21

$ if (( num > 15 )); then
>     echo "You are old enough to drive in most places."
> fi
You are old enough to drive in most places.
```

Remember that the `(( ))` syntax is the alternative form to `let`. The syntax shown is preferred as it is considered to be more readable. The previous syntax can also be written as:

```
$ if let "num > 15"; then
>     echo "You are old enough to drive in most places."
> fi
You are old enough to drive in most places.
```

When comparing strings in Korn shell, use double square brackets `[[ ... ]]`. Here, the shell is particular about white space. You *must* use white space around every component within `[[ ... ]]`. This includes putting a white space after `[[` and before `]]`.

When comparing a string to a pattern, the string must appear on the left side of the equal sign and the pattern must appear on the right.

Table 7-2 shows string comparisons.

Table 7-2 String Comparison

Bourne and Korn Shell	Korn Shell	Returns True if:
<code>[str1 = str2]</code>	<code>[[str1 == str2]]</code>	<i>str1</i> equals <i>str2</i>
<code>[str1 != str2]</code>	<code>[[str1 != str2]]</code>	<i>str1</i> does not equal <i>str2</i>
Not available	<code>[[str1 == pattern]]</code>	<i>str1</i> matches pattern
Not available	<code>[[str1 != pattern]]</code>	<i>str1</i> does not match pattern
<code>[str1 < str2]</code>	<code>[[str1 < str2]]</code>	<i>str1</i> precedes <i>str2</i> in lexical order
<code>[str1 > str2]</code>	<code>[[str1 > str2]]</code>	<i>str1</i> follows <i>str2</i> in lexical order
<code>[-z str1]</code>	<code>[[-z str1]]</code>	<i>str1</i> has length zero (holds the null value)
<code>[-n str1]</code>	<code>[[-n str1]]</code>	<i>str1</i> has nonzero length (contains one or more characters)

Note – Lexical order means that lowercase letters have greater value than uppercase letters. As such, attempting to compare mixed-case strings might produce unexpected results.

Note – In regard to string comparisons with either the [] or [[]] statement, use quotes around literal strings or variables. The quotes are necessary when the variable value or string value has embedded spaces.

✓ *Be aware: In the Korn shell when comparing two strings or a string and a pattern:*

The [...] takes "either" = or ==

Therefore, you can use:

if ["\$name" == "fred"] or if ["\$name" = "fred"]

The [[...]] takes "either" = or ==

if [["\$name" == "fred"]] or if [["\$name" = "fred"]]

In the case of [[]], the Korn shell automatically replaces a single equals (=) with two equals (==). This can be seen by set -x; for example:

```
$ set -x
$ if [[ "$name" = "fred" ]]
> then
>     echo "fred is here!"
> fi
+ [[ fred == fred ]]
+ echo fred is here!
fred is here!
```

The following example sets a variable and then tests the value of the variable using the double square brackets in an if statement.

```
$ name=fred

$ if [[ "$name" == "fred" ]]
> then
>     echo "fred is here!"
> fi
fred is here!
```

When comparing a variable or string against a pattern, the pattern is not quoted; using quotes hides the pattern-match capability of the pattern metacharacters. Table 7-3 shows the metacharacters used for string comparison.

Table 7-3 Pattern Match Metacharacters for String Comparisons

Metacharacter	Meaning
?	Matches any one single character
[]	Matches one character in the specified set
*	Matches zero or more occurrences of any characters

Note – It is important that the contents of the double-square-bracket conditional tests start and end with a space. Surround the conditional operators by at least one space. Also, as the square brackets act as a quoting mechanism, do not use quotes to surround the pattern text.

The following example sets a variable and then compares the value of the variable against a pattern. The pattern is required to be on the right side of the operator.

```
$ name=fred

$ if [[ "$name" == f* ]]; then
>     echo "fred is here!"
> fi
fred is here!
```

Incorrect quoting is shown in the following example.

```
$ name=fred

$ if [[ "$name" == "f*" ]] ; then
>     echo "fred is here"
> fi
```

if/then/else *Syntax*

In a conditional, you frequently have tasks to perform when the tested command succeeds, as well as when the tested command fails. The shell can accommodate this situation with the `if/then/else` syntax.

In the `if/then/else` form of the `if` statement, the block of statements after the `then` statement are executed if the command succeeds. Execution then continues with the statement following the `fi` statement.

If the command in the `if` statement fails, then the block of statements after the `then` statement are skipped, and those statements following the `else` are executed. Execution then continues with the statement following the `fi` statement.

The syntax for `if/then/else` is:

```
if command
then
    block of statements
else
    block of statements
fi
```

For example:

```
$ cat snoopynap.ksh
#!/bin/ksh

# Script name: snoopynap.ksh

name=snoopy

if [[ "$name" == "snoopy" ]]
then
    echo "It was a dark and stormy night."
else
    echo "Snoopy is napping."
fi
```

```
$ cat findroot.ksh
```

```
#!/bin/ksh
```

```
# Script name: findroot.ksh
```

```
if grep root /etc/passwd > /dev/null  
then
```

```
    echo "Found root!"
```

```
else
```

```
    echo "root not in the passwd!"
```

```
    echo "Do not logout until the passwd file is repaired!"
```

```
fi
```

if/then/elif/else *Syntax*

In this form of the `if` statement, the `else` becomes another `if` statement or “else if” instead of a simple `else`.

The shell first evaluates *command1*, then *command2*, and so on, stopping with the first command that succeeds. The statements associated with that successful command are then executed, followed by any statements after the `fi` statement.

If none of the commands succeeds, then the statements following the `else` statement are executed. Execution then continues with any statements following the `fi` statement.

The syntax for `if/then/elif/else` is:

```
if command1
then
    block of statements
elif command2
then
    block of statements
else
    block of statements
fi
```

For example:

```
$ cat snoopy2.ksh
#!/bin/ksh

# Script name: snoopy2.ksh

name=snoopy

if [[ "$name" == "snoopy" ]]
then
    echo "It was a dark and stormy night."
elif [[ "$name" == "charlie" ]]
then
    echo "You're a good man Charlie Brown."
elif [[ "$name" == "lucy" ]]
then
    echo "The doctor is in."
elif [[ "$name" == "schroder" ]]
```

```
then
    echo "In concert."
else
    echo "Not a Snoopy character."
fi
```

Note – The `if/then/elif/fi` syntax can have as many `elif` *command* statements as needed before the final `else` statement. Follow each `elif` by a `then` statement.

In this example, the `TERM` variable value is tested by comparing it against different known values. As soon as one of the tests succeeds, the statements that follow the `then` statement are executed. If all comparisons of `TERM` fail, the statements following the `else` statement are executed.

```
$ cat termcheck.ksh
#!/bin/ksh

# Script name: termcheck.ksh

if [[ "$TERM" == "sun" ]]
then
    echo "You are using the sun console device."
elif [[ "$TERM" == "vt100" ]]
then
    echo "You are using a vt100 emulator."
elif [[ "$TERM" == "dtterm" ]]
then
    echo "You are using a dtterm emulator."
else
    echo "I am not sure what emulator you are using."
fi
```

Using `if` to Check Command-Line Arguments

Instead of setting a value to a variable and then executing a script, frequently, you put the values on the command line.

The script captures the command-line arguments in special variables: `$#`, `$1`, `$2`, `$3`, and so on. `$#` captures the number of command-line arguments.

The following example sets variables within a script.

```
$ cat numtest.ksh
#!/bin/ksh

# Script name: numtest.ksh

num1=5
num2=6

if (( $num1 > $num2 ))
then
    print "num1 is larger"
else
    print "num2 is larger"
fi
```

To change this script to require you to enter command-line arguments:

```
$ cat argtest.ksh
#!/bin/ksh

# Script name: argtest.ksh

if (( $1 > $2 ))
then
    print "num1 is larger"
else
    print "num2 is larger"
fi
```

To execute the script:

```
$ ./argtest.ksh 21 11
num1 is larger
```

```
$ ./argtest.ksh 1 11
num2 is larger
```

The command-line arguments are shown in Table 7-4:

Table 7-4 Command-Line Arguments

Positional Parameter Name	Description of Command-Line Argument
\$0	The script name
\$1	The value of the first argument to the script
\$2	The value of the second argument to the script
\$9	The value of the ninth argument to the script
\${10}	The value of the tenth argument to the script— Korn shell only; for Bourne shell, use the <code>shift</code> statement
\${11}, \${12}, ...	The value of the eleventh, twelfth, and so on arguments to the script—for Korn shell only
\$#	The number of arguments passed to the script
\$*	The value of all command-line arguments

Creating the USAGE Message

As you write a script and set up user interaction, generally the script is expecting a certain type of user input. For example, if the script prints a request for an age, it is expecting you to enter a numeric value. If you enter a name instead, the script might attempt an arithmetic operation on the variable and get an error.

The script should verify that the type of input and the number of values input are correct. If they are not correct, then the script can print an error message in the form of a USAGE message; for example:

```
if (( $# != 2 ))
then
    print "USAGE: $0 arg1 arg2 "
    exit
fi
```

In this case, the script is expecting two positional parameters to be entered when the script is run. If you did not give the two parameters, the script prints out the USAGE message.

Including the USAGE message is a good programming practice rather than a shell or operating system command. It is the conventional way to notify the person that executes the script that execution was not done correctly. Most operating system commands provide this type of information when you try to execute the command with an undefined option, such as `ls -z`.

```
$ ls -z
ls: illegal option -- z
usage: ls -1RaAdCxmnllogrtucpFbqisfL [files]
```

```
$ cat /etc/init.d/volmgt
#!/sbin/sh
#
# Copyright (c) 1997-1998 by Sun Microsystems, Inc.
# All rights reserved.
#
#ident  "@(#)volmgt      1.6      98/12/14 SMI"

case "$1" in
'start')
    if [ -f /etc/vold.conf -a -f /usr/sbin/vold ]; then
        echo 'volume management starting.'
        /usr/sbin/vold >/dev/msglog 2>&1 &
    fi
    ;;

'stop')
    /usr/bin/pkill -x -u 0 vold
    ;;

*)
    echo "Usage: $0 { start | stop }"
    exit 1
    ;;

esac
exit 0
```

✓ *The `exit` statement is described later in this module.*

Using `if` to Check Leap Years

The next example script uses the `date` statement to set the variable `month` to an integer representing the current month (01 is January, 12 is December).

The value of the variable `month` is then tested. If the current month is February (`month` is 02), then the messages concerning the number of days in February is printed.

If the month is not February, but is April, June, September, or November, then the message The current month has 30 days. is printed; otherwise, the current month must be January, March, May, July, August, October, or December. All of these months have 31 days. The `else` statement covers this last case.

Note – The test in the `elif` branch uses pattern matching specific to the Korn shell. These metacharacters are described in Appendix E, “Shell Metacharacters for Pattern Matching for File Names.” The specific syntax used in the example requires that it matches exactly one of the specified patterns.

```
$ cat monthcheck.ksh
#!/bin/ksh

# Script name: monthcheck.ksh

month=$(date +%m)

if (( month == 2 ))
then
    echo "February usually has 28 days."
    echo "If it is a leap year, it has 29 days."
elif [[ $month = @(04|06|09|11) ]]
then
    echo "The current month has 30 days."
else
    echo "The current month has 31 days."
fi
```

\$ date

Fri Mar 13 13:28:24 GMT 2000

\$./monthcheck.ksh

The current month has 31 days.

✓ *The pattern matching used with the `elif` statement is a form of file name pattern matching syntax. These patterns are covered, in detail, in Appendix E, “Shell Metacharacters for Pattern Matching for File Names.”*

✓ *The `@` in the `elif` statement:*

```
elif [[ $mth = @(04|06|09|11) ]]
```

means “matches exactly one of the following patterns.”

Nested if Statements

You can use an `if` statement inside another `if`. In other words, it is legal to have nested `if` statements.

Note – You can have as many levels of nested `if` statements as you can logically track.

In the following example, you input the year as a command-line argument, and the script assigns the value of \$1 to the variable `year`. The rest of the script determines if the year entered is a leap year, printing an appropriate message if it is.

The second `if` statement contains an `if` statement as one of its statements, which is where the nesting occurs. For the script to print that the year is a leap year in this case, the condition that the year entered be evenly divisible by 4 must be true, and the condition that it not be evenly divisible by 100 must also be true.

The script is then run several times from the command line. The numbers input to the script are chosen to test that something gets printed each time. It is not necessary to always have an `else` with an `if`; however, you must include an `fi` statement for each `if` statement.

```
$ cat leap.ksh
#!/bin/ksh

# Script name: leap.ksh

# Assume the user enters the year on the command line
# when they execute the script.

year=$1

if (( (year % 400) == 0 ))
then
    print "$year is a leap year!"
elif (( (year % 4) == 0 ))
then
    if (( (year % 100) != 0 ))
    then
        print "$year is a leap year!"
    else
        print "$year is not a leap year."
    fi
else
    print "$year is not a leap year."
fi

$ ./leap.ksh 2000
2000 is a leap year!

$ ./leap.ksh 1900
1900 is not a leap year.

$ ./leap.ksh 2050
2050 is not a leap year.
```

Testing File Objects

Sometimes a script might need to be able to determine the permissions on the file or exactly what type of file it is.

The permissions on a file can be tested using one of several flags shown in Table 7-5. The file or path name might be literal or stored in a variable.

Table 7-5 Determining File Permissions and Ownerships

Flag	Bourne or Korn Test	Korn Test	Description
-r	[-r <i>file</i>]	[[-r <i>file</i>]]	Can the file be read by user?
-w	[-w <i>file</i>]	[[-w <i>file</i>]]	Can the file be altered by user?
-x	[-x <i>file</i>]	[[-x <i>file</i>]]	Can the file be executed by user?
-0	Not available	[[-0 <i>file</i>]]	Is the file owned by the effective user ID of this process?
-G	Not available	[[-G <i>file</i>]]	Is the file group the effective group ID of this process?
-u	[-u <i>file</i>]	[[-u <i>file</i>]]	Does the file has the set-user-ID bit set?
-g	[-g <i>file</i>]	[[-g <i>file</i>]]	Does the file have the set-group-ID bit set?
-k	[-k <i>file</i>]	[[-k <i>file</i>]]	Does the file have the sticky bit set?

Knowing the type of file with which you are working is important. For example, you cannot perform the same operations on a directory as you can on a regular file. (Try running the `cat` command on a directory file or the `cd` command on a regular file.)

The type of file can be determined using the flags shown Table 7-6.

Table 7-6 Determining the File Type

Flag	Bourne or Korn Test	Korn Test	Description
-f	[-f <i>file</i>]	[[-f <i>file</i>]]	Is the file a regular file?
-d	[-d <i>file</i>]	[[-d <i>file</i>]]	Is the file a directory?
-c	[-c <i>file</i>]	[[-c <i>file</i>]]	Is the file a character special file?
-b	[-b <i>file</i>]	[[-b <i>file</i>]]	Is the file is a block special file?
-p	[-p <i>file</i>]	[[-p <i>file</i>]]	Is the file a named pipe?
-S	Not available	[[-S <i>file</i>]]	Is the file a socket?
-L	Not available	[[-L <i>file</i>]]	Is the file a symbolic link?
-s	[-s <i>file</i>]	[[-s <i>file</i>]]	Does the file exists and have a size greater than 0?
-e	Not available	[[-e <i>file</i>]]	Does the file exists?

- ✓ *Explain that there are many different file types allowed in a UNIX environment. Unfortunately, there are too many to describe in this course.*
- ✓ *Have the students refer to the man page for more information. See `man ksh` for Korn shell and `man sh` for Bourne shell.*

Boolean AND, OR, and NOT

The Boolean AND operator is `&&` for the Korn shell and `-a` for the Bourne shell. It requires two statements. If both statements succeed, the AND operator returns true; otherwise, it returns false.

The Boolean OR operator is `||` for the Korn shell and `-o` for the Bourne shell. It requires two statements. If both statements fail, the OR operator returns false; otherwise, it returns true.

✓ *The Korn shell Boolean operators will short circuit, meaning if the first command in an AND operation fails, the second command is not executed. Similarly with the Korn shell Boolean NOT, if the first command succeeds, the second command is not executed.*

The Boolean NOT operator is `!`. It performs a logical inversion of the value passed to it. (Success becomes failure or failure becomes success.) It can be used inside `((...))` or within `[... ]`.

```
$ cat leap2.ksh
#!/bin/ksh

# Script name: leap2.ksh

# Assume the user enters the year on the command line
# when they execute the script.

year=$1

if (( ( year % 400 ) == 0 )) ||
    (( ( year % 4 ) == 0 && ( year % 100 ) != 0 ))
then
    print "$year is a leap year!"
else
    print "$year is not a leap year."
fi
```

The operators `&&` and `||` can occur both outside and inside `((...))` or `[...]`. The example shows the `||` operator outside `((...))` and the `&&` operator inside `((...))`.

```
$ ./leap2.ksh 2000
2000 is a leap year!
```

```
$ ./leap2.ksh 2003
2003 is not a leap year.
```

The same program written with Bourne shell Boolean relational operators is:

```
$ cat leap2.sh
#!/bin/sh

# Script name: leap2.sh

# Assume the user enters the year on the command line
# when they execute the script.

year=$1

if [ 'expr $year % 400' -eq 0 -o \
    'expr $year % 4' -eq 0 -a 'expr $year % 100' -ne 0 ]
then
    echo "$year is a leap year!"
else
    echo "$year is not a leap year."
fi

$ ./leap2.sh 2000
2000 is a leap year!

$ ./leap2.sh 2003
2003 is not a leap year.
```

This example was complicated in the Bourne shell because of the lack of built-in arithmetic. A simpler example of the AND and OR operators is the following Bourne shell version of the Korn shell `monthcheck.sh` script shown earlier in this module.

```
$ cat monthcheck.sh
#!/bin/sh

# Script name: monthcheck.sh

mth='date +%m'

if [ "$mth" -eq 02 ]
then
    echo "February usually has 28 days."
    echo "If it is a leap year, it has 29 days."
elif [ \( "$mth" -eq 04 \) -o \( "$mth" -eq 06 \) -o \
      \( "$mth" -eq 09 \) -o \( "$mth" -eq 11 \) ]
then
    echo "The current month has 30 days."
else
    echo "The current month has 31 days."
fi
```

- ✓ *The `elif` statement has a line continuation after the second comparison to avoid line wrap.*
- ✓ *The parenthesis were used to show that within the `[ ]` command, any parenthesis require a back slash.*
- ✓ *You might want to describe the use of `||` and `&&` on a command line.*

The Boolean NOT is often used in testing file objects. For example, to test if a file is *not* readable as opposed to readable or to test if an object is *not* a regular file, use the following statements:

```
if [[ ! -r $var ]]    # if $var is not readable ...
if [[ ! -f $var ]]    # if $var is not a regular file...
```

The case Statement

The syntax for the `case` statement is:

```
case value in
pattern1)
    statement1
    ...
    statementn
    ;;

pattern2)
    statement1
    ...
    statementn
    ;;

*)
    statement1
    ...
    statementn
    ;;
esac
```

In the syntax given for the `case` statement, *value* refers to any value, but is usually the value of some variable.

Include double-semicolon terminator `;;` after the last statement in the group for each pattern given. This prohibits the shell from *falling through to* the statements for the next pattern and executing them. You can think of `;;` as saying “Break out of the `case` statement now and go to the statement that follows the `esac` statement.”

The patterns used in the `case` statement can be any pattern, including the shell metacharacters listed in Table 7-7 and Table 7-8.

Table 7-7 Shell Metacharacters for `case` Pattern

Metacharacter	Description
<code>?</code>	Any single character
<code>*</code>	Zero or more occurrences of any character
<code>[]</code>	Any single character in the specified set

Table 7-8 Additional Korn Shell Metacharacters for `case` Pattern

Metacharacter	Description
<code>?(pat1 pat2 ... patn)</code>	Matches zero or one of the specified patterns
<code>@(pat1 pat2 ... patn)</code>	Matches exactly one of the specified patterns
<code>*(pat1 pat2 ... patn)</code>	Matches zero, one, or more of the specified patterns
<code>+(pat1 pat2 ... patn)</code>	Matches one or more of the specified patterns
<code>!(pat1 pat2 ... patn)</code>	Matches any pattern except the specified patterns

The last pattern in a `case` statement is often `*`. If the value of the variable being tested does not match any of the other patterns, it always matches the pattern `*`. This is often called the *default pattern match* and is analogous to the `else` statement in the `if` constructs.

Example: Using the case Statement

The example for the `case` statement is the script `if_scr2` rewritten to use the `case` statement in place of the `if` statement.

The first two patterns within the `case` statement are the string patterns that the variable `mth` was compared against in the `if` statement in the script `if_scr2`.

The last pattern in the `case` statement is `*`. If `mth` does not match the first two patterns, it always matches this one. It is analogous to the `else` within an `if` statement.

```
$ cat case.ksh
#!/bin/ksh

# Script name: case.ksh

mth=$(date +%m)

case "$mth" in
02)
    print "February usually has 28 days."
    print "If it is a leap year, it has 29 days."
    ;;
04|06|09|11)
    print "The current month has 30 days."
    ;;
*)
    print "The current month has 31 days."
    ;;
esac

$ date
Tue Jul 13 08:25:16 PDT 1993

$ ./case.ksh2
The current month has 31 days.
```

A more familiar example is a boot script, such as `/etc/init.d/volmgt`. In many boot scripts, the first argument to the script is checked in a `case` statement to determine if the daemon should be started or stopped. In the following example, the `case` not only searches for the patterns `start` and `stop`, but it also uses the default `*` that it executes when you type something other than `start` or `stop`.

```
$ cat /etc/init.d/volmgt
#!/sbin/sh
#
# Copyright (c) 1997-1998 by Sun Microsystems, Inc.
# All rights reserved.
#
#ident  "@(#)volmgt      1.6      98/12/14 SMI"

case "$1" in
'start')
    if [ -f /etc/vold.conf -a -f /usr/sbin/vold ]; then
        echo 'volume management starting.'
        /usr/sbin/vold >/dev/msglog 2>&1 &
    fi
    ;;

'stop')
    /usr/bin/pkill -x -u 0 vold
    ;;

*)
    echo "Usage: $0 { start | stop }"
    exit 1
    ;;

esac
exit 0
```

- ✓ *You might want to have the students stop and start the volume manager by executing the script:*

```
/etc/init.d/volmgt stop
/etc/init.d/volmgt start
```

- ✓ *Also, you might want them to execute the script with another word so the `case` construct executes the statements for the default case.*

```
/etc/init.d/volmgt go
```

Replacing Complex `if` Statements With `case`

- ✓ *Why would the `case` statement be used instead of the `if` statement?*
- ✓ *It is much easier to understand what the `case` statement is doing and, therefore, is easier to debug.*

When you have many alternatives to check a variable against, the syntax for an `if/then/elif/else` can get very confusing. Many shell programmers use the `case` statement in these situations.

The snoopy example was written with `if/then/elif`.

```
$ cat snoopy2.ksh
#!/bin/ksh

# Script name: snoopy2.ksh

name=snoopy

if [[ "$name" == "snoopy" ]]
then
    echo "It was a dark and stormy night."
elif [[ "$name" == "charlie" ]]
then
    echo "You're a good man Charlie Brown."
elif [[ "$name" == "lucy" ]]
then
    echo "The doctor is in."
elif [[ "$name" == "schroder" ]]
then
    echo "In concert."
else
    echo "Not a Snoopy character."
fi
```


You can rewrite it with an easier-to-read case statement.

```
$ cat snoopy3.ksh
#!/bin/ksh

# Script name: snoopy3.ksh

name=lucy

case $name in
"snoopy")
    echo "It was a dark and stormy night."
    ;;

"charlie")
    echo "You're a good man Charlie Brown."
    ;;

"lucy")
    echo "The doctor is in."
    ;;

"schroder")
    echo "In concert."
    ;;

*)
    echo "Not a Snoopy character."
    ;;
esac
```

The following example is compressed. It performs the same operations as the previous example; however, it places several statements on the same line and does not have blank lines.

```
#!/bin/ksh
case $a in
    "snoopy") echo "It was a dark and stormy night." ;;
    "charlie") echo "You're a good man Charlie Brown" ;;
    "lucy") echo "The doctor is in." ;;
    *) echo "Not a Snoopy character" ;;
esac
```

The exit Statement

The `exit` statement terminates execution of the entire script. It is most often used if the input requested from the user is incorrect, a statement ran unsuccessfully, or some other error occurred.

The `exit` statement takes an optional argument that is an integer. This number is passed back to the parent shell, where it is stored in the shell reserved variable `?`. A nonzero integer argument to the `exit` statement means that the script ran unsuccessfully. A zero argument means the script ran successfully.

If no argument is given to the `exit` statement, the shell uses the current value of `?`.

✓ *The value of `?` is the exit status of the statement executed before `exit`.*

```
$ cat /etc/init.d/volmgt
#!/sbin/sh
#
# Copyright (c) 1997 by Sun Microsystems, Inc.
# All rights reserved.
#
#ident      "@(#)volmgt      1.5   97/12/08 SMI"

case "$1" in
'start')
    if [ -f /etc/vold.conf -a -f /usr/sbin/vold ]; then
        echo 'volume management starting.'
        /usr/sbin/vold >/dev/console 2>&1 &
    fi
    ;;

'stop')
    /usr/bin/pkill -x -u 0 vold
    ;;

*)
    echo "Usage: $0 { start | stop }"
    exit 1
    ;;

esac
exit 0
```

```
$ /etc/init.d/volmgt go
Usage: /etc/init.d/volmgt { start | stop }
$ echo $?
1

$ /etc/init.d/volmgt start
volume management starting.
$ echo $?
0
```

The `exit` statement is often used to terminate a script because of unexpected user input or the occurrence of an error.

Exercise: Conditionals



Exercise objective – In this lab, you answer questions about one of the system boot scripts and write scripts to practice the concepts, statements, and commands described in this module.

Preparation

Refer to the lecture notes as necessary to write the following scripts as specified in the following tasks.

Change the directory to `mod7/lab` before beginning the exercise.

When composing the script, you might want to execute commands on the system to ensure you have the correct command and option to give you the requested output.

- ✓ *Given the varied abilities of the students, some might finish all the tasks listed and others might only complete a portion of the tasks.*
- ✓ *You might want to tell the students to answer the questions for the first task, and then write as many of the scripts as time allows. They might want to begin with the script that interests them most.*

Tasks

1. Modify your `/.profile` to ensure the Korn shell is only invoked as your login shell after you test and verify that the shell file exists. Therefore, if `/usr` was not mounted, the `/.profile` file would not invoke the Korn shell.

2. Read through the following lines from the `/etc/init.d/nfs.server` script, and answer the questions that follow.

```
# If /etc/dfs/dfstab exists and has non-blank or non-commented-out
# lines, then run shareall to export them, and then start up mountd
# and nfsd if anything was successfully exported.
```

```
startnfsd=0
if [ -f /etc/dfs/dfstab ] && /usr/bin/egrep -v '^[          ]*(#|$)' \
    /etc/dfs/dfstab >/dev/null 2>&1; then

    /usr/sbin/shareall -F nfs
```

The preceding lines of code, less the comments, determine when the machine should attempt to share all the directories listed in the `dfstab` file. Given that, answer the following questions.

- a. What does the following command do?

```
[ -f /etc/dfs/dfstab ]
```

-
- b. What does the following command do?

```
/usr/bin/egrep -v '^[          ]*(#|$)' /etc/dfs/dfstab >/dev/null 2>&1
```

-
- c. What does the `if` statement evaluate?

-
3. Write a script (named `filetype`) that takes exactly one command-line argument and assumes that the command-line argument is a path name to a file or directory.
 - a. Output a `USAGE` message, and exit the script immediately when the script is executed with more or less than one command-line argument.

- b. If the path name is a directory:
 - List the directory name.
 - List the contents of the directory.
 - List the file space consumed by the directory and all files and subdirectories, in Kbytes (realize that this command must perform a calculation before the number is displayed. Therefore, the script will have to wait if you choose a directory structure that is deep or large.)
- c. Assume the path name is a file:
 - List the file name.
 - List the file size in bytes.
 - Tell that the file is:
 - Block special
 - Char special
 - A set-user-id bit file

Hint: To validate the character-special and blocked-special tests, use the physical device name associated with a slice of your local disk.

An example might be:

```
/devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a
```

for the block-special device,

```
/devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a,raw
```

for the character-special device,

```
/usr/bin/crontab
```

for the file with set-user-id permission.

4. Copy the adduser script from the mod6 lab.

Modify the script to:

- a. Take exactly one command-line argument assumed to be the new user's name. Output a USAGE message and, exit the script immediately when the script is executed with more or less than one command-line argument.
- b. Either assign the value of \$1 to the variable name or change the grep command to search for \$1.

-
- c. If the user name already exists in the `mypasswd` file, print a message, print the actual `mypasswd` entry for the user, and then exit the script.
 - d. In the previous lab, you used `sed` to create a file of nonsystem UID number. Numerically sort the contents of this file, and store the output into `currentuid4`.
 - e. The last line in `currentuid4` has the maximum UID number currently in use. Increment that number by 1 for the new user.
 - f. Print the new user name and UID.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Modify your `/.profile` to ensure the Korn shell is only invoked as your login shell after you test and verify that the shell file exists. Therefore, if `/usr` was not mounted, the `/.profile` file would not invoke the Korn shell.

```
if [ -f /usr/bin/ksh ]
then
    SHELL=/usr/bin/ksh
    export SHELL
    /usr/bin/ksh
fi
```

2. Read through the following lines from the `/etc/init.d/nfs.server` script, and answer the questions that follow.

```
# If /etc/dfs/dfstab exists and has non-blank or non-commented-out
# lines, then run shareall to export them, and then start up mountd
# and nfsd if anything was successfully exported.
```

```
startnfsd=0
if [ -f /etc/dfs/dfstab ] && /usr/bin/egrep -v '^[ \t]*#|'$)' \
    /etc/dfs/dfstab >/dev/null 2>&1; then

    /usr/sbin/shareall -F nfs
```

The preceding lines of code, less the comments, determine when the machine should attempt to share all the directories listed in the `dfstab` file. Given that, answer the following questions.

- a. What does the following command do?

```
[ -f /etc/dfs/dfstab ]
```

Tests to determine if `/etc/dfs/dfstab` exists and if it is a regular file. The exit status is 0 if it exists and 1 if it is nonexistent.

- b. What does the following command do?

```
/usr/bin/egrep -v '^[      ]*(#|$)' /etc/dfs/dfstab >/dev/null 2>&1
```

*The **egrep** command finds all lines that do not begin with zero or more white spaces followed by a # or end of line (\$) in the file /etc/dfs/dfstab. The output and error messages are put into /dev/null. **egrep** returns 0 if it successfully found any lines with the pattern and 1 if it failed to find the specified pattern.*

- c. What does the **if** statement evaluate?

*The **if** statement waits for the Boolean to test the exit status of the **-f** command and the exit status of the **egrep** command.*

*The **&&** operator defines that if both commands succeed (return 0 exit status), then it returns true. In this situation, the **if** executes the statements following the **then** statement.*

*The **&&** operator defines that if one or both of the commands fail (return a nonzero exit status), then it returns false. In this situation, the **if** executes the statements following the **else** statement if it exists, or the **fi** statement.*

3. Write a script (named **filetype**) that takes exactly one command-line argument and assumes that the command-line argument is a path name to a file or directory.

- a. Output a USAGE message, and exit the script immediately when the script is executed with more or less than one command-line argument.

```
if [ $# -ne 1 ]; then
    echo "Usage: filetype pathname"
    exit 1
fi
```

- b. If the path name is a directory:

- List the directory name.
- List the contents of the directory.
- List the file space consumed by the directory and all files and subdirectories, in Kbytes (realize that this command must perform a calculation before the number is displayed. Therefore, the script will have to wait if you choose a directory that is deep or large.)

```

if [ -d $1 ]; then
    echo "$1 is a directory."
    echo "Following is a listing of the $1 directory."
    ls $1
    echo " "
    echo "The number of kilobytes used by directory $1 is: \c"
    du -s -k $1 | nawk '{print $1}'
else

```

c. Assume the path name is a file:

- List the file name.
- List the file size in bytes.
- Tell that the file is:
 - block special
 - char special
 - a set-user-id bit file

```

if [ -d $1 ]; then
...
else
    echo "$1 is a file."
    echo "The size of $1 in bytes is: \c"
    ls -l $1 | nawk '{print $5}'
    echo
    if [ -b $1 ]; then
        echo "$1 is a block special file."
    elif [ -c $1 ]; then
        echo "$1 is a character special file."
    elif [ -u $1 ]; then
        echo "$1 has the set-user-id permission."
    else

```

fi

Hint: To validate the character-special and blocked-special tests, use the physical device name associated with a slice of your local disk.

An example might be:

/devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a

for the block-special device,

/devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a,raw

for the character-special device,

/usr/bin/crontab

for the file with set-user-id permission.

Full Script Solution for 3

```
$ cat filetype.sh
#!/bin/sh

# Purpose: This file will determine is the pathname passed on
#          the command line is a file or directory. Then it will
#          print information about the pathname.
#
# Scriptname: filetype.sh

if [ $# -ne 1 ]; then
    echo "Usage: filetype pathname"
    exit 1
fi

if [ -d $1 ]; then
    echo "$1 is a directory."
    echo "Following is a listing of the $1 directory."
    ls $1
    echo " "
    echo "The number of kilobytes used by directory $1 is: \c"
    du -s -k $1 | awk '{print $1}'
else
    echo "$1 is a file."
    echo "The size of $1 in bytes is: \c"
    ls -l $1 | awk '{print $5}'
    echo
    if [ -b $1 ]; then
        echo "$1 is a block special file."
    elif [ -c $1 ]; then
        echo "$1 is a character special file."
    elif [ -u $1 ]; then
        echo "$1 has the set-user-id permission."
    else
        echo "There is nothing special to say about file $1."
    fi
fi

echo "Finished"
```

4. Copy the `adduser` script from the `mod6` lab.

```
$ cp ../../mod6/lab/adduser .
```

Modify the script to:

- a. Take exactly one command-line argument assumed to be the new user's name. Output a `USAGE` message, and exit the script immediately when the script is executed with more or less than one command-line argument.

```
if [ $# -ne 1 ]
then
    echo "Usage: adduser newusername"
    exit 1
fi
```

- b. Either assign the value of `$1` to the variable `name` or change the `grep` command to search for `$1`.

```
name=$1
```

- c. If the user name already exists in the `mypasswd` file, print a message, print the actual `mypasswd` entry for the user, and then exit the script.

```
if grep "^$name:" ./mypasswd > /dev/null 2>&1
then
    echo "The username $1 is already in use, here "
    echo "is the entry from the ./mypasswd file."
    echo
    grep "^$name:" ./mypasswd
    exit 2
fi
```

- d. In the previous lab, you used `sed` to create a file of nonsystem UID numbers. Numerically sort the contents of this file, and store the output into `currentuid4`.

```
sort -n ./currentuid3 > ./currentuid4
```

- e. The last line in `currentuid4` has the maximum UID number currently in use. Increment that number by 1 for the new user.

```
lastuid='sed -n '$p' ./currentuid4'
uid='expr $lastuid + 1'
```

- f. Print the new user name and UID.

```
echo "The uid for $name is: $uid"
```

Full Script Solution for 4

```
$ cat adduser.sh
```

```
#!/bin/sh
```

```
# Purpose: To write a script to add user to the system.
```

```
# Name: adduser_sh
```

```
# Check for only a single command line argument
```

```
if [ $# -ne 1 ]
```

```
then
```

```
    echo "Usage: adduser newusername"
```

```
    exit 1
```

```
fi
```

```
# Assign the value of $1 to the variable name
```

```
name=$1
```

```
if grep "^$name:" ./mypasswd > /dev/null 2>&1
```

```
then
```

```
    echo "The username $1 is already in use, here "
```

```
    echo "is the entry from the ./mypasswd file."
```

```
    echo
```

```
    grep "^$name:" ./mypasswd
```

```
    exit 2
```

```
fi
```

```
# Use nawk to extract all the UIDs into the temp file currentuid
```

```
nawk -F: '{print $3}' ./mypasswd > ./currentuid
```

```
# Use sed to remove all 1, 2, and 3 digit UIDs from currentuid, and
```

```
# place the output in the temp file currentuid2
```

```
sed -e '/^.$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2
```

```
# Use sed to remove UIDs 60001, 60002, and 65534 from currentuid2,
```

```
# and place the output in the temp file currentuid3
```

```
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3
```

```
# Sort the UIDs in currentuid3 numerically
sort -n ./currentuid3 > ./currentuid4

# Calculate the next available UID
lastuid='sed -n '$p' ./currentuid4'

uid='expr $lastuid + 1'
echo "The uid for $name is: $uid"
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use the exit status of a command as conditional control
- ☐ Use the `if` statement to test a condition
- ☐ Pass values using command-line arguments (positional parameters) into a script
- ☐ Create USAGE messages
- ☐ Place parameters on the command line
- ☐ Use conditional constructs `if`, `then`, `elif`, `else`, and `fi`
- ☐ Use `exit`, `let`, and test statements (`[[ ]]` , `(( ))`)
- ☐ Apply Boolean logic `&&`, `||`, and `!`
- ☐ Use the `case` statement

Objectives

Upon completion of this module, you will be able to:

- Use the `print` and `echo` statements to display text
- Use the `read` statement to interactively assign data to a shell variable
- Read user input into one or more variables using one `read` statement
- Use special characters, with `print` and `echo`, to make the displayed text more user-friendly
- Create a *here* document
- Use file descriptors to read from and write to multiple files

Input and Output in a Script

While some scripts run without any interaction with the user, many scripts require input from the user or give output to the user as the script is running.

Advantages of no interaction include:

- The script runs the same way every time
- The script can run in the background

Advantages of user interaction include:

- The script is more flexible
- The user can customize the script as it runs
- The script can report its progress as it runs

The Korn Shell `print` Statement

You use the `print` statement for output. Use it wherever you would use the `echo` statement. It is more versatile than the `echo` statement.

The `print` statement has several options:

- n Suppresses the newline after printing the message. This usually is used when printing a prompt for user input.
- r Turns off the special meaning of the `\` character.
- R Does not interpret the `-` that follows as an option to the `print` statement, except if followed by `n`; that is, if the `-n` option follows `-R`, it is still taken as an option. This option is useful if you need to print negative numbers.
- Same as `-R`, except that a following `-n` option is taken literally.

The `print` statement also interprets the following as special characters when they are enclosed in double quotes:

- `\n` Prints a newline character, which enables you to print a message on several lines using one `print` statement
- `\t` Prints a tab character, which is useful when creating tables or a report
- `\a` Rings the bell on the terminal, which draws the attention of the user
- `\b` Backspaces one character, which overwrites the previous character

Note – Provide the special characters to the `print` statement within double quotes. The statements `print \n` and `print "\n"` do not give the same results.

Examples: Using print

The following are examples of the various `print` options and special characters displayed on the command line. Experiment with these to get a feel for how they work.

```
$ print "Hello there.\nHow are you?"
Hello there.
How are you?
```

```
$ print -r "Hello there.\nHow are you?"
Hello there.\nHow are you?"
```

```
$ print "-2 was the temperature this morning."
ksh: print: bad option(s)
```

```
$ print -R "-2 was the temperature this morning."
-2 was the temperature this morning.
```

```
$ print -- "-2 was the temperature this morning."
-2 was the temperature this morning.
```

```
$ print -- -n "is the option."
-n is the option.
```

```
$ print -R -n "is the option."
is the option.$
```

```
$ print -n "No newline printed here. "
No newline printed here. $
```

```
$ print "Hello\tout\tthere!"
Hello   out       there!
```

```
$ print "\aListen to me!"
<bell rings>Listen to me!
```

```
$ print "Overwrite\b the 'e' in 'Overwrite'."
Overwrit the 'e' in 'Overwrite'.
```

✓ *One use of the `\b` option is to print bold on an old teletype machine.*

Examples: Using echo

The following are examples of the various `echo` options and special characters displayed on the command line. Experiment with these to get a feel for how they work.

These examples have been included to show that you have an alternative to the Korn shell-specific `print` statement.

Although it looks as though the last example does not work, this is only because the shell overwrote the closing square bracket when the next command line prompt is displayed.

```
$ echo "Hello there.\nHow are you?"
```

```
Hello there.
```

```
How are you?
```

```
$ echo "Hello there.\n\nHow are you?"
```

```
Hello there.\n\nHow are you?"
```

```
$ echo "-2 was the temperature this morning."
```

```
-2 was the temperature this morning.
```

```
$ echo "No newline printed here. \c"
```

```
No newline printed here. $
```

```
$ echo "Hello\tout\tthere!"
```

```
Hello    out    there!
```

```
$ echo "\007Listen to me!"
```

```
<bell rings>Listen to me!
```

```
$ echo "Overwrite\b the 'e' in 'Overwrite'."
```

```
Overwrit the 'e' in 'Overwrite'.
```

```
$ echo "Type a letter [ ]\b\b\c"
```

```
Type a letter [$
```

✓ *The last example does not have a typographical error in it.*

The read Statement

The counterpart of the `print` or `echo` statement is the `read` statement. The `read` statement reads input typed in by the user from the keyboard or a line from a file.

- The input is parsed (broken down) into *tokens*.

A *token* is any group of consecutive characters that do not contain white spaces. Thus, the first token begins with the first non-white space character and ends when a white space character is encountered. The second token begins with the next non-white space character and ends with the first white space character thereafter, and so on. White space can be included if quotes are used around the token.

- The `read` statement continues reading characters until a newline is encountered.
- The `read` statement uses the contents of the `IFS` variable as token delimiters. By default, the values are white space; however, you can change this to include other characters, such as commas, colons, or other field separators.

✓ **The user can change the contents of the `IFS` variable by simple assignment; for example,**

```
IFS=:          # a colon
IFS=".,?;:!"   # commonly used punctuation
```

✓ **The contents of `IFS` are used by such statements as `read`, `set`, `select`, and `for` statements (which are described later) as well as the `$*` and `$@` command-line argument references.**

- The first token is saved in the first variable name following the `read` statement, the second token in the second variable, and so on. If there are more tokens than variables supplied to `read`, the last variable holds all remaining tokens.

Note – If there are more variables than tokens, the extra variables have no value assigned to them; however, they still exist as valid variables in the shell.

- If there are no variable names supplied to the `read` statement, the Korn shell puts the values read in the `REPLY` variable. The Bourne shell returns an error.

Examples: Using read

The number of variables supplied to `read` matches the number of tokens typed on the command line.

```
$ read var1 var2 var3
abc def ghi
$ echo $var1
abc
$ echo $var2
def
$ echo $var3
ghi
```

The number of variables supplied to `read` is less than the number of tokens typed on the command line.

```
$ read num string junk
134 bye93;alk the rest of the line is put in 'junk'
$ echo $num
134
$ echo $string
bye93;alk
$ echo $junk
the rest of the line is saved in 'junk'
```

The number of variables supplied to `read` is more than the number of tokens typed on the command line.

```
$ read token1 token2
one
$ echo $token1
one
$ echo $token2
```

Variable names are not supplied to `read` when using Korn shell. In this case, the Korn shell populates the `REPLY` variable with the user input.

```
$ read
What is this saved in?
$ echo $REPLY
What is this saved in?
```

Variable names are not supplied to `read` when using the Bourne shell. In this case, the Bourne shell does not populate the `REPLY` variable; it gives an error message.

```
$ read  
read: missing arguments
```


Printing a Prompt

This example shows how to prompt the user for some input using a `\c` in the output string. A `read` statement obtains the input.

The input is read and saved in variables using the `read` statement. An extra variable, *junk*, is supplied with both `read` statements to pick up any extra input by the user.

The input is then used in a message that prints to the screen with the `echo` statement.

```
$ cat io1.sh
#!/bin/sh

# Script name: io1.sh

# This script prompts for input and prints messages
# involving the input received.

echo "Enter your name: \c"
read name junk

echo "Hi $name, how old are you? \c"
read age junk

echo "\n\t$age is an awkward age, $name,"
echo "    You're too old to depend on your parents,"
echo "and not old enough to depend on your children."

$ ./io1.sh
Enter your name: Murdock.
Hi Murdock, how old are you? 25
```

```
    25 is an awkward age, Murdock.
    You're too old to depend on your parents,
    and not old enough to depend on your children.
```

Similarly, you could prompt for input using the `print` statement with the `-n` option. The `-n` option leaves the cursor at the end of the text line.

```
$ cat io2.ksh
#!/bin/ksh

# Script name: io2.ksh

# This script prompts for input and prints messages
# involving the input received.

print -n "Enter your name: "
read name junk

print -n "Hi $name, how old are you? "
read age junk

print "\n\t$age is an awkward age, $name,"
print "    You're too old to depend on your parents,"
print "and not old enough to depend on your children."
```

```
$ ./io2.ksh
Enter your name: Murdock.
Hi Murdock, how old are you? 25
```

```
    25 is an awkward age, Murdock.
    You're too old to depend on your parents,
and not old enough to depend on your children.
```

Prompting for Input – Korn Shell Shortcut

When you use one variable with the `read` statement, you can put the prompt for the input within the `read` statement itself. The syntax is:

```
read var?"prompt"
```

Note – There is no space between the variable name and the `?`, nor between the `?`, and the prompt string that is enclosed within quotes.

Although this prompting facility is available in the Korn shell, it is considered better practice to use either `echo` or `print` to display the prompt message. The `echo` and `print` statements are more flexible in their use as they can display many lines of text as one output string. It is also more difficult to debug the script when combining the `read` statement with a prompt string in one statement line.

The following example shows how to put the prompts into `read` statements instead of using `print` statements.

The output from running the script is the same as the output from the execution of script `io2.ksh`.

```
$ cat io3.ksh
#!/bin/ksh

# Script name: io3.ksh

# This script prompts for input and prints messages
# involving the input received.

read name?"Enter your name: "

read age?"Hi $name. How old are you? "

print "\n\t$name is an awkward age, $name,"
print "    You're too old to depend on your parents,"
print "and not old enough to depend on your children."

$ ./io3.ksh
```

```
Enter your name: Murdock
Hi Murdock. How old are you? 25
```

```
    25 is an awkward age, Murdock.
    You're too old to depend on your parents,
    and not old enough to depend on your children.
```

- ✓ *There is another version of this script, which is called io4.ksh.*
- ✓ *Ask the students to try this version and the io4.ksh version, and enter more than one word for the name. Ask them to state the difference between the two versions of the same script.*

When you put the prompt for input into the read statement, you can supply an extra variable to pick up extra input by the user; for example:

```
$ read name?" Enter your name: "
Enter your name: John Murdock
$ print $name
John Murdock
```

```
$ read name?" Enter your name: "more
Enter your name: John Murdock
```

```
$ print $name
John
```

```
$ print $more
Murdock
```

File Input and Output

The script can receive input from a file and send output to a file so that the script can run without user interaction. Later, the user can review the output file, or another script can use the output file as its input.

File input and output are accomplished in the shell by integer handles that the kernel uses to track all open files in a process. These numeric values are known as file descriptors. The best known file descriptors are 0 (stdin), 1 (stdout), and 2 (stderr).

The numbers 3 through 9 are for programmer-defined file descriptors. You can use these to associate numeric values to path names. Therefore, in a program, if there is a need to read or write multiple times to the same file, a shorthand file descriptor value might reduce errors in referencing the file name. Also, a change to the file name only needs to be done once if the file is subsequently accessed through the file descriptor. Table 8-1 shows the syntax for file redirection.

Table 8-1 Redirection in the Shell

Command	Description
<code>< file</code>	Takes standard input from <i>file</i>
<code>0< file</code>	Takes standard input from <i>file</i>
<code>> file</code>	Puts standard output to <i>file</i>
<code>1> file</code>	Puts standard output to <i>file</i>
<code>2> file</code>	Puts standard error to <i>file</i>
<code>exec fd> /some/filename</code>	Assigns the file descriptor <i>fd</i> to <i>/some/filename</i> for output
<code>exec fd< /some/filename</code>	Assigns the file descriptor <i>fd</i> to <i>/some/filename</i> for input
<code>read <&fd var1</code>	Reads from the file descriptor <i>fd</i> and stores into variable <i>var1</i>
<code>cmd>& fd</code>	Executes <i>cmd</i> and send output to the file descriptor <i>fd</i>
<code>exec fd<&-</code>	Closes the file descriptor <i>fd</i>

User-Defined File Descriptors

A file descriptor is a way to assign a numeric value to a file. Instead of using the file name, you can use the file descriptor.

One of the built-in commands in the shell is `exec`. You can use this command to assign a file descriptor to a file. The syntax is:

```
exec fd> filename  
exec fd< filename
```

No spaces are allowed between the file descriptor number (*fd*) and the redirection symbol (> for output, < for input).

After a file descriptor has been assigned to a file, you can use the descriptor with the shell redirection operators. On output, if the file did not exist, it is created. If it did exist, it is emptied. On input, if the file did not exist, an error occurs.

```
command >&fd  
command <&fd
```

The file descriptor assigned to the file is valid in the current shell only.

File Descriptors in the Bourne Shell

In the following example, the syntax for reading and writing using file descriptors use the Bourne syntax for the `read` and `echo` statements. This syntax works with both shells.

In the following example:

1. Copy `/etc/hosts` to the `/tmp/hosts2` file .
2. Use `grep` to read `/tmp/hosts2`, strip out the comment lines, and send the output to the `/tmp/hosts3` file.
3. Assign File Descriptor 3 to `/tmp/hosts3` for input, then each `read` statement issued to File Descriptor 3 reads a record from the file. The statement used to associate File Descriptor 3 to the input file named `/tmp/hosts3` is:

```
exec 3< /tmp/hosts3
```

4. Assign File Descriptor 4 to `/tmp/hostsfinal` for output. If the output file does not exist, it is created. If it does exist, its size truncates to 0 bytes. The statement that associates File Descriptor 4 to the output file is:

```
exec 4> /tmp/hostsfinal
```

5. Read `/tmp/hosts3` and output two fields to `/tmp/hostsfinal`

Reading from the input file is accomplished by specifying the file descriptor number to the `<&` argument of the `read` statement. This causes a line of the input file to be read for each `read` operation beginning with the first line, and continuing on sequentially.

You write text to the output file by specifying the file descriptor number to the `>&` argument of the `print` statement. This causes the output to be written as a line in the output file. The output file is written sequentially.

6. You close the input file when it is no longer needed, which is a good practice. The operating system closes the file automatically when the process terminates if the program fails to do so.
7. When all writes to the output file are complete, close the file.

```
$ cat readex.sh
#!/bin/sh

# Script name: readex.sh

cp /etc/hosts /tmp/hosts2      # Step 1 - Copy /etc/hosts

##### Step 2 - Strip out comment lines
grep -v '^#' /tmp/hosts2 > /tmp/hosts3

##### Step 3 - fd 3 is input file /tmp/hosts3
exec 3< /tmp/hosts3

##### Step 4 - fd 4 is output file /tmp/hostsfinal
exec 4> /tmp/hostsfinal

##### The following 4 statements accomplish STEP 5

read <& 3 addr1 name1 alias      # Read from fd 3
read <& 3 addr2 name2 alias      # Read from fd 3

echo $name1 $addr1 >& 4          # Write to fd 4 (do not write aliases)
echo $name2 $addr2 >& 4          # Write to fd 4 (do not write aliases)

##### END OF STEP 5 statements

exec 3<&-                        # Step 6 - close fd 3

exec 4<&-                        # Step 7 - close fd 4

$ ./readex.sh
$ more /tmp/hosts2
#
# Internet host table
#
127.0.0.1      localhost
192.9.200.111  ultrabear      loghost
192.9.200.121  ladybear
```



```
$ more /tmp/hosts3
127.0.0.1      localhost
192.9.200.111 ultrabear      loghost
192.9.200.121 ladybear
```

```
$ more /tmp/hostsfinal
localhost 127.0.0.1
ultrabear 192.9.200.111
```

File Descriptors in the Korn Shell

The read statement uses a `-ufd` syntax rather than the `<& fd` syntax in the Korn shell.

The print statement uses a `-ufd` syntax to direct the output to File Descriptor 4 in the Korn shell.

```
$ cat readex.ksh
#!/bin/ksh

# Script name: readex.ksh

cp /etc/hosts /tmp/hosts2      # Step 1 - copy /etc/hosts

# Step 2 - Strip out comment lines
grep -v '^#' /tmp/hosts2 > /tmp/hosts3

# Step 3 - fd 3 is an input file /tmp/hosts3
exec 3< /tmp/hosts3

# Step 4 - fd 4 is output file /tmp/hostsfinal
exec 4> /tmp/hostsfinal

##### The following 4 statements accomplish STEP 5

read -u3 addr1 name1 alias      # read from fd 3
read -u3 addr2 name2 alias      # read from fd 3

print -u4 $name1 $addr1         # write to fd 4 (do not write aliases)
print -u4 $name2 $addr2         # write to fd 4 (do not write aliases)

##### END OF STEP 5 statements

exec 3<&-                        # Step 6 - close fd 3

exec 4<&-                        # Step 7 - close fd 4

$ ./readex.ksh
```

```
$ more /tmp/hosts2
#
# Internet host table
#
127.0.0.1      localhost
192.9.200.111 ultrabear      loghost
192.9.200.121 ladybear

$ more /tmp/hosts3
127.0.0.1      localhost
192.9.200.111 ultrabear      loghost
192.9.200.121 ladybear

$ more /tmp/hostsfinal
localhost 127.0.0.1
ultrabear 192.9.200.111
```

The here Document

Frequently, your script might call on another script or utility that requires input. To run your script without operator interaction, you must supply that input within your script. The *here* document provides a means to do this.

The syntax for the *here* document is:

```
command << Keyword
input1
input2
...
Keyword
```

For example:

```
$ cat termheredoc.ksh
#!/bin/ksh

# Script name: termheredoc.ksh

print "Select a terminal type"
cat << ENDINPUT
    sun
    ansi
    wyse50
ENDINPUT

print -n "Which would you prefer? "
read termchoice

print
print "You choice is terminal type: $termchoice"

$ ./termheredoc.ksh
Select a terminal type
    sun
    ansi
    wyse50
Which would you prefer? sun

You choice is terminal type: sun
```

Note – Do not place spaces after the last line of input and the first character of the keyword.

Note – All lines of the *here* document must be left-justified. Do not use leading spaces.

```
#!/bin/ksh

# This script automates installing the SUNWaudio software package.
#
# The assumption is the answers to the installation questions have
# been documented by performing an actual install. Running the
# script command prior to doing a package installation would
# allow for such documentation.
#
# This software package only asks two questions:
# Do you want to install these conflicting files [y,n,?,q]
# Do you want to continue with the installation of <SUNWaudio> [y,n,?]
#
# In each case the answer we will give is y for yes. Hence the two
# lines containing y in the here document.

print "About to install the SUNWaudio package."
pkgadd -d spool SUNWaudio << ENDINPUT
y
y
ENDINPUT
```

✓ *The original keyword recommended by Bourne was !.*

Exercise: Interactive Scripts



Exercise objective – In this lab, you write one or more of the shell scripts specified in the following tasks.

One task is to write a backup script that takes a file system as a command-line argument. This script then asks the user to enter the `ufsdump` level (full or incremental) that should be specified in the command.

Another task is to continue writing the `adduser` script begun in an earlier lab exercise. The script should now prompt for the user's primary group, login shell, and comment information.

Preparation

Refer to the lecture notes as necessary to perform the following tasks.

Change the directory to `mod8/lab` before beginning the exercise.

When writing the script involving the file system backup, display the man page for `ufsdump` if syntax help is needed.

When writing the script involving adding a new user, look at the `/etc/passwd` file, or read the man page on the `/etc/passwd` file (`man passwd.4`) if you are unsure of the field order.

When writing the script involving adding a new user, read over the exercise from the last module or your solution to it to remind yourself what that version of the script was to accomplish.

Task

1. Write a script named `backscript` that automates the `ufsdump` command so that the person who executes the script always uses the desired options.

Note – Write the backup to the file `/dev/null`, which saves time and obviates the need to use physical media.

Note – Backup something small, such as `/export/home`.

Implement the following features in the script. Write each step, and then test that portion of the code, rather than writing the entire script all at once.

The script should:

- a. Take exactly one argument that is assumed to be the file system name. If the test is not equal to one, output a **USAGE** message and exit.
- b. Determine if the name entered is a valid directory; if not, output that it is an unknown file system, and then exit.
- c. If the name entered is a valid directory, do the following:
 1. Output the name of the file system as confirmation.
 2. Prompt the user to input the desired full or incremental backup level number (you might want to list these for the user, perhaps as a *here* document).
 3. Read the level number entered by the user, and test it to ensure it is in the proper range.
 4. If the level number is out of range, output that it is an invalid backup level, and then exit.
 5. If the level number is in range, show the user the backup command that will be issued, and prompt the user to indicate if the user is ready to have the script perform the backup of the file system. (Hint: Because the backup level is stored in a variable (**LEVEL**) and you want to include that variable as one of the options, enclose the variable name in `{ }` to shield it from the option that follows; for example, `${LEVEL}f`.)
 6. If the user enters a **y**, meaning the user wants to proceed with the backup, execute the `ufsdump` command. When it finishes, the script is done.
 7. If the user enters anything other than a **y**, instruct the user to try later when the user is ready.

- d. For example executions of the script, run the solution with the following arguments:

```
$ ./backupscript
```

```
$ ./backupscript /foo
```

```
$ ./backupscript /export/home
```

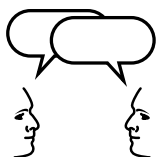
2. Copy the `adduser` script from the `mod7` lab. Now that the user name and `uid` number have been determined, you continue to gather the remaining information to create an entry for the `mypasswd` file.

Modify the script to:

- a. Prompt the user to enter a group name, read in the number, and verify that the name entered exists in the `/etc/group` file.
- b. If the group name is not in `/etc/group`, tell the user that is not a valid group, and exit the script.
- c. Prompt the user for the login shell for the new user. You might want to list the ones you will accept with a *here* document.
- d. Read the requested shell choice.
- e. If the shell choice is acceptable:
 1. Prompt for the comment field information.
 2. Read the comment information.
 3. Assume the login directory for the user is `/export/home/username`.
 4. Print an entry for the new user using colon delimiters between the seven fields.
 5. Append the new user entry at the end of the `mypasswd` file.
- f. If the shell requested is not one you expect, tell the user that the shell is not a valid shell, and exit the script.

Hint: You can run the solution to get a sense of the flow of the script. When doing this, also put in invalid information if you want to test the error messages.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Write a script named `backupscrip` that automates the `ufsdump` command so that the person who executes the script always uses the desired options.

Note – Write the backup to the device `/dev/null`, which saves time and obviates the need to use physical media.

Note – Backup something small, such as `/export/home`.

Implement the following features in the script. Write each step, and then test that portion of the code, rather than writing the entire script all at once.

The script should:

- a. Take exactly one argument that is assumed to be the file system name. If the test is not equal to one, output a `USAGE` message and exit.

```
if [ $# -ne 1 ]; then
    echo "Usage: backupscrip filesystem"
    exit 1
fi
```

- b. Determine if the name entered is a valid directory; if not, output that it is an unknown file system, and then exit.

```
if [ -d $1 ]; then
    ...
else
    echo "Unknown filesystem, exiting..."
    exit 4
fi
```

- c. If the name entered is a valid directory, do the following:

1. Output the name of the file system as confirmation.

```
if [ -d $1 ]; then
    echo "$1 is the filesystem to be backed up."
```

2. Prompt the user to input the desired full or incremental backup level number (you might want to list these for the user, perhaps as a *here* document).

```
    echo "Select a ufsdump level"
    cat << ENDDUMPLEVELS
> 0  # which is a full backup
> 1
> 2
> 3
> 4
> 5
> 6
> 7
> 8
> 9
ENDDUMPLEVELS
```

3. Read the level number entered by the user, and test it to ensure it is in the proper range.

```
read LEVEL
```

4. If the level number is out of range, output that it is an invalid backup level, and then exit.

```
if [ $LEVEL -ge 0 -a $LEVEL -le 9 ]; then
...
else
    echo "Invalid backup level, exiting..."
    exit 2
fi
```

5. If the level number is in range, show the user the backup command that will be issued, and prompt the user to indicate if the use is ready to have the script perform the backup of the file system. (Hint: Because the backup level is stored in a variable (`LEVEL`) and you want to include that variable as one of the options, enclose the variable name in `{}` to shield it from the option that follows; for example, `${LEVEL}f`.)

```
if [ $LEVEL -ge 0 -a $LEVEL -le 9 ]; then
    echo "Ready to do backup with the following command:"
    echo "    ufsdump ${LEVEL}uf /dev/null $1"
    echo "Are you ready to do the backup now? [y, n]\c "
else
```

6. If the user enters a y meaning the user wants to proceed with the backup, execute the ufsdump command. When it finishes, the script is done.

```
read ANSWER
    if [ $ANSWER = "y" ]; then
        ufsdump ${LEVEL}uf /dev/null $1
    else
```

7. If the user enters anything other than a y, instruct the user to try later when the user is ready.

```
if [ $ANSWER = "y" ]; then
    ...
else
    echo "You did not input a y, try later when you are ready."
    exit 3
fi
```

- d. For example executions of the script, run the solution with the following arguments:

```
$ ./backupscript
$ ./backupscript /foo
$ ./backupscript /export/home
```

Full Script Solution for 1

```
$ cat backupscript.sh
```

```
#!/bin/sh
```

```
# Purpose - To ensure that the correct options are always used when
#           performing a system backup with the ufsdump command.
#
#           This script takes one argument which is assumed to be a
#           filesystem name, it uses the u option to update the
#           /etc/dumpdates file, and it asks the user which dump
#           level number should be used.
#
```

```
# Name: backupscript.sh
#
if [ $# -ne 1 ]; then
    echo "Usage: backupscript filesystem"
    exit 1
fi

if [ -d $1 ]; then
    echo "$1 is the filesystem to be backed up."
    echo "Select a ufsdump level"
    cat << ENDDUMPLEVELS
> 0 # which is a full backup
> 1
> 2
> 3
> 4
> 5
> 6
> 7
> 8
> 9
ENDDUMPLEVELS
    read LEVEL

    if [ $LEVEL -ge 0 -a $LEVEL -le 9 ]; then
        echo "Ready to do backup with the following command:"
        echo "    ufsdump ${LEVEL}uf /dev/null $1"
        echo "Are you ready to do the backup now? [y, n]\c "
        read ANSWER
        if [ $ANSWER = "y" ]; then
            ufsdump ${LEVEL}uf /dev/null $1
        else
            echo "You did not input a y, try later when you are ready."
            exit 3
        fi
    else
        echo "Invalid backup level, exiting..."
        exit 2
    fi
else
    echo "Unknown filesystem, exiting..."
    exit 4
fi
```

2. Copy the `adduser` script from the `mod7` lab. Now that the user name and `uid` number have been determined, you continue to gather the remaining information to create an entry for the `mypasswd` file.

```
$ cp ../../mod7/lab/adduser .
```

Modify the script to:

- a. Prompt the user to enter a group name read in the number, and verify that the name entered exists in the `/etc/group` file.

```
echo "what primary group should $a belong to? "
echo "Please specify the group name: \c"
read group junk
```

- b. If the group name is not in `/etc/group`, tell the user that is not a valid group, and exit the script.

```
grep "^$group:" /etc/group > /dev/null 2>&1
if [ $? -ne 0 ]
then
    echo "The group $group is not valid."
    echo
    exit 2
fi
```

- c. Prompt the user for the login shell for the new user. You might want to list the ones you will accept with a *here* document.

```
echo "Good, now select a login shell for user $1"
cat << LOGINSHELLS
> csh
> ksh
> sh
LOGINSHELLS
```

- d. Read the requested shell choice.

```
read ushell
```

- e. If the shell choice is acceptable:

```
if [ $ushell = "csh" -o $ushell = "ksh" -o $ushell = "sh" ]
```

1. Prompt for the comment field information.

```
echo "Please enter the comment information for the user:"
```

2. Read the comment information.

```
read comment
```

3. Assume the login directory for the user is
/export/home/username
4. Print an entry for the new user using colon delimiters
between the seven fields.

```
echo "$1:x:$uid:$group:$comment:/export/home/$1:$shell"
```

5. Append the new user entry at the end of the mypasswd
file.

```
echo "$1:x:$uid:$group:$comment:/export/home/$1:$shell" >> ./mypasswd
```

- f. If the shell requested is not one you expect, tell the user that
the shell is not a valid shell, and exit the script.

Hint: You can run the solution to get a sense of the flow of the script. When doing this, also put in invalid information if you want to test the error messages.

```
else
```

```
    echo "Sorry, that is not a valid shell, exiting..."
    exit 3
```

Full Script Solution for 2

```
#!/bin/sh
```

```
# Purpose: To write a script to add user to the system.
# Name: adduser.sh
```

```
# Check for only a single command line argument
if [ $# -ne 1 ]
then
    echo "Usage: adduser newusername"
    exit 1
fi
```

```
# Assign the value of $1 to the variable name
```

```
name=$1

if grep "^$name:" ./mypasswd > /dev/null 2>&1
then
    echo "The username $1 is already in use, here "
    echo "is the entry from the ./mypasswd file."
    echo
    grep "^$name:" ./mypasswd
    exit 2
fi

# Use awk to extract all the UIDs into the temp file currentuid
awk -F: '{print $3}' ./mypasswd > ./currentuid

# Use sed to remove all 1, 2, and 3 digit UIDs from currentuid, and
# place the output in the temp file currentuid2
sed -e '/^.$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2

# Use sed to remove UIDs 60001, 60002, and 65534 from currentuid2,
# and place the output in the temp file currentuid3
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3

# Sort the UIDs in currentuid3 numerically
sort -n ./currentuid3 > ./currentuid4

# Calculate the next available UID
lastuid='sed -n '$p' ./currentuid4'

uid='expr $lastuid + 1'
echo "The uid for $name is: $uid"

# Prompt for a group name and verify whether it exists in /etc/group

echo "What primary group should $a belong to? "
echo "Please specify the group name: \c"
read group junk

grep "^$group:" /etc/group > /dev/null 2>&1
```



```
if [ $? -ne 0 ]
then
    echo "The group $group is not valid."
    echo
    exit 2
fi

echo "Good, now select a login shell for user $1"
cat << LOGINSHELLS
> csh
> ksh
> sh
LOGINSHELLS

read ushell

if [ $ushell = "csh" -o $ushell = "ksh" -o $ushell = "sh" ]
then
    echo "Please enter the comment information for the user:"
    read comment

    echo "The new user entry looks like this:"
    echo "$1:x:$uid:$group:$comment:/export/home/$1:$ushell"
    echo " "
    echo "New user $1 has been added to the ./mypasswd file"
    echo "$1:x:$uid:$group:$comment:/export/home/$1:$ushell" >>
    ./mypasswd
else
    echo "Sorry, that is not a valid shell, exiting..."
    exit 3
fi
```

Check Your Progress

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Use the `print` and `echo` statements to display text
- ☐ Use the `read` statement to interactively assign data to a shell variable
- ☐ Read user input into one or more variables using one `read` statement
- ☐ Use special characters, with `print` and `echo` to make the displayed text more user-friendly
- ☐ Create a *here* document
- ☐ Use file descriptors to read from and write to multiple files

Objectives

Upon completion of this module, you will be able to:

- Write scripts that use `for`, `while`, and `until` loops
- Write a script using the `select` statement
- Describe when to use loops within a script
- Generate argument lists using command, variable, and file-name substitution

Shell Loops

There are many times in a shell script when you want to repeatedly execute a statement or group of statements until some specified condition occurs. In addition, you might want to execute a group of statements for each element in a certain list. The shell provides three looping constructs for these situations: `for`, `while`, and `until`.

The `for` loop allows you to specify a list of values. A group of statements is executed for each value in the list.

The `while` and `until` loops continually execute a group of statements until a specified condition becomes false or true, respectively.

The following pages look at each of these loops in detail.

The for Loop

The `for` loop in the shell takes a list of words (strings) as an argument. The number of words in the list determines the number of times the statements in the `for` loop are executed.

The syntax for the `for` loop is:

```
for var in argument_list ...  
do  
    statement1  
    ...  
    statementn  
done
```

where:

var is any variable name.

argument_list can be any list of words, strings, or numbers.
argument_list can be literal or generated by using a shell command or shell-command-line metacharacter.

The statements are any operating-system command, user program, shell script, or shell statement that returns (produces) a list.

The value of the variable *var* is set to the first word in the list the first time through the loop. The second time through the loop, its value is set to the second word in the list, and so on. The loop terminates when *var* has taken on each of the values from the argument list, in turn, and there are no remaining arguments.

The for Loop Argument List

The argument list can be any list of words, strings, or numbers. You can generate the argument list using any of the following methods (or combination of methods):

- Explicit list
- Variable's contents
- Command-line arguments
- Command substitution
- File-name substitution

Explicit List

When the arguments are listed for the `for` loop, they are called an explicit list. This is the simplest form of an argument list. The loop is executed once for each element of the list.

```
for var in arg1 arg2 arg3 arg4 ... argn
```

The following example is a `for` loop using an explicit list of elements:

```
for fruit in apple orange banana peach kiwi
do
    print "Value of fruit is: $fruit"
done
```

The output of this `for` loop is:

```
Value of fruit is: apple
Value of fruit is: orange
Value of fruit is: banana
Value of fruit is: peach
Value of fruit is: kiwi
```

The Contents of a Variable

When the arguments are in a variable and the statement is executed, the variable's contents are substituted. If the variable is empty, the loop exits.

✓ *It is good programming practice to validate the contents of a variable before using them in the loop.*

```
for var in $var_sub
```

In the following example, the text entered at the prompt becomes the value of the variable `INPUT`. This variable represents the argument list of the `for` construct. Therefore, the text in `INPUT` is broken into words or tokens based on white space.

```
$ cat ex1.sh
#!/bin/sh

# Script name: ex1.sh

echo "Enter some text: \c"
read INPUT

for var in $INPUT
do
    echo "var contains: $var"
done

$ ./ex1.sh
Enter some text: I like the Korn shell.
var contains: I
var contains: like
var contains: the
var contains: Korn
var contains: shell.
```


Command-Line Arguments

In the following example, the text entered on the command line becomes the argument list of the `for` construct. Therefore, the command line text is broken into words or tokens based on white space.

```
for var in (the command-line arguments)
```

```
$ cat ex2.sh
```

```
#!/bin/sh
```

```
# Script name: ex2.sh
```

```
for var in $*
```

```
do
```

```
    echo "command line contains: $var"
```

```
done
```

```
$ ./ex2.sh The Bourne shell is good too.
```

```
command line contains: The
```

```
command line contains: Bourne
```

```
command line contains: shell
```

```
command line contains: is
```

```
command line contains: good
```

```
command line contains: too.
```

Command Substitution

The syntax for command substitution in a Korn shell is:

```
for var in $(cmd_sub)
```

The syntax for command substitution in a Bourne or Korn shell is:

```
for var in 'cmd_sub'
```

The following example uses the output of the `cat` command as the argument list.

```
$ cat fruit1
```

```
apple
orange
banana
peach
kiwi
```

```
$ cat ex3.ksh
```

```
#!/bin/ksh
```

```
# Script name: ex3.ksh
```

```
for var in $(cat fruit1)
```

```
do
```

```
    print "$var"
```

```
done
```

```
$ ./ex3.ksh
```

```
apple
orange
banana
peach
kiwi
```

The following example also uses the output of the `cat` command as the argument list, but it does so in a Bourne-shell syntax.

```
$ cat fruit2
```

```
Apple
Orange
Banana
Peach
Kiwi
```

```
$ cat ex4.sh
#!/bin/sh

# Script name: ex4.sh

for var in 'cat fruit2'
do
    echo "var contains: $var"
done
```

```
$ ./ex4.sh
var contains: Apple
var contains: Orange
var contains: Banana
var contains: Peach
var contains: Kiwi
```



If the file containing the list was in the following format, what is the result of the for loop?

```
$ cat fruit3
Apple Orange Banana Peach Kiwi
```

```
$ cat ex5.ksh
#!/bin/ksh

# Script name: ex5.ksh

for var in $(cat fruit3)
do
    print "$var"
done
```

✓ **The results do not change. The IFS variable is any white space, so both a carriage return and a space or tab separates each field in the file.**

If the file containing the list was in the following format, what would you need to do to use each item as a separate argument?

```
$ cat fruit4
apple:orange:banana:peach:kiwi
```

```
$ cat ex6.ksh
#!/bin/ksh

# Script name: ex6.ksh

for var in $(cat fruit4)
do
    print "$var"
done
```

```
$ ./ex6.ksh
apple:orange:banana:peach:kiwi
```

✓ *Set the IFS variable to include the colon.*

File Names in Command Substitution

Some commands provide file names and directory names as their output.

In the following example, the shell substitutes the output of the command, `ls /etc/p*` (`/etc/passwd` `/etc/profile` and so on), as the argument list for the `for` loop.

```
$ cat ex7.ksh
#!/bin/ksh

# Script name: ex7.ksh

for var in $(ls /etc/p*)
do
    print "var contains: $var"
done
```

The `for.ksh` example script uses the output of an `ls` command to create the argument list in the `for` statement.

```
$ cat for.ksh
#!/bin/ksh

# Script name: for.ksh

print "Subdirectories in $(pwd):"

for fname in $(ls)                # using command substitution to
do                                # generate an argument list
    if [[ -d $fname ]]
    then
        print $fname
    fi
done
```

```
$ cd /usr/share
```

```
$ /SA245_LF/mod9/examples/for.ksh
```

```
Subdirectories in /usr/share:
```

```
lib
```

```
man
```

```
src
```

```
$ cd
```

```
$ ./for.ksh
```

```
Subdirectories in /home/user200:
```

```
filesub
```

```
functions
```

File-Name Substitution

The `ls` command provides a list of files and directories. You can use the output of the `ls` command as the argument list for the `for` loop. Additionally, there is a syntax for specifying just files and directories.

```
for var in file_list
```

In the following example, the shell substitutes the names of files that match `/etc/p*` as the argument list.

```
ls /etc/p*
/etc/passwd /etc/profile /etc/prtvtoc
...
for var in /etc/p*
```

File-Name Metacharacters

Metacharacters are frequently used when specifying file names as the argument list, for example:

```
for var in a* ab??? s*[m-z]
```

Note – If you use file-name metacharacters to generate some or all of the list of words and there are no files that match the pattern given, the shell does not expand the pattern. That is, if no file names match the metacharacter pattern given in the list in a `for` statement, the metacharacter pattern is taken literally as a value in the list.

Consider the following example:

```
for x in z*
do
    print "Working on file $x."
    <other statements>
done
```

This example is intended to work on files in the current directory that begin with the letter `z`; however, if the current directory does not contain any files beginning with the letter `z`, then there is only one element in the list for the `for` loop: `z*`. The statements in the `for` loop are executed only once, and the `print` statement prints:

Working on file `z*`.

The statements following the `print` statement result in an error message from the shell if these are statements that use the file `z*` as an argument. No such file exists in the current directory so the statements will fail.

Mid-Module Exercise: Loops



Exercise objective – In this lab, you write a script with a loop construct.

Preparation

Refer to the lecture notes as necessary to correctly compose the commands.

Change the directory to `mod9/lab` before beginning the exercise.

Tasks

1. Write a script that lists all the start or stop scripts in a specified `rc#.d` directory.
 - a. Name the script `rcscripts`.
 - b. Write the script so that it does not require command-line arguments.
 - c. For all start scripts in the `/etc/rc3.d` directory print:
 - The script name
 - The inode number of the script
 - All other files under `/etc` with the same inode number

Task Solutions

1. Write a script that lists all the start or stop scripts in a specified rc#.d directory.
 - a. Name the script rcscripts.
 - b. Write the script so that it does not require command-line arguments.

```
if [ $# -ne 0 ]; then
    echo "Usage: rescripts "
    exit 1
fi
```

- c. For all start scripts in the /etc/rc3.d directory, print:

```
for sscript in /etc/rc3.d/S*
do
```

- The script name

```
print "The script name is $sscript"
```

- The inode number of the script

```
print -n "The inode number is "
inode=`ls -i $sscript | awk '{print $1}'`
print "$inode \n"
```

- All other files under /etc with the same inode number

```
print "The other files under /etc with the same inode number are: "
find /etc -inum $inode
```

Complete Script Solution for 1

```
#!/bin/ksh

# Purpose: This script will list all the start scripts in the /etc/rc3.d
#          directory. Additionally it will report the inode number for
#          each
#          script, and then list all files under /etc with the same inode
#          number.
#
# Scriptname: rcscripts.ksh

if [ $# -ne 0 ]; then
    echo "Usage: rcscripts.ksh "
    exit 1
fi

for sscript in /etc/rc3.d/S*
do
    print "The script name is $sscript"

    print -n "The inode number is "
    inode=`ls -i $sscript | awk '{print $1}'`
    print "$inode \n"

    print "The other files under /etc with the same inode number are:"
    "
    find /etc -inum $inode
    print "\n\n"
done

echo "Finished"
```

The while Loop

The `while` loop allows you to repeatedly execute a group of statements while a command executes successfully. The syntax for the `while` loop is:

```
while command_control
do
    statement1
    ...
    statementn
done
```

command_control can be any command that exits with a success or failure status.

The statements in the body of the `while` loop can be any utility commands, user programs, shell scripts, or shell statements.

When a `while` statement is executed, the *command_control* is evaluated. If the *command_control* succeeds, all the statements between the `do` and `done` are executed, and then the controlling command is again executed.

As long as the controlling command succeeds, the loop body continues to execute.

As soon as the *command_control* fails, the statement following the `done` statement is executed.

Note – The `do` statement is a separate statement and must appear on a line by itself (not on the line containing the `while command_control` statement) unless it is preceded by a semicolon. The same is true of the `done` statement in that it must exist on a line of its own or be preceded by a semicolon if it exists at the end of the last statement line in the loop.

while *Loop Syntax*

The following examples are all valid forms of the `while` syntax.

While the contents of `$var` are equal to the string *string_value*, the loop continues.

```
while [ "$var" = "string_value" ]  
while [[ "$var" == "string_value" ]]
```

While the value of `$num` is less than or equal to 10, the loop continues.

```
while [ $num -le 10 ]  
while (( num <= 10 ))
```

Just as in the `if` statement, the controlling command of a `while` loop is often a `((...))` or `[[ ... ]]` or `[ ... ]` command. Frequently, a variable within the test changes value in the `while` loop so that the loop eventually terminates.

The following two examples show how you can alter numeric values in the loop body to cause the `while` loop to terminate.

```
$ cat whiletest.sh  
#!/bin/sh  
  
# Script name: whiletest.sh  
  
num=5  
  
while [ $num -le 10 ]  
do  
    echo $num  
    num='expr $num + 1'  
done
```

```
$ cat whiletest.ksh
#!/bin/ksh

# Script name: whiletest.ksh

num=5

while (( num <= 10 ))
do
    echo $num
    (( num = num + 1 ))    # let num=num+1
done
```

There are two commands in the shell that always return the same exit status. The commands are `true` and `false`. `true` always causes the test to succeed (zero errors), and the predefined `false` always causes the test to fail (some number of errors). The following example causes an infinite loop.

```
while true
```

If you want to debug your script by forcing the condition to be false, use the following:

```
while false
```

Using the `((...))` syntax of the Korn shell, which evaluates numeric expressions, it is possible for a single numeric variable or value to be present in the `while` test. In this case, if the value of the numeric is nonzero, the test succeeds, and the loop executes. However, if the value of the numeric is 0, the test fails, and the code following the loop executes.

```
$ cat whiletest2.ksh
```

```
#!/bin/ksh
```

```
# Script name: whiletest2.ksh
```

```
num=5
```

```
while (( num ))
```

```
do
```

```
    echo $num
```

```
    let num=num-1
```

```
    # let "num = num + 1"
```

```
done
```

✓ ***The statement:***

```
while (( num ))
```

evaluates to the logical negation of num. Therefore, the program remains in the loop as long as the value of num is not 0.

Example: while Loop

```
$ cat while.ksh
#!/bin/ksh

# Script name: while.ksh

num=1

while (( num < 6 ))
do
    print "The value of num is: $num"
    (( num = num + 1 ))          # let num=num+1
done

print "Done."
```



```
$ ./while.ksh
Value of n is: 1
Value of n is: 2
Value of n is: 3
Value of n is: 4
Value of n is: 5
Done.
```

The variable *n* initializes to 1, and a `while` loop is entered.

Note – This `while` loop uses *n* instead of `$n` because the `((...))` command automatically does variable expansion.

The *n* forces integer arithmetic, whereas using `$n` performs arithmetic on strings. Integer arithmetic is faster.

Within the `while` loop, the current value of *n* is printed to `stdout`.

Lastly, the variable *n* is incremented and the condition in the `while` statement is checked again. If the value of the variable *n* did not change within the `while` loop, the program is in an *infinite* loop; that is, a loop that never ends.

Keyboard Input

You can place the `read` statement in the `while` condition. Each time the user inputs something from the keyboard, the loop executes. When the user presses Control-D, this tells the `read` statement that input is complete, the condition becomes false, and execution jumps to after the `done` statement.

```
$ cat readinput.ksh
#!/bin/ksh

# Script name: readinput.ksh

print -n "Enter a string: "

while read var
do
    print "Keyboard input is: $var"
    print -n "\nEnter a string: "
done

print "End of input."
```

```
$ ./readinput.ksh
Enter a string: OK
Keyboard input is: OK

Enter a string: This is fun
Keyboard input is: This is fun

Enter a string: I'm finished.
Keyboard input is: I'm finished.

Enter a string: ^d End of input.
```

Redirecting Input for a `while` Loop

Instead of input from the keyboard or `stdin`, you can specify a file from which to read the input. The redirection is done on the last line of the script:

```
done < phonelist
```

By redirecting on `stdin`, the file is opened only once. Each time around the loop, `read` returns the next line from the file. Lines are read into the loop while there are lines to read in from the file. After the end of file is reached, a true state no longer exists, and the loop terminates.

After the loop has terminated, the statement that follows the `done` statement executes.

✓ *Point out that the input redirection occurs on the line containing the word `done`. Remind the students that a loop is a complete command structure and any input redirection must come after the complete command structure.*

```
$ cat phonelist
```

```
Claude Rains:214-555-5107
Agnes Moorehead:710-555-6538
Rosalind Russel:710-555-0482
Loretta Young:409-555-9327
James Mason:212-555-2189
```

```
$ cat internalredir.ksh
```

```
#!/bin/ksh
```

```
# Script name: internalredir.ksh
```

```
# set the Internal Field Separator to a colon
IFS=:
```

```
while read name number
do
```

```
    print "The phone number for $name is $number"
```

```
done < phonelist
```

```
$ ./internalredir.ksh
```

```
The phone number for Claude Rains is 214-555-5107
```

```
The phone number for Agnes Moorehead is 710-555-6538
```

```
The phone number for Rosalind Russel is 710-555-0482
```

```
The phone number for Loretta Young is 409-555-9327
```

```
The phone number for James Mason is 212-555-2189
```

The *until* Loop

The *until* loop is very similar to the *while* loop, except that the *until* loop executes as long as the command fails. After the command succeeds, the loop exits, and execution of the script continues with the statement following the *done* statement.

The syntax for the *until* loop is:

```
until control_command
do
    statement1
    ...
    statementn
done
```

The *control_command* can be any command that exits with a success or failure status. The commands are any utility command, user program, shell script, or shell statement.

If the controlling condition fails, the body of the loop (all the statements between *do* and *done*) execute, and the controlling command executes again. As long as the controlling command continues to fail, the body of the loop continues to execute.

As soon as the controlling command succeeds, the statement following the *done* statement executes; for example:

```
$ cat until.ksh
#!/bin/ksh

# Script name: until.ksh

num=1

until (( num == 6 ))
do
    print "The value of num is: $num"
    (( num = num + 1 ))
done

print "Done."
```

```
$ ./until.ksh
The value of num is: 1
The value of num is: 2
The value of num is: 3
The value of num is: 4
The value of num is: 5
Done.
```

The break Statement

The `break` statement allows you to exit the current loop. It is often used in an `if` statement that is contained within a `while` loop, with the condition in the `while` loop always evaluating to true. This is useful if the number of times the loop is executed depends on input from the user and not some predetermined number.

Note – The *null* statement (`:`) always evaluates to true; therefore, the statements `while :` and `while ((1))` are interchangeable.

The `break` statement exits out of the *innermost* loop in which it is contained.

```
$ cat break.ksh
#!/bin/ksh

# Script name: break.ksh

typeset -i num=0

while true
do
    print -n "Enter any number (0 to exit): "
    read num junkbreak.ksh

    if (( num == 0 ))
    then
        break
    else
        print "Square of $num is $(( num * num )). \n"
    fi
done

print "script has ended"
```

\$ **./break.ksh**

Enter any number (0 to exit): **5**

Square of 5 is 25.

Enter any number (0 to exit): **-5**

Square of -5 is 25.

Enter any number (0 to exit): **259**

Square of 259 is 67081.

Enter any number (0 to exit): **0**

script has ended

The continue Statement

Use the `continue` statement within a loop to force the shell to skip the statements in the loop that occur below the `continue` statement and return to the top of the loop for the next iteration.

When you use the `continue` statement in a `for` loop, the variable *var* takes on the value of the next element in the list.

When you use the `continue` statement in a `while` or an `until` loop, execution resumes with the test of the *control_command* at the top of the loop.

Example: continue Statement

The `continue.ksh` example script renames all files in the current directory whose names contain a capital letter to essentially the same file name, but in all lowercase letters.

First, the script prints the name of the file on which it is currently working. If this file name contains no capital letters, the script executes the `continue` statement, forcing the shell to go to the beginning of the `for` loop and get the next file name.

If the file name contains a capital letter, the original name is saved in the variable *orig*. The name is also copied into the variable *new*; however, the line `typeset -l new` at the beginning of the script causes all letters stored in the variable to convert to lowercase during the assignment. When this has been done, the script performs a `mv` command using the variables *orig* and *new* as arguments.

The script then prints a message concerning the name change for the file and gets the next file to be worked on.

When the `for` loop is finished, the message `Done .` prints to let the user know the script has completed.

```
$ cat continue.ksh
#!/bin/ksh

# Script name: continue.ksh

typeset -l newcontinue.ksh

for file in *
do
    print "Working on file $file..."

    if [[ $file != *[A-Z]* ]]
    then
        continue
    fi

    orig=$file
    new=$file
    mv $orig $new
    print "New file name for $orig is $new."
done

print "Done."
```

```
$ cd test.dir
$ ls
Als          a          s0rt.dAtA   slAlk
Data.File    recreate_names  scR1        teXtfile
```

```
$ ../continue.ksh
Working on file Als...
New file name for Als is als.
Working on file Data.File...
New file name for Data.File is data.file.
Working on file a...
Working on file recreate_names...
Working on file s0rt.dAtA...
New file name for s0rt.dAtA is sort.data.
Working on file scR1...
New file name for scR1 is scr1.
Working on file slAlk...
New file name for slAlk is slalk.
Working on file teXtfile...
New file name for teXtfile is textfile.
Done.
```

```
$ ls
```

```
a
```

```
als
```

```
data.file
```

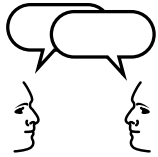
```
recreate_names
```

```
scr1
```

```
slalk
```

```
sort.data
```

```
textfile
```



The script does not check if a lowercase version of a file name containing capital letters already exists before executing the `mv` command. Therefore, it is possible to overwrite an existing file. How could this script be improved to avoid that problem?

The Korn Shell select Loop

The `select` statement in the Korn shell creates a menu. This construct is for the Korn shell only. The syntax for creating a menu is:

```
select var in list
do
    statement1
    ...
    statementn
done
```

The variables *var* and *list* follow the same syntactic rules as are used in the `for` loop (although the operation of the `select` loop is substantially different). If *list* contains metacharacters, the metacharacters are expanded into file names.

The elements in *list* are the menu choices presented to the user. The Korn shell automatically numbers each menu choice (starting with 1). The user must enter the number corresponding to the user's choice if the input is to be valid.

Although you can use any statements within the menu loop, the `case` statement is most often used to match the choice selected by the user and to take certain actions depending on that choice.

The input the user types to the prompt is saved in the variable `REPLY`.

If the user does not enter any input except for pressing the Return key, then the `REPLY` variable is set to the null string, and the shell redisplay the menu choices.

The menu loop is exited by the user typing the end-of-file (EOF) character, which is Control-D on most Sun systems.

The PS3 Reserved Variable

After displaying the list of choices for the user, the shell prints a prompt and waits for user input. The value of the prompt is the value of the `PS3` variable. You can set this variable to any value; however, it is helpful if the value makes sense with regard to the choices that are presented to the user.

Sometimes a script produces so much output between the time the menu list is first displayed and the current menu prompt that the user is no longer able to see (or remember) the menu choices. To redisplay the menu choices, the user presses the Return key in response to the menu prompt.

The `select` syntax actually creates a loop. The user is repeatedly presented with the menu choices followed by the prompt (the value of the `PS3` variable). The menu loop is exited when the user types the EOF character for their system as the response to the menu prompt.

A more graceful way to exit the menu loop is shown later in this module.

Note – The default value of the `PS3` variable in the Korn shell is `#?`. Therefore, if you fail to set the `PS3` variable, the system uses the string `#?` as the prompt and then waits for user input. If this happens, the user might not know that the script is waiting for input.

An Example of a Menu

The following script gives the user five fruit choices and then prompts for their fruit choice.

A case statement is used in the menu loop to take appropriate action on the choice selected by the user. The default case, the * pattern, matches any input by the user that is not one of the numbers of the choices on the menu.

The script then executes. Several valid choices and some invalid choices are shown to illustrate how the menu loop works.

```
$ cat menu.ksh
#!/bin/ksh

# Script name: menu.ksh

PS3="Enter the number for your fruit choice: "

select fruit in apple orange banana peach pear
do
    case $fruit in
        apple)
            print "An apple has 80 calories."
            ;;
        orange)
            print "An orange has 65 calories."
            ;;
        banana)
            print "A banana has 100 calories."
            ;;
        peach)
            print "A peach has 38 calories."
            ;;
        pear)
            print "A pear has 100 calories."
            ;;
```

```
*)
    print "Please try again. Use '1'-'5'"
;;
esac

done

$ ./menu.ksh
1) apple
2) orange
3) banana
4) peach
5) pear
Enter the number for your fruit choice: 3
A banana has 100 calories.
Enter the number for your fruit choice: 7
Please try again. Use '1'-'5'
Enter the number for your fruit choice: apple
Please try again. Use '1'-'5'
Enter the number for your fruit choice: 1
An apple has 80 calories.
Enter the number for your fruit choice: ^d
```

Exiting the Menu Loop

The user can exit the menu loop at any time by entering the EOF character on their system; however, unless the user knows this or you include a message explaining this in your menu prompt, the user can get stuck in the menu loop.

You can include a string in your menu choices to help the user exit the menu. The string could simply say `Quit Menu`. Then the action in the `case` statement for this menu choice is usually the `break` statement. This exits the menu loop, and execution of the script moves to the first statement following the `done` statement in the `select/do/done` syntax.

If there are no statements following the `done` statement, the script terminates.

```
$ cat menu1.ksh
#!/bin/ksh

# Script name: menu1.ksh

PS3="Enter the number for your fruit choice: "

select fruit in apple orange banana peach pear "Quit Menu"
do
    case $fruit in
        apple)
            print "An apple has 80 calories."
            ;;

        orange)
            print "An orange has 65 calories."
            ;;

        banana)
            print "A banana has 100 calories."
            ;;

        peach)
            print "A peach has 38 calories."
            ;;
```



```
        pear)
            print "A pear has 100 calories."
            ;;

        "Quit Menu")
            break
            ;;

        *)
            print "You did not enter a correct choice."
            ;;
    esac
done

$ ./menu1.ksh
1) apple
2) orange
3) banana
4) peach
5) pear
6) Quit Menu
Enter the number for your fruit choice: 3
A banana has 100 calories.
Enter the number for your fruit choice: 6
```

Submenus

The shell allows any statement within the `select` loop to be another `select` loop. This enables you to create a menu that has one or more submenus.

You usually include the `break` statement in the action for one or more choices on the submenu to exit the submenu loop and return to the outer menu loop.

Because the `PS3` variable is also used for the prompt in any submenu, you must be careful when moving from one menu to another to reset this variable to the prompt for the menu to which you are moving.

An example illustrating a submenu and the resetting of the `PS3` variable is provided on the next pages.

Example: Using Submenus

The `submenu.ksh` example script first creates two variables, `main_prompt` and `dessert_prompt`, to hold the prompts for the main menu and the dessert submenu, respectively.

The main menu is exited when the user chooses `Order Completed`, at which time the script prints the message `Enjoy your meal`.

When the user selects the main menu choice “dessert,” a submenu appears, asking the user to input the number for the dessert choice.

In the `case` statement for the dessert menu, the `break` statement is used for each menu choice. (The default choice does not use the `break` statement because you want the user to reenter a dessert choice.) This exits the dessert menu. Then the menu prompt resets to the value of the `main_prompt` variable, and control returns to the main (outer) menu loop.

Note – All `print` statements use single quotes so that the `$` in the prices is printed.

Because of formatting in this course book, several lines in the following script wrap.

```
$ cat submenu.ksh
#!/bin/ksh

# Script name: submenu.ksh

main_prompt="Main Menu: What would you like to order? "
dessert_menu="Enter number for dessert choice: "
PS3=$main_prompt

select order in "broasted chicken" "prime rib" "stuffed lobster" dessert
"Order Completed"
do
    case $order in
        "broasted chicken") print 'Broasted chicken with baked potato,
rolls, and salad is $14.95.';;
        "prime rib") print 'Prime rib with baked potato, rolls, and fresh
vegetable is $17.95.';;
        "stuffed lobster") print 'Stuffed lobster with rice pilaf, rolls,
and salad is $15.95.';;
        dessert)
            PS3=$dessert_menu
            select dessert in "apple pie" "sherbet" "fudge cake" "carrot
cake"
            do
                case $dessert in
                    "apple pie") print 'Fresh baked apple pie is $2.95.'
                    break;;
                    "sherbet") print 'Orange sherbet is $1.25.'
                    break;;
                    "fudge cake") print 'Triple layer fudge cake is $3.95.'
                    break;;
                    "carrot cake") print 'Carrot cake is $2.95.'
                    break;;
                    *) print 'Not a dessert choice.';;
                esac
            done
            PS3=$main_prompt;;
            "Order Completed") break;;
            *) print 'Not a main entree choice.';;
        esac
    done
done
print 'Enjoy your meal.'
```

Sample Run of submenu.ksh Script

```
$ ./submenu.ksh
1) broasted chicken
2) prime rib
3) stuffed lobster
4) dessert
5) Order Completed
Main Menu: What would you like to order? 3
Stuffed lobster with rice pilaf, rolls, and salad is $15.95.
Main Menu: What would you like to order? 4
1) apple pie
2) sherbet
3) fudge cake
4) carrot cake
Enter number for dessert choice: 3
Triple layer fudge cake is $3.95.
Main Menu: What would you like to order? 5
Enjoy your meal.
```

The for and select Statements Revisited

The `for` and `select` statements do not have to explicitly supply a list of values. If a list is not provided, the shell assumes the list to be the values of the positional parameters.

If the positional parameters do not have any values, then the `for` loop terminates without executing any statements within its loop. It does not cause an error from the shell.

The `pospara.ksh` example script is similar to the earlier `pos_par.scr` script up through the `for` loop, although the list in the `for` loop is omitted here.

The omission of the list of values in the `for` loop syntax means that the values of the positional parameters are used for the list. Thus, the result of executing the `for` loop in this script is identical to the execution of the `for` loop in the `pos_par.scr` script (where the values of the positional parameters were explicitly used as the list with the syntax `in $*`).

```
$ cat pospara.ksh
#!/bin/ksh

# Script name: pospara.ksh

set uno duo tres          # resets the value of the positional parameters
print "Executing script $0\n"

print "One, two, three in Latin is:"
for x                      # defaults to "in $"
do
    print $x
done

$ ./pospara.ksh
Executing script pospara.ksh

One, two, three in Latin is:
uno
duo
tres
```

The shift Statement

Sometimes a script does not require a specific number of arguments from the user; that is, the user is allowed to give as many arguments to the script as they want.

In these situations, the arguments of the script are usually processed in a `while` loop with the condition being `(( $# ))`. This condition is true as long as the number of arguments is greater than zero. Within the script, `$1`, together with the `shift` statement, processes each argument.

Because doing a `shift` reduces the number of arguments, eventually the condition in the `while` loop becomes false and the loop terminates.

Note – If no number is supplied as an argument to the `shift` statement, the number is assumed to be 1.

The syntax for the `shift` statement is:

```
shift [ num ]
```

All positional parameters are shifted to the left the number of positions indicated by *num* (or by 1 if *num* is omitted).

The *num* left-most parameters are eliminated after the shift. For example, the statement:

```
shift 4
```

eliminates the first four positional parameters. The value of the fifth parameter becomes the value of `$1`, the value of the sixth parameter becomes the value of `$2`, and so on.

It is an error for *num* to be larger than the number of positional parameters.

Example: Using the shift Statement

The `shift.ksh` example script contains a usage message that shows that the script is to be run with some arguments, although the number of arguments given is variable.

If the user does not provide any arguments, the usage message is printed and the script exits; otherwise, the `while` loop is entered. Each time through the loop, the current value of the positional parameter `$1` is printed and the `shift` statement executes.

The `shift` statement reduces the number of arguments by one as it shifts the values of the positional parameters one position to the left. (`$1` is assigned the value of `$2`, `$2` is assigned the value of `$3`, and so on, while the value of `$1` is forgotten).

After each argument has been printed, the value of `(( $# ))` is false, and the `while` loop terminates.

The statement `print $*` shows that nothing is printed after the execution of the `while` loop because the value of `$#` is 0.

The values of the positional parameters are then set to letters of the alphabet using the `set` statement and printed using the statement `print $*` (to show the new values of the positional parameters).

The last two statements in the script, `shift 4` and `print $*`, illustrate what occurs when a larger shift is made.

```
$ cat shift.ksh
#!/bin/ksh

# Script name: shift.ksh

USAGE="usage: $0 arg1 arg2 ... argN"

if (( $# == 0 ))
then
    print $USAGE
    exit 1
fi

print "The arguments to the script are:"
while (($#))
do
    print $1
    shift
done

print 'The value of $* is now:' $*
```

```
$ ./shift.ksh one two three four
The arguments to the script are:
one
two
three
four
The value of $* is now:
$
```

✓ ***A good example of using shift can be found in the last 30 lines of the /etc/init.d/inetinit script.***

Exercise: Loops



Exercise objective – In this lab, you write scripts that use loops and menus.

Preparation

Two of the exercises involve modifying scripts from previous lab exercises, the `adduser` and `filetype` scripts. If you have not written one of these and want to do the lab in this module, familiarize yourself with the online solution.

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod9/lab` before beginning the exercise.

When writing the script on paper you might want to execute commands on the system to ensure you have the correct command and option to give you the prescribed output.

Tasks

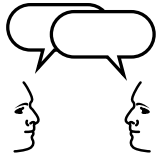
1. Make a copy of the `filetype` script completed in the Module 7 lab, and name the copy `filetype2`.
2. Modify the code so it accepts one or more path names on the command line and prints a `USAGE` message if it receives no arguments.
3. Use a loop construct to test each path name entered on the command line to determine if it is a file or directory.

4. Copy the `adduser` script from the `mod8` lab.

Modify the script to:

- a. Create a menu for the list of available shells you want to offer as login shells.
 - b. When the user selects a value not in the menu, print a message stating that is an unknown choice, and then force the user to reenter until the user enters a correct menu choice.
 - c. When the user selects a valid shell from the menu, print a verification of which shell was selected. Then allow the program to continue prompting the user for the comment-field information (which was written in a previous lab).
5. Copy the `filetype2` script to `filetype3`. Modify the script `filetype3` such that:
 - ▼ If it uses a `while` loop, change the code to use an `until` loop.
 - ▼ If it uses an `until` loop, change the code to use a `while` loop.

Exercise Summary



Discussion – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

Task Solutions

1. Make a copy of the `filetype` script completed in the `mod8` lab, and name the copy `filetype2`.

```
$ cp ../../mod8/lab/filetype filetype2
```

2. Modify the code so it accepts one or more path names on the command line and prints a `USAGE` message if it receives no arguments.

```
if [ $# -eq 0 ]; then
    echo "Usage: filetype2 pathname [pathname2...]"
    exit 1
fi
```

3. Use a loop construct to test each path name entered on the command line to determine if it is a file or directory.

```
while [ $# -ne 0 ]
do
    if [ -d $1 ]; then
    ...
    else
        echo "$1 is a file."
    ...
done
```

Complete Script Solution for 1, 2, and 3

```
#!/bin/sh

# Purpose: This script will determine whether the pathnames passed
#          on the command line are a file or directory. Then it will
#          print information about the pathname.
#
# Scriptname: filetype2.sh

if [ $# -eq 0 ]; then
    echo "Usage: filetype2.sh pathname [pathname2...]"
    exit 1
fi

while [ $# -ne 0 ]
```

```

do
    if [ -d $1 ]; then
        echo "$1 is a directory."
        echo "Following is a listing of the $1 directory."
        ls $1
        echo " "
        echo "The number of kilobytes used by directory $1 is:
\c"

        du -s -k $1 | nawk '{print $1}'
    else
        echo "$1 is a file."
        echo "The size of $1 in bytes is: \c"
        ls -l $1 | nawk '{print $5}'
        echo
        if [ -b $1 ]; then
            echo "$1 is a block special file."
        elif [ -c $1 ]; then
            echo "$1 is a character special file."
        elif [ -u $1 ]; then
            echo "$1 has the set-user-id permission."
        else
            echo "There is nothing special to say about file
$1
."
        fi
    fi
    shift
    echo "\n\n"
done

echo "Finished"

```

4. Copy the adduser script from the mod8 lab.

```
$ cp ../../mod9/lab/adduser .
```

Modify the script to:

- a. Create a menu for the list of available shells you want to offer as login shells.
- ```
select ushell in csh ksh sh
```
- b. When the user selects a value not in the menu, print a message stating that is an unknown choice, and then force the user to reenter until the user enters a correct menu choice.

```
*)
 print "Unknown choice, try again."
 ;;
esac
```

- c. When the user selects a valid shell from the menu, print a verification of which shell was selected. Then allow the program to continue prompting the user for the comment-field information (which was written in a previous lab).

```
select ushell in csh ksh sh
do
 case $ushell in
 csh)
 print "$ushell was selected."
 break
 ;;

 ksh)
 print "$ushell was selected."
 break
 ;;

 sh)
 print "$ushell was selected."
 break
 ;;

 *)
 print "Unknown choice, try again."
 ;;
 esac
done
```

### *Complete Script Solution for 4*

```
#!/bin/ksh

Purpose: To write a script to add user to the system. Generate a
menu for the login shell choices.
#
Name: adduser.ksh
```



```
Check for only a single command line argument
if [$# -ne 1]
then
 echo "Usage: adduser.ksh newusername"
 exit 1
fi

Assign the value of $1 to the variable name
name=$1

if grep "^$name:" ./mypasswd > /dev/null 2>&1
then
 echo "The username $1 is already in use, here "
 echo "is the entry from the ./mypasswd file."
 echo
 grep "^$name:" ./mypasswd
 exit 2
fi

Use awk to extract all the UIDs into the temp file currentuid
awk -F: '{print $3}' ./mypasswd > ./currentuid

Use sed to remove all 1, 2, and 3 digit UIDs from currentuid, and
place the output in the temp file currentuid2
sed -e '/^.$$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2

Use sed to remove UIDs 60001, 60002, and 65534 from currentuid2,
and place the output in the temp file currentuid3
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3

Sort the UIDs in currentuid3 numerically
sort -n ./currentuid3 > ./currentuid4

Calculate the next available UID
lastuid='sed -n '$p' ./currentuid4'

uid='expr $lastuid + 1'
echo "The uid for $name is: $uid"
```

```
Prompt for a group name and verify whether it exists in /etc/group
```

```
echo "What primary group should $a belong to? "
echo "Please specify the group name: \c"
read group junk
```

```
grep "^$group:" /etc/group > /dev/null 2>&1
if [$? -ne 0]
then
 echo "The group $group is not valid."
 echo
 exit 2
fi
```

```
PS3="Enter the number: "
select ushell in csh ksh sh
do
 case $ushell in
 csh)
 print "$ushell was selected."
 break
 ;;

 ksh)
 print "$ushell was selected."
 break
 ;;

 sh)
 print "$ushell was selected."
 break
 ;;

 *)
 print "Unknown choice, try again."
 ;;
 esac
done

if [$ushell = "csh" -o $ushell = "ksh" -o $ushell = "sh"]
then
 echo "Please enter the comment information for the user:"
```

```

 read comment

 echo "The new user entry looks like this:"
 echo "$1:x:$uid:$group:$comment:/export/home/$1:$shell"
 echo " "
 echo "New user $1 has been added to the ./mypasswd file"
 echo "$1:x:$uid:$group:$comment:/export/home/$1:$shell" >>
 ./mypasswd
 else
 echo "Sorry, that is not a valid shell, exiting..."
 fi

```

5. Copy the filetype2 script to filetype3. Modify the script filetype3 such that:

- ▼ If it uses a while loop, change the code to use an until loop.
- ▼ If it uses an until loop, change the code to use a while loop.

Change:

while [ \$# -ne 0 ]

To:

until [ \$# = 0 ]

### *Complete Script Solution for 5*

```

#!/bin/sh

Purpose: This script will determine whether the pathnames passed
on the command line are a file or directory. Then it will
print information about the pathname.
#
Scriptname: filetype3.sh

if [$# -eq 0]; then
 echo "Usage: filetype3.sh pathname [pathname2...]"
 exit 1
fi

until [$# = 0]
do
 if [-d $1]; then
 echo "$1 is a directory."
 echo "Following is a listing of the $1 directory."
 fi
 shift
done

```

```
ls $1
echo " "
echo "The number of kilobytes used by directory $1 is:
\c"
du -s -k $1 | nawk '{print $1}'
else
echo "$1 is a file."
echo "The size of $1 in bytes is: \c"
ls -l $1 | nawk '{print $5}'
echo
if [-b $1]; then
 echo "$1 is s block special file."
elif [-c $1]; then
 echo "$1 is s character special file."
elif [-u $1]; then
 echo "$1 has the set-user-id permission."
else
 echo "There is nothing sepecial to say about file
$1."
fi
fi
shift
echo "\n\n"
done

echo "Finished"
```

---

## *Check Your Progress*

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Write scripts that use `for`, `while`, and `until` loops
- ☐ Write a script using the `select` statement
- ☐ Describe when to use loops within a script
- ☐ Generate argument lists using command, variable, and file-name substitution



# *Advanced Variables, Parameters, and Argument Lists*

---

10 

## *Objectives*

Upon completion of this module, you will be able to:

- Declare strings, integers, and array variables
- Manipulate string variables
- Change the values of the positional parameters using the `set` statement within a script
- Use Korn shell arrays
- Set default values for parameters
- Use the Korn shell built-in statements `let`, `print`, `set`, and `typeset`

## Types of Variables

In the Bourne shell there are two types of variables: string and constant.

In the Korn shell there are four types of variables: strings, integers, arrays, and constants.

- All variables are of type *string* unless explicitly declared otherwise.
- You can also specify *constants* in the shell. A constant is a read-only variable that has been assigned a value when it is declared and the value cannot be changed.

✓ **To create a variable constant, use the `readonly` command in Bourne shell or the `typeset -r` command in the Korn shell.**

- The data type of a variable determines the values that can be assigned to the variable.

You can assign any value to a string variable. Integer variables can only hold number values and arrays might be restrictive, depending on whether it is an array of integers or strings.

## Variable Names

When you access the value of a variable by preceding its name with a \$, you might need to isolate the variable name from the characters that immediately follow it; for example:

```
$ flower=rose
$ print "$flower $flowers $flowerbush"
rose
$ print "${flower}s ${flower}bush"
rose roses rosebush
```



## The Korn Shell `typeset` Statement

The `typeset` statement sets attributes for a variable. In some cases, it can actually change the value of a variable, as with right- or left-justification. The attributes are shown in Table 10-1.

**Table 10-1** `typeset` Options

| Syntax                         | Description                                                                                  |
|--------------------------------|----------------------------------------------------------------------------------------------|
| <code>\${#var}</code>          | Returns the length of string <i>var</i> .                                                    |
| <code>typeset -u var</code>    | Converts <i>var</i> to all uppercase characters.                                             |
| <code>typeset -l var</code>    | Converts <i>var</i> to all lowercase characters.                                             |
| <code>typeset -LZ var</code>   | Strips leading zeros from the string <i>var</i> .                                            |
| <code>typeset -Lnum var</code> | Left-justifies <i>var</i> within the field width specified by <i>num</i> .                   |
| <code>typeset -Rnum var</code> | Right-justifies <i>var</i> within the field width specified by <i>num</i> .                  |
| <code>typeset -i var</code>    | <i>var</i> can only contain integer values.                                                  |
| <code>typeset -r var</code>    | <i>var</i> is read-only. The value in <i>var</i> cannot be changed by subsequent assignment. |

You can force a variable to be stored as an integer with `typeset -i`. Any arithmetic performed on such variables is faster than if it is used without `typeset -i`.

## *Example: String Manipulations*

To correctly view a right-justified string with leading spaces requires quoting the variable in the output statement.

```
$ cat strman1.ksh
#!/bin/ksh

Script name: strman1.ksh

typeset -R8 word="happy"

typeset -L5 word1="depressed"

print "123456789"
print "$word"
print

print "123456789"
print "$word1"

$./strman1.ksh
123456789
 happy

123456789
depre
```

Without the quotes, the leading spaces are not printed. Consider the following example and output:

```
$ cat strman2.ksh
#!/bin/ksh

Script name: strman2.ksh

typeset -R8 word="happy"

typeset -L5 word1="depressed"

print "123456789"
print $word
print

print "123456789"
print $word1

$./strman2.ksh
123456789
happy

123456789
depre
```

## Example: Using typeset

The following script demonstrates string manipulations. The script converts all characters in a string to uppercase and then lowercase characters. The script then left- and right-justifies the characters within the string.

The line that prints 123456789 is included so you can check the output with regard to the field widths assigned to the variables `ljust` and `rjust`.

```
$ cat strman3.ksh
#!/bin/ksh

Script name: strman3.ksh

string1="manipulation"
print "Length of string1 is ${#string1} characters \n"

string2="CaSes"
print "string2 is $string2"

typeset -u string2
print "string2 in upper case: $string2"

typeset -l string2
print "string2 in lower case: $string2 \n"

typeset -L7 ljust
ljust="hi there"

typeset -R5 rjust
rjust="farewell"

print " 123456789"
print "Value of ljust: $ljust"
print "Value of rjust: $rjust \n"

lzero="00034;lsl"
print "Value of lzero: $lzero"

typeset -LZ lzero
print "New value of lzero: $lzero"
```

```
$./strman3.ksh
Length of string1 is 12 characters
string2 is CaSes
string2 in upper case: CASES
string2 in lower case: cases
 123456789
Value of ljust: hi ther
Value of rjust: ewell
Value of lzero: 00034;lsl
New value of lzero: 34;lsl
```

## *Declaring an Integer Variable*

You can declare an integer variable in two ways by using either `typeset -i` or `integer` in front of the variable name. The first is more flexible because it also allows you to specify the base in which the variable is represented.

```
typeset -i int_var1[=value] int_var2[=value] ... int_varn[=value]
```

or

```
integer int_var1[=value] int_var2[=value] ... int_varn[=value]
```

An `integer` variable can have only integer numbers assigned to it. An assignment of a number with a decimal part results in the decimal being truncated.

An assignment containing nonnumeric characters to an `integer` variable results in an error message.

```
$ typeset -i num # base 10 integer
```

```
$ num=5
```

```
$ print $num
```

```
5
```

```
$ typeset -i num # base 10 integer
```

```
$ num=25.34 # truncation will occur on the decimal portion
```

```
$ print $num
```

```
25
```

```
$
```

```
$ typeset -i num # base 10 integer
$ num=27
$ print $num
27
$ typeset -i8 num # change to base 8
$ print $num
8#33
$
```

*typeset -i 8 is setting the output base to base 8 (octal). Therefore, until a subsequent change, the value of num is output in octal. In the output, the value of the variable is preceded with the current base if it is not base 10 (decimal).*

```
$ num=two
/usr/bin/ksh: two: bad number
$ print $num
8#33
```

## Arithmetic Operations on Korn Shell Variables

Arithmetic evaluation is invoked by placing an integer expression within two pairs of parentheses: `((...))`.

For readability, place a space before and after any arithmetic operator within the double pair of parentheses.

✓ **Some of the arithmetic operations were described in Module 3, “The Shell Environment.” Table 10-2 shows all the operations.**

Table 10-2 summarizes the math operators.

**Table 10-2** Arithmetic Operations on Integers

| Operator | Operations               | Example                                | Result  |
|----------|--------------------------|----------------------------------------|---------|
| +        | Addition                 | <code>((x = 24 + 25))</code>           | 49      |
| -        | Subtraction              | <code>((x = 100 - 25))</code>          | 75      |
| *        | Multiplication           | <code>((x = 4 * 5))</code>             | 20      |
| /        | Division                 | <code>((x = 10 / 3))</code>            | 3       |
| %        | Modulo<br>(remainder)    | <code>((x = 10 % 3))</code>            | 1       |
| #        | Base                     | 2#1101010 or 16#6A                     | 10#106  |
| <<       | Shift bits left          | <code>((x = 2#11 &lt;&lt; 3))</code>   | 2#11000 |
| >>       | Shift bits right         | <code>((x = 2#1001 &gt;&gt; 2))</code> | 2#10    |
| &        | Bit-wise AND             | <code>((x = 2#101 &amp; 2#110))</code> | 2#100   |
|          | Bit-wise OR              | <code>((x = 2#101   2#110))</code>     | 2#111   |
| ^        | Bit-wise<br>exclusive OR | <code>((x = 2#101 ^ 2#110))</code>     | 2#11    |

The first five operators listed in Table 10-2 perform standard arithmetic operations. The last six operators do bit-wise operations.



## Bit-wise Operations

The # operator designates the *base* of the value that follows it. For example, 2#101 says that the value 101 is a base 2 value (2#101 would be 5 in decimal).

---

**Note** – If you are not familiar with bit-wise operations, examine the values in binary (as is shown here) rather than in decimal.

---

The << operator performs a binary *shift left* by as many bits as are indicated by the number that follows the operator. The expression 2#10 << 1 yields the value 2#100. The expression 2#10100 << 2 yields the value 2#1010000.

|               |   |   |   |   |   |   |
|---------------|---|---|---|---|---|---|
| Initial value |   |   | 0 | 1 | 0 | 0 |
| << 2          | 0 | 1 | 0 | 0 |   |   |
| Result        | 0 | 1 | 0 | 0 | 0 | 0 |

Vacated positions are padded with 0 or 1 based on whether the number is positive or negative, respectively)

The >> operator performs a binary *shift right* by as many bits as are indicated by the number that follows the operator. The expression 2#10 >> 1 yields the value 2#1. The expression 2#10100 >> 2 yields the value 2#101.

The & operator *ANDs* two binary numbers together. This means that the AND operation is performed on the corresponding digit of 0 or 1 in each number, resulting in a 1 if both digits are 1; otherwise, the result is 0.

|        |   |   |   |   |
|--------|---|---|---|---|
|        | 1 | 1 | 0 | 0 |
| &      | 1 | 0 | 1 | 0 |
| Result | 1 | 0 | 0 | 0 |

The `|` operator *ORs* two binary numbers together. This means that the OR operation is performed on the corresponding digit of 0 or 1 in each number, resulting in a 1 if either digit is a 1; otherwise, the result is 0.

|                |   |   |   |   |
|----------------|---|---|---|---|
|                | 1 | 1 | 0 | 0 |
| <code> </code> | 1 | 0 | 1 | 0 |
| Result         | 1 | 1 | 1 | 0 |

The `^` operator performs an exclusive OR on two binary numbers together. This means that an exclusive OR is performed on the corresponding digit of 0 or 1 in each number, resulting in 1 if only one of the digits is a 1. If both digits are 0 or both are 1, then the result is 0.

|                |   |   |   |   |
|----------------|---|---|---|---|
|                | 1 | 1 | 0 | 0 |
| <code>^</code> | 1 | 0 | 1 | 0 |
| Result         | 0 | 1 | 1 | 0 |

## Creating Bourne Shell Constants

A variable can be made *read-only* with the following syntax:

```
readonly var[=value]
```

The square brackets around *=value* mean that the assignment of a value is not always necessary. For instance, if the variable had previously been created and assigned a value, and you now want to make it read-only (and not change its current value), do not use *=value*.

If the variable did not previously exist, and you make it read-only, you may never assign a value to the variable.

A read-only variable cannot change its value. This is why read-only variables are referred to as *constants*; for example:

```
$ sh
$ var=constant
$ readonly var
$ unset var
var: is read only

$ var=new_value
var: is read only
```

## Creating Korn Shell Constants

A variable can be made *read-only* by using either of the following syntaxes:

```
typeset -r var[=value]
readonly var[=value]
```

The square brackets around *=value* mean that the assignment of a value is not always necessary. For instance, if the variable had previously been created and assigned a value, and you now want to make it read-only (and not change its current value), do not use *=value*.

If the variable did not previously exist, assign a value to it when you make it read-only.

A read-only variable cannot change its value. This is why read-only variables are referred to as *constants*.

For example:

```
$ ksh
$ typeset -r cvar=constant
$ unset cvar
ksh: cvar: is read only

$ cvar=new_value
ksh: cvar: is read only
```

## Removing Portions of a String

Table 10-3 summarizes the syntax used to remove portions of a string.

**Table 10-3** Remove Portions of a String

| Syntax                            | Description                                                                                      |
|-----------------------------------|--------------------------------------------------------------------------------------------------|
| <code>\${str_var%pattern}</code>  | Removes the smallest right-most substring of string <i>str_var</i> that matches <i>pattern</i> . |
| <code>\${str_var%%pattern}</code> | Removes the largest right-most substring of string <i>str_var</i> that matches <i>pattern</i> .  |
| <code>\${str_var#pattern}</code>  | Removes the smallest left-most substring of string <i>str_var</i> that matches <i>pattern</i> .  |
| <code>\${str_var##pattern}</code> | Removes the largest left-most substring of string <i>str_var</i> that matches <i>pattern</i> .   |

Any of the shell metacharacters can be used in the pattern following the symbols %, %, #, and ##.

**Note** – When the pattern does not contain any metacharacters, then `${str_var%pattern}` and `${str_var%%pattern}` have the same value, as does `${str_var#pattern}` and `${str_var##pattern}`.

- ✓ **You can perform similar operations in the Bourne shell using the `expr` command. Examples can be seen in the `/usr/bin/basename` or `/usr/bin/dirname` scripts.**

## Examples: Removing Portions of a String

Removing portions of a string is particularly useful when working with path names. Sometimes just the name of the file itself is needed, so you must strip off everything in the path name except for the *last component* (the group of characters following the very last / in the path name).

Sometimes the parent directory is required of a file for which you have the absolute path name. Then you must remove the last / and the characters that follow it.

Set the value of variable *stringx* to /usr/bin/local/bin:

```
$ stringx=/usr/bin/local/bin
```

The *smallest* right-most substring that matches /bin and /bin\* in both of these cases is /bin. Thus, the result is /usr/bin/local:

```
$ print ${stringx%/bin}
/usr/bin/local
$ print ${stringx%/bin*}
/usr/bin/local
```

The *largest* right-most substring that matches /bin is /bin. Thus, the result is the same as for the preceding two cases.

```
$ print ${stringx%%/bin}
/usr/bin/local
```

The *largest* right-most substring that matches /bin\* is /bin/local/bin. Thus, the result that is printed is just the string /usr:

```
$ print ${stringx%%/bin*}
/usr
```

The *smallest* left-most substring that matches `/usr/bin` and `*/bin` is `/usr/bin` in both of these cases. Thus, the result that is printed is `/local/bin`:

```
$ print ${stringx#/usr/bin}
/local/bin
```

```
$ print ${stringx#*/bin}
/local/bin
```

The *largest* left-most substring that matches `/usr/bin` is `/usr/bin`. Thus, the result is the same as for the proceeding two cases:

```
$ print ${stringx##/usr/bin}
/local/bin
```

The *largest* left-most substring that matches `*/bin` is `/usr/bin/local/bin`. Thus, the result printed is the string blank (null):

```
$ print ${stringx###*/bin}
```

The *largest* left-most substring that matches `*/` is `/usr/bin/local/`. Thus, the result printed is the string `bin`:

```
$ print ${stringx##*/}
bin
```

## *Korn Shell Arrays*

Arrays are variables that contain more than one value.

You do not declare arrays explicitly nor do you explicitly set the size of an array. The array is created when you first use it. It is treated as an array when you first assign a value to one element of the array variable. Each array can hold up to 1024 values.

You can create arrays of strings or integers. By default, an array contains strings. To create an array of integers, you must declare a variable as an integer, and then use it as an array name and assign integer values to the elements; for example:

```
integer my_array
my_array[1]=5
my_array[12]=16
```

The first element of an array is indexed by 0, the second element by 1, and so on. Therefore, the largest index value that is valid is 1023.

All arrays in the Korn shell are one-dimensional.

You must enclose an array reference in braces for the Korn shell to recognize it as such, such as `${arr[1]}` instead of `$arr[1]`.

The syntax for accessing the value of the *i*th array element is, where *i* is an integer:

```
{array_name[i]}
```

To print the values of all array elements, use the syntax:

```
{array_name[*]}
```

To print the actual number of elements (assigned values) in the array, use the syntax:

```
{#array_name[*]}
```



Array elements do not have to be assigned in order. Moreover, you can skip the assignment of values to any elements you want:

```
arr[2]=two
arr[4]=4
arr[8]=eight
arr[16]=16
```

Array elements that are skipped over are not assigned a value and, effectively, are treated as though they do not exist.

---

**Note** – You cannot use the `export` statement with arrays in the Korn shell.

---

## *Examples: Array*

The first two examples illustrate how to create arrays of strings. You do not need to enclose the values assigned to the various array elements within double quotes unless the string value contains special characters, such as spaces or tabs.

To create an array of three strings:

```
$ arr[0]=big
$ arr[1]=small
$ arr[2]="medium sized"
```

To create an array of three strings using the `set` statement:

```
$ set -A arr big small "medium sized"
```

---

**Note** – Not all Korn shell implementations support `set -A`.

---

In the following example, note the creation of the array of integers. The variable `num` is first declared as an integer variable and then used as the name of an array to assign integers to the first five elements of the array. If you try to assign a value other than an integer to any of the elements of the array, you get an error message about bad number.

To create an array of five integers:

```
$ integer num
$ num[0]=0
$ num[1]=100
$ num[2]=200
$ num[3]=300
$ num[4]=400
```

To print the number of array elements in array `num`:

```
$ print ${#num[*]}
5
```

To print the values of all array elements in array *arr*:

```
$ print ${arr[*]}
big small medium sized
```

To unset the array *arr*:

```
$ unset arr
```

## Command-Line Arguments

The execution of scripts is made versatile by the ability to run a script based on arguments supplied on the command line. In this way, the operation of the script varies depending on what arguments were given to the script.

The Korn shell automatically assigns special variable names, called *positional parameters*, to each argument supplied to a script on the command line. The positional parameter names and meanings are shown in Table 10-4.

**Table 10-4** Positional Parameters

| Positional Parameter Name | Description                                                                |
|---------------------------|----------------------------------------------------------------------------|
| \$0                       | The name of the script                                                     |
| \$1                       | The first argument to the script                                           |
| \$2                       | The second argument to the script                                          |
| \$9                       | The ninth argument to the script                                           |
| \${10}, \${11}, \${n}     | The tenth and up argument to the script (Korn shell only)                  |
| \$#                       | The number of arguments to the script                                      |
| \$@                       | A list of all arguments to the script                                      |
| \$*                       | A list of all arguments to the script                                      |
| \${#N}                    | The length of the value of positional parameter <i>N</i> (Korn shell only) |

Notice that `$@` and `$*` have the same meaning. This is true if they are not enclosed in double quotes `" "`. The distinction is described in greater detail later in this module.

---

**Note** – The Bourne shell stores all the arguments passed to the script but can only refer the positional parameters `$1` through `$9`. To obtain the values beyond the ninth argument, use the `shift` statement, which is destructive in nature.

---

## Using the shift Statement

The `shift` statement shifts, by default, the values held in the positional parameter. The `shift` statement drops the first value (`$1`) and shifts all other values to the left. So the value in `$2` is shifted or copied into `$1`, then the value in `$3` is shifted or copied into `$2`, and so on. This is shown in the following example.

```
$ cat argtest.sh
#!/bin/sh

Script name: argtest.sh

echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 $10 are: ' $1 $2 $9 $10
echo

shift
echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 are: ' $1 $2 $9

shift 2
echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 are: ' $1 $2 $9

echo '${10}: ' ${10}
```

```
$./argtest.sh a b c d e f g h i j k l m n
```

```
$#: 14
```

```
$@: a b c d e f g h i j k l m n
```

```
$*: a b c d e f g h i j k l m n
```

```
$1 $2 $9 $10 are: a b i a0
```

```
$#: 13
```

```
$@: b c d e f g h i j k l m n
```

```
$*: b c d e f g h i j k l m n
```

```
$1 $2 $9 are: b c j
```

```
$#: 11
```

```
$@: d e f g h i j k l m n
```

```
$*: d e f g h i j k l m n
```

```
$1 $2 $9 are: d e l
```

```
./argtest.sh: bad substitution
```

The echo of `${10}` causes the error message at the end of the script because the Bourne shell cannot access command-line parameters beyond `$9`.

In the Korn shell, braces are needed around the argument number when referring to all command-line arguments beyond the ninth one. For example, to display the contents of the tenth argument, use the syntax `${10}`.

To view the difference, copy the previous script and change the interpreter to Korn shell.

```
$ cat argtest.ksh
#!/bin/ksh

Script name: argtest

echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 $10 are: ' $1 $2 $9 $10
echo

shift
echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 are: ' $1 $2 $9

shift 2
echo '$#: ' $#
echo '$@: ' $@
echo '$*: ' $*
echo
echo '$1 $2 $9 are: ' $1 $2 $9

echo '${10}: ' ${10}
```

```
$./argtest.ksh a b c d e f g h i j k l m n
```

```
$#: 14
```

```
$@: a b c d e f g h i j k l m n
```

```
$*: a b c d e f g h i j k l m n
```

```
$1 $2 $9 $10 are: a b i a0
```

```
$#: 13
```

```
$@: b c d e f g h i j k l m n
```

```
$*: b c d e f g h i j k l m n
```

```
$1 $2 $9 are: b c j
```

```
$#: 11
```

```
$@: d e f g h i j k l m n
```

```
$*: d e f g h i j k l m n
```

```
$1 $2 $9 are: d e l
```

```
${10}: m
```



## Using Positional Parameters

Frequently, a script checks the number of parameters passed to it and sends a message to the user if the number of parameters is not what was expected; for example:

```
$ cat checkpara.ksh
#!/bin/ksh

Script name: checkpara.ksh

if (($# != 2))
then
 print "Two arguments were expected."
 exit
fi
```

You cannot use a positional parameter name on the left of an assignment statement. For example, the following statement causes an error message from the shell:

```
$ 3="third argument"
ksh: 3=third argument: not found
```

✓ *Ask the students to try assigning a value to a variable, called 3, as in the preceding example.*

## Assigning Positional Parameter Values Using *set*

Although you cannot use any positional parameter name on the left side of an assignment statement, you can still assign values to the positional parameters if you use the `set` statement:

```
set value1 value2 ... valueN
```

With the preceding syntax, `$1` has value *value1*, `$2` has value *value2*, and so on. The value of the positional parameter `$0` is the name of the script.

You can use the `set` statement to create a parameter list using the statement or variable substitution.

```
set $(cal)
set $var1
```

If you need the positional parameters sorted lexicographically, use the statement `set -s`. This means that if you sorted the list of values in lexical order, the first value on the list is assigned to `$1`, the second to `$2`, and so forth.

```
set -s
```

The statement `set --` unsets all the positional parameters. Thus, `$1`, `$2`, and so on have no values. The value of `$0`, however, is still the name of the script.

```
set --
```

The statements `set -s` and `set --` work on the positional parameters regardless of how the positional parameter names were assigned their values; that is, these statements work whether the values were assigned from command-line arguments or by using the `set` statement.

The use of statement or variable substitution, combined with the `set` statement, can be very useful. For example, to find out how many days are in the current month, you use the `cal` statement. The `cal` statement outputs a value for each day in the month plus an additional nine values, the month, year, and day of week values.

The following example shows the number of days in September. The extra nine values relate to the heading values output by the `cal` statement.

```
$ set $(cal)
$ echo $1
September
$ echo $#
39
```

## *Example: Using set*

The following `pospar2.scr` example script sets the values of the positional parameters using the `set` statement.

The values `a`, `b`, and `c` are passed into the script and assigned to positional parameters `$1`, `$2`, and `$3` respectively. The values of the positional parameters are displayed using the `print` statement and then given new values with the `set` statement.

The `textline` variable is assigned a value, which is a string consisting of several words. The statement `set $textline` assigns new values to the positional parameters. Because `$textline` is replaced by its value (a string of several words), the various words become the values of the positional parameters.

The script then prints all the values of the positional parameters using the `print $*` statement.

The script then prints the values of positional parameters `$1` and `$4`.

Next, the positional parameters are sorted by the statement `set -s`, and then the sorted list is printed using `print $*`.

Lastly, the `set --` statement unsets the positional parameters so that when the `print $0 $*` statement is executed, only the name of the script (held in `$0`) is printed.

```
$ cat pospara2.ksh
#!/bin/ksh

Script name: pospara2.ksh

print "Executing script $0 \n"
print "$1 $2 $3"

set uno duo tres
print "One two three in Latin is:"
print "$1"
print "$2"
print "$3 \n"

textline="name phone address birthdate salary"
set $textline
print "$*"
print 'At this time $1 =' $1 'and $4 =' $4 "\n"

set -s
print "$* \n"

set --
print "$0 $*"

$./pospara2.ksh a b c
Executing script ./pospara2.ksh

a b c
One two three in Latin is:
uno
duo
tres

name phone address birthdate salary
At this time $1 = name and $4 = birthdate

address birthdate name phone salary
```

## *The Values of "\$@" and "\$\*"*

The values of `$@` and `$*` are identical, but the values of `"$@"` and `"$*"` are different.

The expansion of `"$@"` is a list of strings comprised of the values of the positional parameters. The expansion of `"$*"` is one long string consisting of the values of the positional parameters separated by the first character in the set of delimiters of the `IFS` variable, for example:

```
$ cat posparatest1.ksh
```

```
#!/bin/ksh
```

```
Script name: posparatest1.ksh
```

```
set This is only a test
```

```
print 'Here is the $* loop.'
```

```
for var in "$*"
```

```
do
```

```
 print "$var"
```

```
done
```

```
print \n"
```

```
print 'Here is the $@ loop.'
```

```
for var in "$@"
```

```
do
```

```
 print "$var"
```

```
done
```

```
$./posparatest1.ksh
```

```
Here is the $* loop.
```

```
This is only a test
```

```
Here is the $@ loop.
```

```
This
```

```
is
```

```
only
```

```
a
```

```
test
```

✓ *If you fail to quote the `$*` and `$@` in the for loop control statement, the output for both loops is one word per line.*

"\$@" expands to "\$1" "\$2" "\$3" ... "\$n"; that is, *n* separate strings.

"\$\*" expands to "\$1x\$2x\$3x...\$n", where *x* is the first character in the set of delimiters for the IFS variable. This means that "\$\*" is one long string.

When you use quotes to group tokens into a string, the string sets the value of a single positional parameter.

**\$ cat posparatest2.sh**

```
#!/bin/sh

Script name: posparatest2.sh

set "This is a test" and only a test

echo 'Here is the $* loop output: '
for var in "$*"
do
 echo "$var"
done

echo "\n"
echo 'Here is the $@ loop output: '
for var in "$@"
do
 echo "$var"
done
```

```
$./posparatest2.sh
```

```
Here is the $* loop output:
```

```
This is a test and only a test
```

```
Here is the $@ loop output:
```

```
This is a test
```

```
and
```

```
only
```

```
a
```

```
test
```



## Exercise: Advanced Variables, Parameters, and Argument Lists



**Exercise objective** – In this lab, you write scripts that manipulate the positional parameters, use a loop construct, and perform integer arithmetic.

### Preparation

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod10/lab` before beginning the exercise.

When writing the script on paper, you might want to execute commands on the system to ensure you have the correct command and option to give you the prescribed output.

### Tasks

1. Write a Korn script that displays the following information:
  - a. The name of the script being executed ( `$0` ).
  - b. The first, second, and tenth parameters that have been passed to the script ( `$1`, `$2` and `${10}` ).
  - c. The number of parameters that were passed to the script ( `$#` ).
  - d. If there were five or more positional parameters, use the `shift` statement to move all the values of the positional parameters over by five places.
  - e. Print all the values remaining in the positional parameters.
  - f. Print the number of positional parameters.

When you have written the script, make it executable, and then run it. Make sure that you test it thoroughly by running it with no parameters, just one parameter, and with several (more than 10) parameters.

2. Write a script to parse information from a long path name. Assume the path name is the only item passed in on the command line.

Name the script `parsepath`.

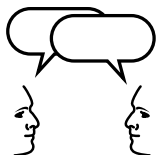
A good path name is: `/usr/share/lib/terminfo/s/sun`.

An example execution is:

```
$./parsepath /usr/share/lib/terminfo/s/sun
```

```
The pathname is: /usr/share/lib/terminfo/s/sun
/usr/share/lib/terminfo/s/sun
/usr/share/lib/terminfo/s
/usr/share/lib/terminfo
/usr/share/lib
/usr/share
/usr
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

Did you see what you expected?

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

How do you think parameters can be used within shell scripts?

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

Are parameters the best way of giving a script the values with which to work?

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

## Task Solutions

1. Write a script that displays the following information:

- a. The name of the script being executed ( `$0` ).

```
print "The name of the script is: $0"
```

- b. The first, second and tenth parameters that have been passed to the script ( `$1`, `$2` and `${10}` ).

```
print "Positional Parameter Value"
print " \ $1 $1"
print " \ $2 $2"
print " \ ${10} ${10}"
```

- c. The number of parameters that were passed to the script ( `$#` ).

```
print "The number of positional parameters is: $#"
```

- d. If there are five or more positional parameters, use the `shift` statement to move all the values of the positional parameters over by five values.

```
if (($# >= 5)); then
...
 shift 5
...
fi
```

- e. Print all the values remaining in the positional parameters.

```
print "Positional parameters remaining:"
print $*
```

- f. Print all the remaining positional parameter values.

```
print "The number of positional parameters is: $#"
```

When you have written the script, make it executable, and then run it. Make sure that you test it thoroughly by running it with no parameters, just one parameter, and with several (more than 10) parameters.

## *Complete Script Solution for 1*

```
$ cat arginfo.ksh
#!/bin/ksh

Purpose: Print out information about the positional parameters.
#
Name: arginfo.ksh

print "The name of the script is: $0"

print "Positional Parameter Value"
print " \ $1 $1"
print " \ $2 $2"
print " \ ${10} ${10}"

print "The number of positional parameters is: $#"
```

```
print

if (($# >= 5)); then
 print "Now shift all values over by 5 places."
 shift 5

 print "Positional parameters remaining:"
 print $*
 print

 print "The number of positional parameters is: $#"
```

```
fi
```

2. Write a script to parse information from a long path name.  
Assume the path name is the only item passed in on the command line.

Name the script `parsepath`.

A good path name is: `/usr/share/lib/terminfo/s/sun`.

An example execution is:

```
$./parsepath.ksh /usr/share/lib/terminfo/s/sun
```

```
The pathname is: /usr/share/lib/terminfo/s/sun
/usr/share/lib/terminfo/s/sun
/usr/share/lib/terminfo/s
/usr/share/lib/terminfo
/usr/share/lib
/usr/share
/usr
```

```
$ cat parsepath.ksh
```

```
#!/bin/ksh
```

```
Purpose: To parse a long pathname.
```

```
#
```

```
Name: parsepath.ksh
```

```
if [$# -ne 1]; then
 echo "Usage: parsepath /pathname"
 exit 1
fi
```

```
name=$1
```

```
print
print "The pathname is: $name"
```

```
while [[-n $name]]
do
 print $name
```

```
 name=${name%/*}
done
```

```
print
```

## *Check Your Progress*

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Declare strings, integers, and array variables
- ☐ Manipulate string variables
- ☐ Change the values of the positional parameters using the `set` statement within a script
- ☐ Use Korn shell arrays
- ☐ Set default values for parameters
- ☐ Use the Korn shell built-in statements `let`, `print`, `set`, and `typeset`





## Objectives

Upon completion of this module, you will be able to:

- Create user-defined functions in a shell script
- Create, invoke, and display functions from the command line
- Pass arguments into a function
- Call functions from special (function) files that are saved in one or more function directories
- Describe where functions are available for use

## *Functions in the Shell*

A function is a set of one or more statements that act as a complete routine. Each function must have a unique name *within that shell or shell script*.

### *Syntax*

There are two syntaxes for creating a function: a Bourne-shell syntax and a Korn-shell syntax. The Korn shell accepts either syntax; however, the Bourne shell only accepts the first syntax.

Bourne-shell syntax:

```
function_name ()
{
 block of statement lines
}
```

Korn-shell syntax:

```
function function_name
{
 block of statement lines
}
```

### *Function Execution*

A function is executed within the shell in which it has been declared; the function is executed as a subroutine of the shell. It is not executed as a subprocess of the current shell. After a function has been loaded into the current shell, it is retained.

## *Positional Parameters*

Functions act like mini-scripts. They can accept parameters that are passed to them, they can use local variables, and they can return values back to the calling shell command line.

Positional parameters passed to the function are not the same positional parameters that are passed to the script; for example:

```
$ cat funparas.ksh
#!/bin/ksh

Script name: funparas.ksh

function hello
{
 print '$1 in the function is: ' $1
}

print 'Input passed and stored in $1 is: ' $1

hello John # execute the function hello

print
print 'After the function $1 is still ' $1

$./funparas.ksh Susan
Input passed and stored in $1 is: Susan
$1 in the function is: John

After the function $1 is still Susan
```

The following customized `.kshrc` file shows three functions: `rgrep`, `rcgrep`, and `killit`. The following examples shows the execution of each of the three functions.

**\$ cat /.kshrc**

```
rgrep () # Bourne shell syntax
{
 find $2 -type file -exec grep $1 {} \; | more
}

function rcgrep # Korn shell syntax
{
 grep $1 /etc/init.d/* | more
}

function killit # Korn shell syntax
{
 pkill -u $1
 print -n "Had to kill process for user: $1 "
 print "on $(date +%D) at $(date +%T)"

 # The previous print statement may be appended to a log file.
}
```

The following function calls `pkill` to kill all processes owned by the user specified as the first argument to the function. It then prints a message that is logged to a file.

**\$ killit annette**

Had to kill process for user: annette on 05/23/00 at 21:38:32

The following example executes a `grep` search through all the files in the `/etc/init.d` directory for the string passed in as the first argument to the function.

```
$ rcgrep sed
/etc/init.d/autoinstall:# are available, then the default profiles in are
used.
/etc/init.d/dtlogin:# This version of the dtlogin.rc script can be used
on the Solaris(TM)
/etc/init.d/inetinit:# tcp used when it loaded.
```

<Output truncated>

The following example performs a recursive `grep` search. Two arguments are passed to the function; the first is the search string, the second the directory from which to begin the search. The `find` statement recursively finds all files under that directory, and the `xargs` statement constructs a command line for the `grep` statement and the path names returned. Therefore, you can apply `grep` to the contents of the files, rather than the file names.

- ✓ **The command:**  
`find /etc/default -type file | grep root`
- ✓ **returns nothing as `grep` is searching for the pattern `root` in the file names returned from the `find` statement.**
- ✓ **As opposed to:**  
`find /etc/default -type file | xargs grep root | more`
- ✓ **that returns output because it is searching for the pattern `root` in the actual files specified by the file names returned from the `find` statement.**

```
$ rgrep root /etc/default
/etc/default/login:# If CONSOLE is set, root can only login on that
device.
/etc/default/login:# Comment this line out to allow remote login by root.
/etc/default/login:# SUPATH sets the initial shell PATH variable for root
/etc/default/login:# to log all root logins at level LOG_NOTICE and
multiple failed login
/etc/default/su:# CONSOLE determines whether attempts to su to root
should be logged
/etc/default/su:# SUPATH sets the initial shell PATH variable for root
/etc/default/su:# root, LOG_INFO messages are generated for su's to other
users, and LOG_CRIT
```

## *Return Values*

A value can pass from a function back to the shell or script that called that function.

The `return` statement terminates the function and passes a value back to the calling shell or script. The `return` statement returns any designated value between 0 (zero) and 255. By default, the value passed by the `return` statement is the current value of the `?` (exit status variable).

## typeset *and* unset

|                                   |                                                 |
|-----------------------------------|-------------------------------------------------|
| <code>typeset -f</code>           | Lists the known functions and their definitions |
| <code>typeset +f</code>           | Lists the known function names                  |
| <code>functions</code>            | Is an alias for <code>typeset -f</code>         |
| <code>unset -f <i>name</i></code> | Unsets the value of the function                |

```
$ typeset -f
function killit
{
 pkill -u $1
 print -n "Had to kill process for user: $1 "
 print "on $(date +%D) at $(date +%T)"

 # The previous print statement may be appended to a log file.
}
function rcgrep
{
 grep $1 /etc/init.d/* |more
}
function rgrep
{
 find $2 -type file -exec grep $1 {} \; | more
}

$ typeset +f
killit
rcgrep
rgrep

$ alias | grep fun
functions='typeset -f'

$ unset -f rcgrep
$ typeset +f
killit
rgrep
```

## Function Files

You can create functions within a shell script, or they can be external to the shell script.

Functions created within a shell script only exist within the shell interpreting that script.

Functions can also be placed within a file. When a function file is created, it must contain the definition of only one function. The name of the function must be the same as the name of the function file. Only one function can be in each function file; for example:

```
$ cat holder
```

```
function holder
{
 print
 print -n "Type some text to continue: "
 read var1
 print "In function holder var1 is: $var1"
}
```

✓ *Because the file has no `#!` line, the file name does not have an extension.*

The function file should be made executable.

The function file can be autoloaded into a shell script and used by that script.



The function can be loaded into the current shell environment by including the directory name (which holds that file) in the FPATH variable. When the function is loaded into the shell environment, it can be invoked as you would any statement; for example:

```
$ cat holdertest.ksh
#!/bin/ksh

Script name: holdertest.ksh

FPATH=.
export FPATH

print "Calling holder..."
holder

print
print "After the function var1 is: $var1"

$./holdertest.ksh
Calling holder...

Type some text to continue: shell scripts
In function holder var1 is: shell scripts

After the function var1 is: shell scripts
```

## *Autoloading Korn Shell Functions With the FPATH Variable*

A function is treated in the same way as a Korn shell built-in statement. When the function is invoked, it is invoked in the current shell and not as a subprocess.

Before a function is invoked, the shell must know that the function exists. It is, therefore, necessary to define your functions at the start of the shell script before any command line that attempts to invoke the function.

If a function has been created as a function file, the FPATH variable must be created, or modified, to include the name of the directory that contains the function file. Declare the FPATH variable before any command line that attempts to invoke a function from one of the function files.

---

**Note** – The FPATH variable is similar to the PATH variable. It can contain the names of one or more directories, each separated by colons.

---

Directories that are listed in the FPATH variable should contain only function files.

✓ *Stress this last point; this information is very important.*

The FPATH variable is an environment variable; for example:

```
$ FPATH=$HOME/function_dir ; export FPATH
```

The files that exist in the \$HOME/function\_dir directory should all be function files. Ensure that no other types of file reside in that directory.

✓ *If a non-function file exists and the name of the file matches a function from a script, the script attempts to process every line of the non-function file. This is a potential security risk.*

By using the FPATH variable, the functions can be autoloaded into a shell script and do not need to be declared in every script.

---

Also, by updating a function file (stored in a directory that is pointed to by the `FPATH` variable), any scripts that use that function autoload the updated version of the function file when the script is next invoked.

## *Exercise: Functions*



**Exercise objective** – In this lab, you write shell scripts that include or use functions.

### *Preparation*

Think about creating a function directory to store only your functions and consider what you would name this directory and where you may create it.

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod11/lab` before beginning the exercise.

When writing the script on paper, you might want to execute statements on the system to ensure you have the correct statement and option to give you the prescribed output.

### *Tasks*

1. Copy the `parsepath` solution from the `mod10` lab, and name the copy `firstfunc`.
2. Take the portion of the code that actually does the parsing and printing of the path names, and place it all in a function named `parsepath`.
3. Modify the code so that it does not take arguments from the command line, and it prints a `USAGE` message if any arguments are received.
4. Prompt the user for a path name, read the path name, call the function, and pass the path name to the function. Do this two or three times using a loop construct.
5. Create a `/myfuncs` directory to hold your functions.

6. Copy the `firstfunc` script to `/myfuncs/parsepath`.
7. Modify `/myfuncs/parsepath` so it only contains the function code.
8. Copy the `firstfunc` script to `secondfunc`.
9. Modify `secondfunc`, and remove the `parsepath` function.
10. Modify `secondfunc`, and add a declaration for the variable `FPATH`; for example:  
  
`FPATH=/myfuncs`
11. Execute `secondfunc`, which should go to the directory specified in `FPATH`. It should also search and find the `parsepath` function in the `parsepath` file.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

## Task Solutions

1. Copy the parsepath solution from the mod10 lab, and name the copy firstfunc.

```
$ cp ../../mod10/lab/parsepath firstfunc
```

2. Take the portion of the code that actually does the parsing and printing of the path names, and place it all in a function named parsepath.

```
function parsepath
{
 name=$1

 print
 print "The pathname is: $name"

 while [[-n $name]]
 do
 print $name
 name=${name%/*}
 done

 print
}

```

3. Modify the code so that it does not take arguments from the command line, and it prints a USAGE message if any arguments are received.

```
Purpose: To parse a long pathname.
#
Name: firstfunc.ksh

if [$# -ne 0]; then
 echo "Usage: firstfunc.ksh"
 exit 1
fi

```

4. Prompt the user for a path name, read the path name, call the function, and pass the path name to the function. Do this two or three times using a loop construct.

```
print -n "Enter a pathname and I will parse it: [Control-D to quit]: "
read pathname junk

while [[-n $pathname]]
do
 parsepath $pathname

 # Enter a control-D to quit
 print -n "Enter a pathname and I will parse it: [Control-D to quit]: "

 read pathname junk
done
```

### *Complete Script Solution for 1, 2, 3, and 4*

```
#!/bin/ksh

Purpose: To parse a long pathname.
#
Name: firstfunc.ksh

function parsepath
{
 name=$1

 print
 print "The pathname is: $name"

 while [[-n $name]]
 do
 print $name
 name=${name%/*}
 done

 print
}

if [$# -ne 0]; then
 echo "Usage: firstfunc.ksh"
 exit 1
fi
```



```
print -n "Enter a pathname and I will parse it: [Control-D to quit]: "
read pathname junk

while [[-n $pathname]]
do
 parsepath $pathname

 # Enter a control-D to quit
 print -n "Enter a pathname and I will parse it: [Control-D to quit]: "

 read pathname junk
done
```

5. Create a /myfuncs directory to hold your functions.

```
$ mkdir /myfuncs
```

6. Copy the firstfunc script to /myfuncs/parsepath.

```
$ cp firstfunc /myfuncs/parsepath
```

7. Modify /myfuncs/parsepath so it only contains the function code.

```
function parsepath
{
 name=$1

 print
 print "The pathname is: $name"

 while [[-n $name]]
 do
 print $name
 name=${name%/*}
 done

 print
}

```

8. Copy the firstfunc script to secondfunc.

```
$ cp firstfunc secondfunc
```

9. Modify secondfunc, and remove the parsepath function.

```
#!/bin/ksh
```

```
Purpose: To parse a long pathname.
#
Name: secondfunc.ksh

if [$# -ne 0]; then
 echo "Usage: secondfunc.ksh"
 exit 1
fi

print -n "Enter a pathname and I will parse it: [Control-D to quit]: "
read pathname junk

while [[-n $pathname]]
do
 parsepath $pathname

 # Enter a control-D to quit
 print -n "Enter a pathname and I will parse it: [Control-D to quit]: "

 read pathname junk
done
```

10. Modify `secondfunc`, and add a declaration for the variable `FPATH`; for example:

```
FPATH=/myfuncs
```

11. Execute `secondfunc`, which should go to the directory specified in `FPATH`. It should also search and find the `parsepath` function in the `parsepath` file.

### *Complete Script Solution for 7, 8, 9, 10, and 11*

```
$ cat secondfunc.ksh
#!/bin/ksh

Purpose: Use a function from FPATH directory to parse a long pathname.
#
Name: secondfunc.ksh

FPATH=/myfuncs
```

```
if [$# -ne 0]; then
 echo "Usage: secondfunc.ksh"
 exit 1
fi
```

```
print -n "Enter a pathname and I will parse it: [Control-D to quit]: "
read pathname junk
```

```
while [[-n $pathname]]
do
 parsepath $pathname

 # Enter a control-D to quit
 print -n "Enter a pathname and I will parse it: [Control-D to quit]: "

 read pathname junk
done
```

```
$ cat /myfuncs/parsepath
function parsepath
{
 name=$1

 print
 print "The pathname is: $name"

 while [[-n $name]]
 do
 print $name
 name=${name%/*}
 done

 print
}
}
```

## *Check Your Progress*

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Create user-defined functions in a shell script
- ☐ Create, invoke, and display functions from the command line
- ☐ Pass arguments into a function
- ☐ Call functions from special (function) files that are saved in one or more function directories
- ☐ Describe where functions are available for use

### *Objectives*

Upon completion of this module, you will be able to:

- Describe how the `trap` statement works
- Include `trap` statements in a script
- Use the `trap` statement to catch signals and handle errors

## Shell Signal Values

A signal is a message that some abnormal event has taken place or a message requesting another process do something. The signal is sent from one process to another process. Typically, a process sends a signal to one of its own subprocesses. You can obtain more information on signals from the `signal` and `kill` man pages.

- ✓ **Also check the `signal.3` head man page:**
- ✓ **The `kill` command is a built-in command; therefore, different shells may recognize only a subset of the operating system signals.**

You use the `kill` command to send signals to processes. The `root` user can send any signal to any process. Other users can only send signals to processes they own.

Some signals that can be sent from the keyboard:

- Send Signal 2 (INT) by typing Control-C.
- Send Signal 3 (QUIT) by typing Control-`\`.
- Send Signal 23 (STOP) by typing Control-S.
- Send Signal 24 (TSTP) by typing Control-Z.
- Send Signal 25 (CONT) by typing Control-Q.

- ✓ **For your information, Signals 23 and 25 are XON and XOFF, respectively.**

The INT and QUIT signals cause the currently running process associated with that tty device (console or window) to terminate. The TSTP signal causes the process to stop or suspend execution. The job is put into the background; the process can be resumed by putting the job into the foreground.

Because most signals sent to a process executing a shell script cause the script to terminate, the next topic describes how to have a script avoid termination from specified signals.

The shell has 46 defined signals. Each signal has a name and a number associated with it. Typing the `kill -l` command displays this list:

|         |         |         |         |         |
|---------|---------|---------|---------|---------|
| EXIT    | HUP     | INT     | QUIT    | ILL     |
| TRAP    | ABRT    | EMT     | FPE     | KILL    |
| BUS     | SEGV    | SYS     | PIPE    | ALRM    |
| TERM    | USR1    | USR2    | CLD     | PWR     |
| WINCH   | URG     | POLL    | STOP    | TSTP    |
| CONT    | TTIN    | TTOU    | VTALRM  | PROF    |
| XCPU    | XFSZ    | WAITING | LWP     | FREEZE  |
| THAW    | CANCEL  | LOST    | RTMIN   | RTMIN+1 |
| RTMIN+2 | RTMIN+3 | RTMAX-3 | RTMAX-2 | RTMAX-1 |
| RTMAX   |         |         |         |         |

The numeric signal values range from 0 (EXIT) through 45 (RTMAX).

You can confirm the numeric value by executing the `kill` command with the `-l` option, followed by the signal name; for example:

```
$ kill -l EXIT
0
```

```
$ kill -l RTMAX
45
```

```
$ kill -l KILL
9
```

```
$ kill -l TSTP
24
```

If you know the number and want to learn or confirm the name of the signal, execute the `kill` command with the `-l` option, followed by the signal number.

```
$ kill -l 0
EXIT
```

```
$ kill -l 45
RTMAX
```

```
$ kill -l 9
KILL
```

```
$ kill -l 24
TSTP
```

You can send a signal to processes running on the system by using the `kill` command:

```
kill -signal pid
```

where *signal* is the signal number or the signal name, and *pid* is the process identification number for the process being sent the signal.

You might have terminated a process by executing the `kill` command and using the `-9` option. The `-9` option sends the KILL signal to the process. You can use either the numeric value or the signal name as shown here.

```
kill -9 pid
kill -KILL pid
```

When you do not specify a signal name or number, the TERM signal, Signal 15, is sent to the process.

✓ *A good example of the use of a trap is `/etc/init.d/network`.*



## Catching Signals With `trap`

You might want to write a script that you do not want the user to immediately terminate using a Control-C, Control-\ or Control-Z. For example, the script might need to do some clean-up before exiting. To avoid this, you use the `trap` statement in your script to catch these signals.

The syntax for using the `trap` statement is:

```
trap 'action' signal
```

where

*action* is a statement or several statements separated by semicolons. If an action is not provided, then no action is performed, but the signal is still “trapped.” Enclose the *action* within a pair of single quotes.

*signal* is the name or number for the signal to be caught.

For example, if you want to trap the use of Control-C, use the following:

```
trap 'echo "Control-C not available"' INT
```

The statements to be executed can be more than one line of typing as long as the closing quote is followed by the signal value or values to be trapped; for example:

```
trap 'echo "Control-C not available"
echo "Core dumps not allowed"
sleep 1
continue' INT QUIT
```

The trap does not work if you attempt to trap the KILL or STOP signals. The shell does not let you catch these two signals, thereby ensuring that you can always terminate or stop a process. This means that shell scripts can still be terminated using the command:

```
kill -9 script_PID
```

or

```
kill -KILL script_PID
```

and the execution of the shell script can be suspended using the Control-S character because both signals can never be trapped within a Korn shell script.

The following statement tells the Korn shell to restore the original actions for the signals before giving the `trap` statement:

```
trap - signal
```

The following statement tells the Korn shell to restore the original actions for the signals prior to giving the `trap` statement:

```
trap signal
```

## Example: Using `trap`

The `trapsig.ksh` example script sets up a `trap` statement for the signals `INT` (Control-C), `QUIT` (Control-\) and `TSTP` (Control-Z). The script does not illustrate any practical application; it just shows how to install signal handling for these signals.

After the `trap` statement, a `while` loop is entered that prints the string `rolling ...` and waits for user input. The `while` loop and the script terminate when the user types in the string `dough`.

The script cannot be terminated by typing Control-C, Control-\, or Control-Z.

The script is executed. The user presses the Return key after the first `rolling ...` prompt. The user then types a `d` to the second `rolling ...` prompt and an `s` to the third.

The users enters a Control-D to the fourth through to the seventh `rolling ...` prompts, which causes the prompts to remain on the same line.

Then the user types a `4` to the eighth `rolling ...` prompt.

The users types a Control-C, a Control-\, and a Control-Z to the latter `rolling ...` prompts, which causes the appropriate `trap` statement to execute.

Finally, the user types the string `dough` and the script terminates.

```
$ cat trapsig.ksh
#!/bin/ksh

Script name: trapsig.ksh

trap 'print "Control-C cannot terminate this script."' INT
trap 'print "Control- cannot terminate this script."' QUIT
trap 'print "Control-Z cannot terminate this script."' TSTP

print "Enter any string (type 'dough' to exit).\"
while ((1))
do
 print -n "Rolling..."
 read string

 if [["$string" = "dough"]]
 then
 break
 fi
done

print "Exiting normally"

$
$./trapsig.ksh
Enter any string (type 'dough' to exit).
Rolling...
Rolling...d
Rolling...s
Rolling...Rolling...Rolling...Rolling...Rolling...4
Rolling...^c
Control-C cannot terminate this script.
Rolling...^\\
Control- cannot terminate this script.
Rolling...^z
Control-Z cannot terminate this script.
Rolling...dough
Exiting normally
$
```

## Catching User Errors With `trap`

In addition to catching signals, you can use the `trap` statement to take specified actions when an error occurs in the execution of a script.

The syntax for this type of `trap` statement is:

```
trap 'action' ERR
```

The value of the `$?` variable indicates when the `trap` statement is to be executed. It holds the exit (error) status of the previously executed command or statement, so any nonzero value indicates an error. Thus the `trap` statement is executed whenever `$?` becomes nonzero.

The `traperr1.ksh` example script requires the user to enter a negative integer number (-1) if they want to exit.

If the user enters an integer that is not a -1, the script prints the square of the number. The script then requests another integer until the user quits the script by entering a -1.

The script is executed, and the user enters the letter `r`. This is not an integer. The user's input is read into the variable `num`, which is declared to only hold integer data types, so the shell prints an error message and exits the script. You can avoid this problem by using a `trap` statement, which is shown on the following pages.

✓ *The trap is added to this script in the next example, shown on a subsequent page.*

```
$ cat traperr1.ksh
#!/bin/ksh

Script name: traperr1.ksh

integer num=2

while ((1))
do
 read num?"Enter any number (-1 to exit): "

 if ((num == -1))
 then
 break
 else
 print "Square of $num is $((num * num)). \n"
 fi
done

print "Exiting normally"

$./traperr1.ksh
Enter any number (-1 to exit): r
traperr1.ksh[9]: r: bad number
Square of 2 is 4.

Enter any number (-1 to exit): -1
```

## Example: Using `trap` With `ERR`

The `trapsig2.ksh` script is the `traperr1.ksh` script rewritten with a `trap` statement, a test of the exit status, and an `exec` statement to redirect standard error messages to `/dev/null`.

The redirection of standard error messages is done so that the user does not see the error messages the shell would otherwise print to the screen. You want the user to see just the message you set up with the `trap` statement if an error occurs.

The value of `$?` is saved in the variable `status` immediately after the `read` statement is executed so that you can check later whether the `read` statement successfully read an integer.

The `if` statement checks to see if the user entered a `-1`. If so, the script breaks out of the `while` loop and terminates. If the user did not enter a `-1` and the value of `status` is `0` (indicating the `read` statement read an integer), the square of the integer entered by the user is printed and the user is again prompted for a number.

If the user does not enter an integer, the value of `$?` is nonzero and is trapped. The `print` statement within the `trap` statement is then executed. Control then returns to the `while` loop, prompting the user for another number.

The script is executed, with the user typing in several integers, then the letter `r`, another integer, and finally `-1` to exit the script. The messages output by the script for the corresponding input from the user are what is expected, based on the preceding description.

```
$ cat trapsig2.ksh
#!/bin/ksh

Script name: trapsig2.ksh

integer num

exec 2> /dev/null
trap 'print "You did not enter an integer."' ERR

while ((1))
do
 print -n "Enter any number (-1 to exit): "
 read num

 status=$?

 if ((num == -1))
 then
 break
 elif ((status == 0))
 then
 print "Square of $num is $((num * num)). \n"
 fi
done

print "Exiting normally"
```

```
$./trapsig2.ksh
Enter any number (-1 to exit): 3
Square of 3 is 9.

Enter any number (-1 to exit): r
You did not enter an integer.trap_err2
Enter any number (-1 to exit): 8
Square of 8 is 64.

Enter any number (-1 to exit): -1
Exiting normally
```



## When to Declare a trap

To trap a signal any time during the execution of a shell script, define the trap at the start of the script.

Alternatively, to trap a signal only when certain command lines are to be executed, you can turn on the trap before the appropriate command lines and turn off the trap after the command lines have been executed.

If a loop is being used, a trap can include the `continue` statement to make the loop start again from its beginning.

You can also trap the `EXIT` signal so that certain statements are executed only when the shell script is being terminated with no errors. For example, if a shell script created temporary files, you could ensure that these are removed using a trap of the `EXIT` signal value.

```
trap 'rm -f /tmp/tfile* ; exit 0' EXIT
```

---

**Note** – The preceding example includes an `exit` statement within the list of statements to be executed when the trap occurs. This is necessary to exit from the script.

---

The following example is a copy of the `/etc/profile` file with some added comments to explain the various trap statements.

```
#ident "@(#)profile 1.18 98/10/03 SMI /* SVr4.0 1.3 */

The profile that all logins get before using their own .profile.

trap "" 2 3 # trap INT (Control-C) and QUIT (Control-\)
 # and give no feedback
export LOGNAME PATH

if ["$TERM" = ""]
then
 if /bin/i386
 then
 TERM=sun-color
 else
 TERM=sun
 fi
```

```
export TERM
fi

Login and -su shells get /etc/profile services.
-rsh is given its environment in its .profile.

case "$0" in
-sh | -ksh | -jsh)

 if [! -f .hushlogin]
 then
 /usr/sbin/quota
 # Allow the user to break the Message-Of-The-Day only.
 # The user does this by using Control-C (INT).
 # Note: QUIT (Control-\) is still trapped (disabled).
 trap "trap '' 2" 2
 /bin/cat -s /etc/motd
 trap "" 2 # trap Control-C (INT) and give no feedback.

 /bin/mail -E
 case $? in
 0)
 echo "You have new mail."
 ;;
 2)
 echo "You have mail."
 ;;
 esac
 fi
esac

umask 022
trap 2 3 # Allow the user to terminate with Control-C (INT) or
 # Control-\(QUIT)
```

## Exercise: Traps



**Exercise objective** – In this lab, you modify a shell script to trap the Control-C signal.

### Preparation

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

Change the directory to `mod12/lab` before beginning the exercise.

You need a copy of the `adduser` script from Module 9 exercises. If you did not complete this exercise, you can copy the solution to complete this lab exercise.

### Tasks

1. Execute the `adduser` script with a new user name, and execute a Control-C at the shell menu prompt.
2. Copy the `adduser` script from the `mod9` lab.

Modify the script to:

- a. Execute the `adduser` script with a new user name, and execute a Control-C at the shell menu prompt.
- b. Add a trap to the `adduser` script to catch the `INT` signal so the user can not terminate on that signal. The trap should notify the user that a Control-C is not available. Place the `trap` statement after the test for the command-line arguments.
- c. Execute the `adduser` script with a new user name and execute a Control-C at the shell menu prompt. Trigger your user notification that Control-C is disabled.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

## Task Solutions

1. Execute the `adduser` script with a new user name, and execute a Control-C at the shell menu prompt.

```
$./adduser michael
```

2. Copy the `adduser` script from the `mod9` lab.

```
$ cp ../../mod9/lab/adduser .
```

Modify the script to:

- a. Execute the `adduser` script with a new user name, and execute a Control-C at the shell menu prompt.

```
$./adduser michael
The uid for michael is: 1003
What primary group should belong to?
Please specify the group name: staff
1) csh
2) ksh
3) sh
Enter the number: ^C
```

- b. Add a trap to the `adduser` script to catch the `INT` signal so the user can not terminate on that signal. The trap should notify the user that a Control-C is not available. Place the `trap` statement after the test for the command-line arguments.

```
trap 'banner "No Control-C"' 2
```

- c. Execute the `adduser` script with a new user name and execute a Control-C at the shell menu prompt. Trigger your user notification that Control-C is disabled.

## *Complete Script Solution for 1*

```
#!/bin/ksh

Purpose: To write a script to add user to the system. Generate a
menu for the login shell choices.
#
Name: adduser.ksh

Check for only a single command line argument
if [$# -ne 1]
then
 echo "Usage: adduser.ksh newusername"
 exit 1
fi

Add a trap for Control-C
trap 'banner "No Control-C"' 2

Assign the value of $1 to the variable name
name=$1

if grep "^$name:" ./mypasswd > /dev/null 2>&1
then
 echo "The username $1 is already in use, here "
 echo "is the entry from the ./mypasswd file."
 echo
 grep "^$name:" ./mypasswd
 exit 2
fi

Use awk to extract all the UIDs into the temp file currentuid
awk -F: '{print $3}' ./mypasswd > ./currentuid

Use sed to remove all 1, 2, and 3 digit UIDs from currentuid, and
place the output in the temp file currentuid2
sed -e '/^.$/d' -e '/^..$/d' -e '/^...$/d' ./currentuid > ./currentuid2
```

```
Use sed to remove UIDs 60001, 60002, and 65534 from currentuid2,
and place the output in the temp file currentuid3
sed -e '/^6000[12]$/d' -e '/^65534$/d' ./currentuid2 > ./currentuid3
```

```
Sort the UIDs in currentuid3 numerically
sort -n ./currentuid3 > ./currentuid4
```

```
Calculate the next available UID
lastuid='sed -n '$p' ./currentuid4'
```

```
uid='expr $lastuid + 1'
echo "The uid for $name is: $uid"
```

```
Prompt for a group name and verify whether it exists in /etc/group
```

```
echo "What primary group should $a belong to? "
echo "Please specify the group name: \c"
read group junk
```

```
grep "^$group:" /etc/group > /dev/null 2>&1
if [$? -ne 0]
then
 echo "The group $group is not valid."
 echo
 exit 2
fi
```

```
PS3="Enter the number: "
select ushell in csh ksh sh
do
 case $ushell in
 csh)
 print "$ushell was selected."
 break

 ksh)
 print "$ushell was selected."
 break
 ;;
 esac
done
```

```
 sh)
 print "$ushell was selected."
 break
 ;;
 *)
 print "Unknown choice, try again."
 ;;
 esac
done

if [$ushell = "csh" -o $ushell = "ksh" -o $ushell = "sh"]
then
 echo "Please enter the comment information for the user:"
 read comment

 echo "The new user entry looks like this:"
 echo "$1:x:$uid:$group:$comment:/export/home/$1:$ushell"
 echo " "
 echo "New user $1 has been added to the ./mypasswd file"
 echo "$1:x:$uid:$group:$comment:/export/home/$1:$ushell" >>
 ./mypasswd
else
 echo "Sorry, that is not a valid shell, exiting..."
fi
```



---

## *Check Your Progress*

Before continuing on to the next module, check that you are able to accomplish or answer the following:

- ☐ Describe how the `trap` statement works
- ☐ Include `trap` statements in a script
- ☐ Use the `trap` statement to catch signals and handle errors



## *The getopt's Statement*

---

A 

The `getopts` statement processes arguments on the command line that are options.

## Processing Script Options With `getopts`

Options or switches are single-letter characters preceded by a + sign or a - sign. By convention, a - sign preceding a character means to turn some flag on, while a + sign means to turn some flag off.

The Bourne shell only supports script options with a - sign preceding the character.

The syntax of `getopts` is:

```
getopts options [opt_args] var
```

The *options* in the `getopts` statement are the valid single-letter characters the script expects as options from the command line. If any single-letter character in *options* is followed by a colon (:), then the shell expects that option to have an argument.

The `getopts` statement does not always process all options on the command line. It quits processing options if an argument that is not an option or an argument to an option is placed between two options. For example, suppose `scriptname` is a script with valid options `x` and `y`, neither of which requires an argument. Then the command:

```
scriptname -x filex -y
```

causes the script to process the `x` option but not the `y` option.

- ✓ **Therefore, as stated in the paragraph, the `getopts` statement quits processing if an argument that is not an option or an argument to an option is encountered.**

**In the example:**

```
scriptname -x filex -y
```

- ✓ **The `getopts` statement only sees the `-x` option because what follows is `filex`, and the `-x` option was not defined to be followed with an argument. However, if you echo `$*` or `$@`, the output is `-x filex -y`, just as it was entered on the command line.**

Arguments to options and the use of colons in the options described later in the module.

---

**Note** – When using the `print $*` or `print $@` statements, you can get an error message if the first argument to the script was an option beginning with a `-` sign. Thus, it is safest to use `print -- $*` or `print -- $@`.

---

---

**Note** – When using the `echo $*` or `echo $@` statements, you do not get an error message.

---

The *var* in the `getopts` statement is any variable name whose value is an option from the command line if the option is one of the valid single-letter characters specified in the `getopts` statement.

## Using the `getopts` Statement

The `getopts` statement is most often used as the condition in a `while` loop, and the `case` statement is usually the command used to specify the actions to be taken for the various options that can appear on the command line.

The variable name used in the `case` statement is the name of the variable specified in the `getopts` statement. In the code fragment, the variable name is `opt_char`.

```
while getopts xy opt_char
do
 case $opt_char in
 x) print "Option is -x";;
 y) print "Option is -y";;
 +x) print "Option is +x";;
 +y) print "Option is +y";;
 esac
done
```

If `-x` was given as an option to a script, the value of `opt_char` is `x`. If `+x` was given as an option to a script, the value of `opt_char` is `+x`.

The correct ways to invoke the script (assume execute permission on the script) are:

```
scriptname [+ -]x [+ -]y
```

or

```
scriptname [+ -]xy
```

The `while` loop is exited when there are no more options to process. As noted earlier, the `getopts` statement assumes there are “no more options to process” as soon as it encounters an argument on the command line that is not an option (does not begin with a `+` or `-` sign) and is not an argument to an option (an argument that does not follow an option that requires an argument).

---

**Note** – Do not use the `shift` statement on command-line arguments until all options to a script have been processed. If you use the `shift` statement within the `while` loop that contains the `getopts` statement, the `getopts` statement does not process correctly.

---

The options on the command line can be given in different ways. The following are some valid possibilities for a script that accepts `x` and `y` as options:

```
scriptname -x -y
scriptname -xy
scriptname +x -y
scriptname +x +y
scriptname +xy
```

✓ *You might want to remind students that the Bourne shell does not support the `+` sign option.*

## *Invalid Options*

Unless you program `getopts` to look for invalid options and what to do when it encounters one, the shell gives its own error message.

To process invalid options given on the command line, precede the list of single-character options with a colon; for example:

```
while getopts :xy opt_char
```

The beginning colon causes `getopts` to:

1. Set the value of the *opt\_char* variable to `?`.
2. Set the value of the `OPTARG` reserved variable to the name of the invalid option.

If the script uses the `case` statement to match the options from the command line, then the pattern `\?` is used to match the value of *opt\_char* when an invalid option is encountered. The backslash is necessary to escape the meaning of the metacharacter `?`.



```
$ cat getoptsex.ksh
#!/bin/ksh

Script name: getoptsex.ksh

USAGE="usage: $0 -x -y"

while getopts :xy opt_char
do
 case $opt_char in
 x)
 echo "You entered the x option"
 ;;

 y)
 echo "You entered the y option"
 ;;

 \?)
 echo "$OPTARG is not a valid option."
 echo "$USAGE"
 ;;

 esac
 done

$./getoptsex.ksh -y -x -z
You entered the y option
You entered the x option
z is not a valid option.
usage: ./getoptsex.ksh -x -y
```

---

**Note** – The Bourne shell does not assign the invalid option to the OPTARG variable.

---

```
$ cat getoptsex.sh
#!/bin/sh

Script name: getoptsex.sh

USAGE="usage: $0 -x -y"

while getopts :xy opt_char
do
 case $opt_char in
 x)
 echo "You entered the x option"
 ;;
 y)
 echo "You entered the y option"
 ;;
 \?)
 echo "$OPTARG is not a valid option."
 echo "$USAGE"
 ;;
 esac
 done

$./getoptsex.sh -y -x -z
You entered the y option
You entered the x option
is not a valid option.
usage: ./getoptsex.sh -x -y
```

## Arguments to Options

If an option requires an argument, then place a colon (:) immediately after the option character in the `getopts` statement.

```
while getopts :x:y opt_char
```

The colon following the x tells `getopts`:

- An argument must immediately follow, with or without a space between the x and the argument.
- Once executed, the required argument to the x option is assigned to the `OPTARG` variable.

---

**Note** – The Bourne shell does not assign the option to the variable `OPTARG` when a required argument is missing.

---

When the script is executed, the options that require an argument must be followed by their arguments before another option can be given. For example, assuming x and y are valid options in a script, with x requiring an argument, then the following commands are all valid ways of invoking the script:

```
scriptname -x x_arg -y
scriptname -xx_arg -y
scriptname -yx x_arg
scriptname -yxx_arg
```

The argument to an option is placed in the `OPTARG` variable so that it can be accessed by the statements in the `case` statement for the corresponding option.

## Example: Using getopt

Consider the following example:

```
$ cat getopt1.ksh
#!/bin/ksh

Script name: getopt1.ksh

USAGE="usage: $0 [-d] [-m month]"

year=$(date +%Y)

while getopt :dm: opt_char
do
 case $opt_char in
 d)
 print -n "Date: " # -d option given
 date
 ;;
 m)
 cal $OPTARG $year # -m option given with an arg
 ;;
 \?)
 print "$OPTARG is not a valid option."
 print "$USAGE"
 ;;
 esac
done
```

The `USAGE` variable holds the value of how the script is to be invoked.

The `year` variable holds the value of the current year (2000).

The `getopt` statement within the `while` loop specifies that this script has two valid options: `d` and `m`. The `m` option is followed by a colon (`:`), so it is required to have an argument supplied to it on the command line. The beginning colon in `:dm:` tells the `getopt` statement to watch

for invalid switches. (It also tells `getopts` to watch for options on the command line that require an argument but have no argument supplied to them.)

- ✓ *Point out to your students the `\?` pattern in the case statement. Recall that if an invalid option is encountered on the command line, the value of `opt_char` is `?`, and the value of the `OPTARG` variable is the name of the invalid option that was given. Use a backslash to escape the special meaning of the `?`, so that the `?` is taken literally and not used as a metacharacter.*

```
$./getopts1.ksh -dk
Date: Thu May 25 15:37:44 MDT 2000
k is not a valid option.
usage: ./getopts1.ksh [-d] [-m month]
```

The `-d` option is correctly processed. Then the invalid option `-k` is encountered and, therefore, the `getopts` statement sets the value of `opt_char` to a `?`. Then the case `\?)` matches the value in `opt_char` and, thus, executes the corresponding statements.

```
$./getopts1.ksh -d
Date: Thu May 25 15:37:52 MDT 2000
$./getopts1.ksh -m
```

You might have expected output because the `-m` option is valid, but the argument requires an argument to perform its action. Remember that the colon after the `m` in `getopts :dm:` states that it requires an argument following it on the command line. If there is no argument, the case `m)` is not matched and processed.

- ✓ *The `getopts` statement recognizes that the argument is missing; therefore, it sets the `opt_char` variable to a `:` (colon) and sets the value of the `OPTARG` reserved variable to the option that is missing an argument. On the next page, a case statement is added for `:` (colon).*

```
$./getopts1.ksh -m 6
June 2000
S M Tu W Th F S
 1 2 3
4 5 6 7 8 9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30
```

```
$./getopts1.ksh -d filex
Date: Thu May 25 15:38:30 MDT 2000
```

- ✓ *Because the -d option does not require an argument to follow, getopts stops when it encounters filex on the command line.*

The last time the getopts1.ksh script is executed, two arguments are given to it: -d and filex. Because filex is not preceded with a - or a + sign, it is not processed as an option to the script.

- ✓ *The Bourne shell version of this script is in the student examples directory and named, getopts1.sh. Given the preceding input, it gives the same output minus the OPTARG value.*

---

**Note** – If filex had been the first argument given to the script, *no* options would have been processed.

---

## Forgetting an Argument to an Option

The `getopts2.ksh` example script is the `getopts1.ksh` script with an added pattern (`:`) in the `case` statement. This added pattern is matched when an option that requires an argument is given on the command line but is not followed with its argument.

The `getopts2.ksh` script is executed and given the `-m` option without an argument to `-m` so that you can see what is printed; otherwise, the script runs the same as the `getopts1.ksh` script.

- ✓ *Point out to your students that the Korn shell `OPTARG` reserved variable holds different values, depending on the situation. These situations and values are summarized as follows:*
  - *The value of `OPTARG` is the name of an invalid option when an invalid option is encountered on the command line during option processing.*
  - *The value of `OPTARG` is the name of the argument supplied on the command line to an option that requires an argument.*
  - *The value of `OPTARG` is the name of the option that requires an argument when an argument is not supplied to the option on the command line.*
- ✓ *Encourage your students to try various ways of submitting options and arguments to scripts on the command line.*

```
$ cat getopts2.ksh
#!/bin/ksh

Script name: getopts2.ksh

USAGE="usage: $0 [-d] [-m month]"

year=$(date +%Y)

while getopts :dm: opt_char
do
 case $opt_char in
 d)
 print -n "Date: " # -d option given
 date
 ;;
 m)
 cal $OPTARG $year # -m option given with an arg
 ;;
 esac
done
```

```

 \?)
 print "$OPTARG is not a valid option."
 print "$USAGE"
 ;;

 :)
 print "The $OPTARG option requires an argument."
 print "$USAGE"
 ;;
 esac
done

```

```

$./getopts2.ksh -m
The m option requires an argument.
usage: ./getopts2.ksh [-d] [-m month]

```

If you rewrite the script for the Bourne shell, the script looks much the same except the syntax for the following changes:

- The command substitution for the year variable
- The print statements are changed to echo
- If the OPTARG variable is used, it would be null (the Bourne shell does not set this)

Therefore, the code resembles:

```

$ cat getopts2.sh
#!/bin/sh

Script name: getopts2.ksh

USAGE="usage: $0 [-d] [-m month]"

year='date +%Y'

while getopts :dm: opt_char
do
 case $opt_char in
 d)
 echo "Date: \c" # -d option given
 date
 ;;
 esac
done

```



```
m) cal $OPTARG $year # -m option given with an arg
 ;;

\?)
 echo "$OPTARG is not a valid option."
 echo $USAGE
 ;;

:)
 echo "The $OPTARG option requires an argument."
 echo "$USAGE"
 ;;
esac
done
```

```
$./getopts2.sh -m
The option requires an argument.
usage: ./getopts2sh [-d] [-m month]
```

The reference to \$OPTARG evaluated to null in the echo statement; otherwise, it executes the same as the Korn shell version.

## Exercise: getopt



**Exercise objective** – In this lab, you modify a shell script to process a command-line argument with the `getopts` statement.

### *Preparation*

Refer to the lecture notes as necessary to answer the following questions and perform the following tasks.

### *Tasks*

1. Copy the `getopts2.ksh` (or `getopts2.sh`) program from the examples directory, and rename the file `getopts3.ksh` (or `getopts3.sh`).
2. Add another option, `c`, that prints a custom date; use the statement:

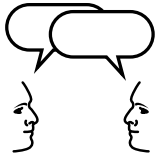
```
date "+%a %b %e %Y"
```

that produces output similar to:

```
Thu May 25 2000
```

The new option does not require an argument.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- ✓ *Manage the discussion here based on the time allowed for this module, which was given in the “About This Course” module. If you find you do not have time to spend on discussion, highlight just the key concepts students should have learned from the lab exercise.*

- Experiences

- ✓ *Ask students what their overall experiences with this exercise have been. Go over any trouble spots or especially confusing areas at this time.*

- Interpretations

- ✓ *Ask students to interpret what they observed during any aspect of this exercise.*

- Conclusions

- ✓ *Have students articulate any conclusions they reached as a result of this exercise experience.*

- Applications

- ✓ *Explore with students how they might apply what they learned in this exercise to situations at their workplace.*

## Task Solutions

1. Copy the `getopts2.ksh` (or `getopts2.sh`) program from the examples directory, and rename the file `getopts3.ksh` (or `getopts3.sh`).

```
cp ../examples/getopts2.ksh getopts3.ksh
```

```
cp ../examples/getopts2.sh getopts3.sh
```

2. Add another option, `c`, that prints a custom date; use the statement:

```
date "+%a %b %e %Y"
```

that produces output similar to:

```
Thu May 25 2000
```

The new option does not require an argument.

```
while getopts :dcm: opt_char
do
...
 c) print -n "Custom date: "
 date "+%a %b %e %Y" ;;
...
done
```

## Complete Script Solution for 2

```
$ cat getopts3.ksh
```

```
#!/bin/ksh
```

```
Script name: getopts3.ksh
```

```
USAGE="usage: $0 [-d] [-m month]"
```

```
year=$(date +%Y)
```

```
while getopts :dcm: opt_char
do
```

```
 case $opt_char in
```

```
 d) print -n "Date: "
```

```
 # -d option given
```

```
 date ;;
 m) cal $OPTARG $year ;; # -m option given with an arg
 \?) print "$OPTARG is not a valid option."
 print "$USAGE" ;;
 :) print "The $OPTARG option requires an argument."
 print "$USAGE" ;;
 c) print -n "Custom date: "
 date "+%a %b %e %Y" ;;
esac
done
```

**\$ cat getopts3.sh**

```
#!/bin/sh
```

```
Script name: getopts3.sh
```

```
USAGE="usage: $0 [-d] [-m month]"
```

```
year='date +%Y'
```

```
while getopts :dcm: opt_char
do
```

```
 case $opt_char in
```

```
 d) echo "Date: \c" # -d option given
 date ;;
```

```
 m) cal $OPTARG $year ;; # -m option given with an arg
```

```
 \?) echo "$OPTARG is not a valid option."
```

```
 echo $USAGE ;;
```

```
 :) echo "The $OPTARG option requires an argument."
```

```
 echo "$USAGE" ;;
```

```
 c) echo "Custom date: \c"
```

```
 date "+%a %b %e %Y" ;;
```

```
 esac
```

```
done
```



## *Advanced* **nawk** *Programming*

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**B** 

---

**Note** – There are two modules that cover **nawk**. Module 6, “The **nawk** Programming Language,” describes the basics of scripting in **nawk**. This appendix covers the programming concepts.

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## *Programming Concepts*

The `nawk` programming language contains many of the programming concepts that were described throughout the course for scripting.

- Conditionals
  - ▼ The `if` statement
- Loops
  - ▼ `while` loop
  - ▼ `do while` loop
  - ▼ `for` loop



## *if Statement*

The `if` statement can have two branches, an `if` branch and an `else` branch. If the condition is true, the `if` branch is executed; if the condition is false, the `else` branch is executed.

```
if (conditional) {
 statements
} else {
 statements }
```

You can nest `if` statements. When examining nested `ifs` and one or more of the `if` statements has an `else` statement, it is difficult to know with which `if` the `else` is operating. The simple rule is: Each `else` works on the closest `if` that does not yet have its own `else`; for example:

```
if (conditional) {
 if (conditional) {
 statements
 } else {
 statements
 }
}
```

This `else` goes with the second `if` (using indentation helps alleviate some of the potential confusion).

## Conditional Printing With `nawk`

In its simplest form, the `if` statement tests a condition and, if that condition is true, the statements are executed. To compare two numbers in the condition, use one of the following relational operators:

|                    |                          |
|--------------------|--------------------------|
| <code>==</code>    | Equal to                 |
| <code>!=</code>    | Not equal to             |
| <code>&gt;</code>  | Greater than             |
| <code>&lt;</code>  | Less than                |
| <code>&gt;=</code> | Greater than or equal to |
| <code>&lt;=</code> | Less than or equal to    |

For example:

```
$ nawk '{num = $5 / $6; if (num > 6) print $1, num}' data.file
southeast 7.14286
central 6.06383
```

```
$ nawk '{if ($6 > .92) print $2, $6, $4}' data.file | sort
CT .94 Watson
NE .94 Nichols
NW .98 Craig
SO .95 Chin
WE .97 Kelly
```

## String Comparisons and Logical Operators

To compare two strings in a conditional, use one of the relational operators shown below:

|                 |                                      |
|-----------------|--------------------------------------|
| <code>==</code> | Equal to                             |
| <code>!=</code> | Not equal to                         |
| <code>~</code>  | Contains a <code>/RE/</code>         |
| <code>!~</code> | Does not contain a <code>/RE/</code> |

The `~` and `!~` operators require some explanation. The left operand is the region of text being searched, which can be the entire record (`$0`) or a specific field of the record (`$1`). The right operand is a regular expression in slashes (`/RE/`) that is being searched for. If the text contains the regular expression, then the condition is true. You can use all the regular expression characters, that have been described, in the conditional's regular expression.

The next examples show the pattern itself as a conditional statement (numeric or string). Each record is tested to see if the conditional is true for that record. If it is true, the *ACTION* is taken on that record. In the second example, an *ACTION* is not listed, so the default action is taken, to print the entire input record.

```
$ nawk '{if ($2 ~ /E/) print $2, $1}' data.file
```

```
WE western
SE southeast
EA eastern
NE northeast
```

```
$ nawk '$2 !~ /E/' data.file
```

```
northwest NW Joel Craig 3.0 .98 3 4
southwest SW Chris Foster 2.7 .8 2 18
southern SO May Chin 5.1 .95 4 15
north NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

## *Logical Operators*

You use two logical operators between any two conditional expressions to join the expressions. The conditional expressions can be either numeric comparisons or string comparisons or a mixture of numeric and string. The logical AND requires both of the joined expressions be true before the combination expression is true. The OR operator only requires that one of them is true. A unary NOT operator exists. You can use the exclamation point to invert the logical value of an expression.

|    |             |
|----|-------------|
| && | Logical AND |
|    | Logical OR  |
| !  | Logical NOT |

For example:

```
$ nawk '{if ($2 ~ /E/ && $6 > .92) print $2, $6, $4}' data.file
WE .97 Kelly
NE .94 Nichols
```

## nawk *while* Loops

When loops are included in a *nawk* script or command, the loop executes one time for each record that is processed. For each record, the loop executes until the condition fails.

The *while* loop is the simplest loop available. It tests the same types of conditions that were used by *if*. In loop constructs, the single statement, or multiple statements enclosed in curly brackets, is known as the body of the loop. If the condition is true, the body of the loop is done, if the condition is false, *nawk* continues with the *nawk* program. The syntax for a *while* loop is:

```
while (condition)
 statement
```

```
while (condition) {
 statements
}
```

The following example uses a *while* loop to print out each field of every record on a line by itself. It prints a blank line after each record is reported.

```
{ i = 1 }
{ while (i <= NF)
 { print $i ; i++} }

{print "\n"}
```

## do *while* Loops

A *do while* loop follows the same philosophy of a *while* loop except that the condition is tested after the body of the loop is executed. The syntax is:

```
do
 { statements }
while (condition)
```

The primary difference between a `while` loop and a `do while` loop is that the `do while` loop executes at least once. For example, suppose that the condition is false for a `while` loop and for a `do while` loop. In the `while` loop, the condition is tested first and because it is false, the body of the loop is not executed. In the `do while` loop, the body of the loop executes first, and then the condition is tested. Because the condition is false, the body of the loop is no longer executed, but it did execute once.

The following example uses a `do-while` loop to print out each field of every record on a line by itself. It prints a blank line after each record is reported.

```
{ i = 1 }

{ do {
 { print $i ; i++ }
 } while (i <= NF)
}

{print "\n"}{
```

## nawk for *Loops*

The for loop has two varieties, one borrowed from the C programming language and the other to process nawk arrays.

```
for (setup_statement ; condition ; step_statement)
 {statements }
```

```
for (index_in_array)
 {statements }
```

In the following example, the loop executes one time for every field in a record. When the value of *a* reaches the value of *NF* (the number of fields in the current record), the loop terminates, and the next record is read from the file to begin the process again.

```
$ cat for.nawk
{ for (a = 1; a <= NF; a++) print $a }
$ nawk -f for.nawk data.file
northwest
NW
Joel
Craig
3.0
.98
3
4
western
WE
Sharon
Kelly
5.3
<output truncated>
```

## Using Loops With Arrays

The second type of `for` loop is used explicitly with `awk` arrays, and it executes once for each array element.

```
for (index_var in array_name) { statements }
```

The *index\_var* contains each array subscript in turn.

With `awk` arrays, it is not always possible to know how many indices there are. Therefore, the syntax of this `for` loop allows the processing of these arrays by creating a special variable (the first word in the `for` loop parentheses) to hold the value of each of the array indices. The second word in the parentheses is always `in` and the third word is the name of the array to be processed. The `for` loop executes one time for each index of the array (each element of the array). Each time through, the value of the special variable (the first word in the parentheses) changes to the next index of the array.

```
$ cat for2.awk
BEGIN {OFS = "\t"}
{
 list[NR] = $1
}
END {
 print "The list of regions is:"
 for (b = 1; b <= NR; b++)
 print list[b]
}
$ awk -f for2.awk data.file
The list of regions is:
northwest
western
southwest
southern
southeast
eastern
northeast
north
central
```



## Nonnumeric Array Indices

Arrays in *nawk* differ from those in some programming languages in that they do not have to be declared before they can be used. Further, the index (the value in the square brackets) does not have to be numeric. The index value is associative, which means that it can be anything that relates to the data being stored.

```
$ cat bigcats
lions
tigers
leopards
tigers
leopards
leopards
tigers
leopards
$ nawk '{a[$1]++}' bigcats
> END {for (c in a) print c, a[c]} bigcats
tigers 3
lions 1
leopards 4
```

In this example, the file being processed contains a list of big cats. The *nawk* statement reads each record, creating an array called *a*. The index of the element is the first field of the record (the name of the cat). The value of each array element always starts at 0 (when the array element is created). That element is incremented (with the ++ operator). Thus, at the end of the first statement, a variable with the name:

*a*[lions]

is given the value of 1.

This continues through the entire file. When a cat that has already been processed before it is read, the array element for that index already exists. Therefore, the current value is incremented by 1. So, at the end of the file, one array element exists for each type of cat and the value of each element is the number of times that cat was encountered in the file.

The `for` loop creates a variable `c` to represent each of the indices (it is not known how many there are going to be) and processes the `a` array. For each element, the value of `c` (the index [a cat name]) and the value of the element (the number of times encountered) prints.



What would the following `nawk` statement do to a file?

```
$ nawk '{a[NR] = $0};
> END {for (c = NR; c > 0; c--) print a[c]}' data.file
```

✓ *The contents of the file are printed in reverse line order.*

## break *and* continue

You use the `break` statement to break out of a loop or stop its execution entirely. The statements in the loop body that follow the `break` are not executed, and execution resumes with the first line after the body of the loop.

```
while (condition) {
 statements
 break
 statements
}
more awk statements
```

### continue Statement

The `continue` statement stops the current iteration of the loop body, returning to the loop control expression.

```
while (condition) {
 statements
 continue
 statements
}
```

The `continue` statement stops the execution of the body of statements in a loop, and execution is sent to the control portion of a loop. In a `while` loop or a `do while` loop, this is the condition expression. The condition is tested again, and if it is true, then the body of the loop is entered again, and the process continues.

In a `for` loop (not the kind explicitly used with arrays), execution moves to the step portion of the loop (the third expression in the parentheses). The step is executed and the condition is tested again. If the condition is true, the loop is executed again. In a `for` loop that is used with arrays (`for (index in array)`), execution begins at the top of the loop body again but with the next array element being processed. The old array element is forgotten and dropped.

The effect of the `continue` statement for each of the types of looping statements is:

|                                                               |                                                        |
|---------------------------------------------------------------|--------------------------------------------------------|
| <code>while</code> and <code>do while</code>                  | The condition is tested again                          |
| <code>for (startup<br/>statement; condition;<br/>step)</code> | The step is taken, and then the<br>condition is tested |
| <code>for (index in array)</code>                             | The next array element is processed                    |

## next *and* exit

Use the `next` and `exit` statements for program flow control.

The `next` statement stops processing the current record, reads the next record from the input file, and starts over at the beginning of the `nawk` program.

The `exit` statement terminates the `nawk` program. An exit status might be given, and it passes to `nawk`'s parent process.

It is possible to stop processing any record of a file. The next record is read in and the `nawk` program begins again with this new record. The statement that tells `nawk` to get the next record is `next`. Typically, a test is performed and, if the test is true (or false, whatever is appropriate), the current record is discarded and the next record read.

The `exit` statement is similar in use in that a test is usually made. If the test is true (or false) then the program terminates, which is accomplished with `exit`.

When `exit` is called, the entire `nawk` process quits. The only argument allowed for `exit` is an optional exit status. As the `nawk` process terminates, it passes an exit status to its parent process. If an argument is used with `exit`, this is the exit status that is returned to `nawk`'s parent process.

## User-Defined Functions

You can create user-defined functions in an `nawk` script file using the `func` or `function` keywords. Placement in the file is not important; the function definition can occur anywhere in the `nawk` script.

The function can take arguments (local to function only) or use any existing variable.

The syntax of a function definition is:

```
func function_name ([optional_arg]...) { statements }
function function_name ([optional_arg]...) { statements }
```

The *function\_name* is how the function is called at some other point in the program. Arguments are allowed but not required. In the definition of the function, only the names of the arguments are required. These arguments can only be accessed within the body of the function (the statements inside the curly braces). You might, however, access any other variable that is being used in the `nawk` script from within a function.

For example:

```
$ cat func.nawk
func MAX(val1, val2) {
 if (val1 > val2)
 return val1
 else
 return val2
}
BEGIN {largest = 0}
{largest = MAX(largest, $5)}
END {print largest}

$ nawk -f func.nawk data.file
5.7
```

You can use the `return` statement to return a value from the function. Use this value to assign a variable its value or to perform a test of some sort with the `if` statement, perhaps. To perform a test, the function is called within the `if` statement. If the function returns a

nonzero value, the `if` statement considers the test to be true; if the function returns a zero value, the `if` statement considers the test to be false, and the `if` statements are not executed; for example:

```
if (function_call()) { statements }
```

## Command-Line Arguments

When a `nawk` command is executed, the number of words on the command line is stored into the built-in variable `ARGC`. The words themselves are stored into the built-in array `ARGV`. Exceptions to this are options to `nawk`, such as the `-f awkscript` and the `-F<char>` options. These options are not counted by `ARGC` nor are they stored as elements in `ARGV`.

For example:

```
$ cat args.nawk
BEGIN {
 print ("The number of words entered is " ARGC)
 print ("The value of var is " var)
 print ("The first word is " ARGV[0])
 print ("The second word is " ARGV[1])
}
{ print ("The value of var is " var) }
```

```
$ nawk -f args.nawk var=32 junkfile
```

```
The number of words entered is 3
The value of var is
The first word is nawk
The second word is var=32
The value of var is 32
```

- ✓ *The junkfile contains a single line with a non-blank character on it.*
- ✓ *Note that -f args.nawk is not part of the word count. Options to nawk, and any modifier, such as the file name, are not placed in ARGC.*
- ✓ *The first time The value of var is is executed, it is within a BEGIN statement. The value of var has not been read at this point.*
- ✓ *The second time The value of var is is executed, it is outside the BEGIN statement. This time the value appears.*
- ✓ *Have the students try putting a second or third non-blank line in the junkfile to see what happens. For each line added, The value of var is 32 is printed.*

---

**Note** – The distinction between `nawk` and `awk` is significant in regard to command-line variables. The built-in variables, `ARGC` and `ARGV`, are not acknowledged by `awk`.

---



## Using Built-in Variables

As `nawk` is processing the input file, it uses several variables. You can provide a value to some of these variables, while other variables are set by `nawk`. Table B-1 lists the `nawk` built-in variables.

**Table B-1** `nawk` Built-In Variables

| Name     | Default Value | Description                                                  |
|----------|---------------|--------------------------------------------------------------|
| OFS      | space         | The output field separator                                   |
| FS       | space or tab  | The input field separator                                    |
| ORS      | \n (newline)  | The output record separator                                  |
| RS       | \n (newline)  | The input record separator                                   |
| OFMT     | %.6g          | The output format for numbers                                |
| NF       |               | The number of fields in current record                       |
| NR       |               | The number of records from beginning of the first input file |
| FNR      |               | The number of records from beginning of current file         |
| ARGC     |               | The number of command-line arguments                         |
| ARGV     |               | An array of command-line arguments                           |
| FILENAME |               | The name of current input file                               |
| RSTART   |               | The index into a string, set by <code>match()</code>         |
| RLENGTH  |               | The length of substring, set by <code>match()</code>         |

## Built-in Arithmetic Functions

Table B-2 lists the `awk` built-in arithmetic functions.

**Table B-2** `awk` Built-in Arithmetic Functions

| Command            | Syntax                                 | Meaning                                                                                                                                                                                                             |
|--------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>atan2</code> | <code>atan2(<i>y</i>, <i>x</i>)</code> | Returns the arc tangent of <i>y</i> / <i>x</i> in radians.                                                                                                                                                          |
| <code>cos</code>   | <code>cos(<i>x</i>)</code>             | Returns the cosine of <i>x</i> in radians.                                                                                                                                                                          |
| <code>exp</code>   | <code>exp(<i>arg</i>)</code>           | Returns the natural exponent of <i>arg</i> .                                                                                                                                                                        |
| <code>int</code>   | <code>int(<i>arg</i>)</code>           | Returns the integer value of <i>arg</i> .                                                                                                                                                                           |
| <code>log</code>   | <code>log(<i>arg</i>)</code>           | Returns the natural logarithm of <i>arg</i> .                                                                                                                                                                       |
| <code>rand</code>  | <code>rand()</code>                    | Generates a random number between 0 and 1. This function returns the same series of numbers each time the script is executed, unless the random number generator is seeded using the <code>srand()</code> function. |
| <code>sin</code>   | <code>sin(<i>x</i>)</code>             | Returns the sine of <i>x</i> in radians.                                                                                                                                                                            |
| <code>sqrt</code>  | <code>sqrt(<i>arg</i>)</code>          | Returns the square root of <i>arg</i> .                                                                                                                                                                             |
| <code>srand</code> | <code>srand(<i>expr</i>)</code>        | Sets a new seed for the random number generator. The default is the time of day. It returns the old seed.                                                                                                           |

## Built-in String Functions

Table B-3 lists the `nawk` built-in string functions.

**Table B-3** `nawk` Built-in String Functions

| Command             | Syntax                                                        | Meaning                                                                                                                                                                                                                                              |
|---------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>gsub</code>   | <code>gsub(<i>r</i>, <i>s</i>[, <i>t</i>])</code>             | Globally substitutes <i>s</i> for each match of the regular expression <i>r</i> in the string <i>t</i> . Returns the number of substitutions. If <i>t</i> is not supplied, the default is <code>\$0</code> .                                         |
| <code>index</code>  | <code>index(<i>str</i>, <i>substr</i>)</code>                 | Returns position of first substring <i>substr</i> in string <i>str</i> , or <code>0</code> if not found.                                                                                                                                             |
| <code>length</code> | <code>length(<i>arg</i>)</code>                               | Returns the length of <i>arg</i> .                                                                                                                                                                                                                   |
| <code>match</code>  | <code>match(<i>s</i>, <i>r</i>)</code>                        | Matches the regular expression pattern <i>r</i> in the string <i>s</i> . It returns the position in <i>s</i> where the match begins or <code>0</code> if no occurrences are found. Sets the values of <code>RSTART</code> and <code>RLENGTH</code> . |
| <code>split</code>  | <code>split(<i>string</i>, <i>array</i>[, <i>sep</i>])</code> | Splits the string into elements of <i>array</i> . <i>string</i> at each occurrence of separator <i>sep</i> . If <i>sep</i> is not specified, <code>FS</code> is used. The number of array elements created is returned.                              |
| <code>sub</code>    | <code>sub(<i>r</i>, <i>s</i>[, <i>t</i>])</code>              | Substitutes <i>s</i> for the first match of the regular expression <i>r</i> in the string <i>t</i> . It returns <code>1</code> if successful; <code>0</code> otherwise. If <i>t</i> is not supplied, the default is <code>\$0</code> .               |
| <code>substr</code> | <code>substr(<i>string</i>, <i>m</i>[, <i>n</i>])</code>      | Returns a substring of <i>string</i> beginning at character position <i>m</i> and consisting of the next <i>n</i> characters. If <i>n</i> is not supplied, all characters to the end of the string are returned.                                     |

**Table B-3** `nawk` Built-in String Functions (Continued)

| Command              | Syntax                           | Meaning                                                                                    |
|----------------------|----------------------------------|--------------------------------------------------------------------------------------------|
| <code>tolower</code> | <code>tolower(<i>str</i>)</code> | Translates all uppercase characters in <i>str</i> to lowercase and returns the new string. |
| <code>toupper</code> | <code>toupper(<i>str</i>)</code> | Translates all lowercase characters in <i>str</i> to uppercase and returns the new string. |

## Built-in Input/Output Processing Functions

Table B-4 lists the `awk` input/output processing functions.

**Table B-4** `awk` Built-in Input/Output Processing Functions

| Command              | Syntax                                                                     | Meaning                                                                                                                                                                         |
|----------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>close</code>   | <code>close(filename-expr)</code><br><code>close(command-expr)</code>      | Closes a file or a pipe. The expression is the same argument that opened the file or pipe.                                                                                      |
| <code>delete</code>  | <code>delete array[element]</code>                                         | Deletes an element of <i>array</i> .                                                                                                                                            |
| <code>getline</code> | <code>getline[var][&lt;file]</code><br><code>command   getline[var]</code> | Reads the next line of input from <code>stdin</code> , an input file, or a pipe.                                                                                                |
| <code>next</code>    | <code>next</code>                                                          | Reads the next input line, and starts a new cycle through pattern or procedure statements.                                                                                      |
| <code>print</code>   | <code>print[args][destination]</code>                                      | Prints <i>arg</i> to the <i>destination</i> . If <i>arg</i> is not specified, prints <code>\$0</code> . If <i>destination</i> is not specified, prints to <code>stdout</code> . |
| <code>printf</code>  | <code>printf (format[,<br/>expression(s)]<br/>[destination])</code>        | Prints according to the formatted expressions.                                                                                                                                  |
| <code>sprintf</code> | <code>sprintf(format[,<br/>expression(s)])</code>                          | Returns the value of formatted expressions. The data is formatted but not printed.                                                                                              |
| <code>system</code>  | <code>system(command)</code>                                               | Executes the specified UNIX commands and returns the status.                                                                                                                    |

## printf() Statement

The syntax of printf() is:

```
printf ("string of characters" [, data_values])
```

where the *data\_values* are used to fill in place holders in the "string of characters". The place holders are:

|    |                      |
|----|----------------------|
| %d | Integer value        |
| %f | Floating point value |
| %c | Character value      |
| %s | String value         |

The following example uses a printf statement to output Fields 4, 6, and 7 of data.file.

```
$ nawk '{ printf "%s %5.1f %d \n", $4, $6, $7 }' data.file
Craig 1.0 3
Kelly 1.0 5
Foster 0.8 2
Chin 0.9 4
Johnson 0.7 4
Beal 0.8 5
Nichols 0.9 3
Shultz 0.9 5
Watson 0.9 5
```

## Built-In Operators

There are many built-in operators and combination assignment operators for `nawk`. These are listed in the following tables.

**Table B-5** `nawk` Relational Operators

| Symbol             | Meaning                            |
|--------------------|------------------------------------|
| <code>==</code>    | Equal to                           |
| <code>!=</code>    | Not equal to                       |
| <code>&gt;</code>  | Greater than                       |
| <code>&lt;</code>  | Less than                          |
| <code>&gt;=</code> | Greater than or equal to           |
| <code>&lt;=</code> | Less than or equal to              |
| <code>~</code>     | Contains <code>/RE/</code>         |
| <code>!~</code>    | Does not contain <code>/RE/</code> |

**Table B-6** Mathematical Operators

| Symbol          | Meaning                 |
|-----------------|-------------------------|
| <code>+</code>  | Addition                |
| <code>-</code>  | Subtraction             |
| <code>*</code>  | Multiplication          |
| <code>/</code>  | Division                |
| <code>%</code>  | Modulus                 |
| <code>^</code>  | Exponentiation          |
| <code>++</code> | Increment variable by 1 |
| <code>--</code> | Decrement variable by 1 |

✓ *The `++` and `--` operators are both pre- and post-increment.*

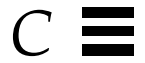
**Table B-7** Combination Assignment Arithmetic Operators

| Symbol | Meaning            |
|--------|--------------------|
| =      | Assignment         |
| +=     | Add to             |
| -=     | Subtract from      |
| *=     | Multiply by        |
| /=     | Divide by          |
| %=     | Modulus by         |
| ^=     | Raise to the power |



## *Additional grep Functionality*

---



In addition to the functionality shown in Module 4, “Regular Expressions and grep,” there are more metacharacters and regular expressions. For a complete listing of all features, refer to the `grep` man page. This appendix describes a few more of the most commonly used features.

## *Regular Expression Metacharacters*

Table C-1 shows the additional regular expression metacharacters.

**Table C-1** grep Metacharacters

| Metacharacter | Function                                                    |
|---------------|-------------------------------------------------------------|
| [^]           | Matches any one character except one from the specified set |
| \( \)         | A RE grouping of characters that can be repeated            |

## Character Classes

Sometimes it is easier to specify what you do not want to match. In this case, specify a character class in which the first character within the brackets is a `^`. Be careful, as the results often surprise first-time users of this metacharacter.

```
$ grep '[^1-5]' /etc/group
root::0:root
other::1:
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
adm::4:root,adm,daemon
<output truncated>
```

You might have been surprised by the output. The command specifies to find any line that contains at least one character that is not in the character class. Because the first character of the first line is an `r`, the line is printed even though there is a `0` in the line.

Consider the following example that outputs lines from `/etc/group` that contain more than one user listed in the final field. You need to be extremely familiar with the syntax of the file to realize that the user list is uniquely identified by a comma separated list of user names. Otherwise, only characters, digits, and the colon are normally present in the entry.

```
$ grep '[^a-zA-Z:0-9]' /etc/group
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
adm::4:root,adm,daemon
uucp::5:root,uucp
tty::7:root,tty,adm
lp::8:root,lp,adm
nuucp::9:root,nuucp
daemon::12:root,daemon
```

If the first symbol following the `[` is a `^`, then a negative character class is specified. In this case, the string matches all characters except those enclosed in the brackets. For example, `[^a-z]` matches any character that is not a lowercase letter.

For example, to find all lines that contain a character that is not `a`, `b`, `c`, or `d`, use the following command:

```
$ grep '[^abcd]' data1
efgh
city
ijkl
aeiou
any
```

If you list only **a**, **b**, and **c** in the expression, the results are different. Because the line also contains a **d**, using **a**, **b**, and **c** in the search pattern does not sufficiently remove the line from the results.

```
$ grep '[^abc]' data1
abcd
efgh
city
ijkl
aeiou
any
```

The example is searching for all lines that have a character that is not **a**, **b**, or **c**.

## *Tagged Regular Expressions*

The backslashed parenthesis (`\()`) delimits a group of characters within a regular expression that can be repeated later in the same regular expression. Each tag created within a regular expression with the backslashed parenthesis is given a numerical value. The first tagged regular expression is automatically given the value 1, the second tagged regular expression is given the value 2, and so on.

You use the backslashed parenthesis when a pattern you are searching with is repeated within the expression, hence, within the line of text. So if you are trying to find lines that contain more than one occurrence of the pattern `the` in the `nfs.server` script, you would issue the following command:

```
$ grep '\(the\).*\1' /etc/init.d/nfs.server
lines, then run shareall to export them, and then start up mountd
logging enabled, or they were shared in the previous session
When the system comes up umask is not set; so set the mode now
```



## *Additional sed Functionality*

---

D 

In addition to the functionality shown in Module 5, “The sed Editor,” there are more commands and features. For a complete listing of all features, refer to the sed man page. This appendix describes a few more of the most commonly used features.

## *Editing Commands*

Additional `sed` editor commands are shown in Table D-1.

**Table D-1** `sed` Commands

| Command         | Function                                       |
|-----------------|------------------------------------------------|
| <code>a\</code> | Appends                                        |
| <code>c\</code> | Changes text in the current line with new text |
| <code>i\</code> | Inserts text above current line                |

The `sed` command has an additional option as shown Table D-2.

**Table D-2** `sed` Options

| Option          | Function                        |
|-----------------|---------------------------------|
| <code>-e</code> | Allows multiple edits on a line |



## Placing Multiple Edits in a Single `sed` Command

There are times when you want to perform several edits on the file. Rather than using multiple `sed` commands, you can use the `-e` option to place the edits in the same command.

The edits are performed in the order that you specify.

```
$ sed -e '2,4d' -e 's/north/North/' data.file
Northwest NW Joel Craig 3.0 .98 3 4
southeast SE Derek Johnson 5.0 .70 4 17
eastern EA Susan Beal 4.4 .8 5 20
Northeast NE TJ Nichols 5.1 .94 3 13
North NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

Delete lines carefully. You might perform edits on a line of text and subsequently remove that line of text from the output. This occurs in the following example with Line 1 of the input file.

```
$ sed -e 's/north/North/' -e '1,4d' data.file
southeast SE Derek Johnson 5.0 .70 4 17
eastern EA Susan Beal 4.4 .8 5 20
Northeast NE TJ Nichols 5.1 .94 3 13
North NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

With each edit you add, the command line becomes more prone to errors. The following example requires three sets of quotes, one for each of the three edits.

```
$ sed -e '1,4d' -e 's/north/North/' -e 's/^east/East/' data.file
southeast SE Derek Johnson 5.0 .70 4 17
Eastern EA Susan Beal 4.4 .8 5 20
Northeast NE TJ Nichols 5.1 .94 3 13
North NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

Multiple search and substitute commands might compound and lead to unexpected results.

```
$ cat animals
```

```
pig
cow
horse
```

```
$ sed -e 's/pig/cow/' -e 's/cow/horse/' animals
```

```
horse
horse
horse
```

## Using sed to Append, Insert, or Change Text

The append command adds a line of text after the matched line. The append command is `a\`. The text to be appended begins on the next line and continues through the subsequent line that is not terminated with a backslash.

Because of the embedded backslash in the syntax for the append, insert, or change commands, these are normally put in script files that are accessed with the `-f` option.

In the following example, a new line is added after each line containing the string `central`.

```
$ cat script2.sed
/central/a\
*** Currently there is 1 employee in the central region. ***

$ sed -f script2.sed data.file
northwest NW Joel Craig 3.0 .98 3 4
western WE Sharon Kelly 5.3 .97 5 23
southwest SW Chris Foster 2.7 .8 2 18
southern SO May Chin 5.1 .95 4 15
southeast SE Derek Johnson 5.0 .70 4 17
eastern EA Susan Beal 4.4 .8 5 20
northeast NE TJ Nichols 5.1 .94 3 13
north NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
*** Currently there is 1 employee in the central region. ***
```

The **i** (insert) command adds a line of text before the current line. In the following example, a new line is inserted before each line containing the string **north**.

```
$ cat script3.sed
/north/i\
*** The north region is the newest in the company. *****
```

```
$ sed -f script3.sed data.file
*** The north region is the newest in the company. *****
northwest NW Joel Craig 3.0 .98 3 4
western WE Sharon Kelly 5.3 .97 5 23
southwest SW Chris Foster 2.7 .8 2 18
southern SO May Chin 5.1 .95 4 15
southeast SE Derek Johnson 5.0 .70 4 17
eastern EA Susan Beal 4.4 .8 5 20
*** The north region is the newest in the company. *****
northeast NE TJ Nichols 5.1 .94 3 13
*** The north region is the newest in the company. *****
north NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

The **c** (change) command changes the matched line with a new line of text. In the following example, the lines containing the pattern **western** are changed with the change command text.

```
$ cat script4.sed
/western/c\
*** The western office employees will now report to the **\
*** manager of the central region. *****
```

```
$ sed -f script4.sed data.file
northwest NW Joel Craig 3.0 .98 3 4
*** The western office employees will now report to the **\
*** manager of the central region. *****
southwest SW Chris Foster 2.7 .8 2 18
southern SO May Chin 5.1 .95 4 15
southeast SE Derek Johnson 5.0 .70 4 17
eastern EA Susan Beal 4.4 .8 5 20
northeast NE TJ Nichols 5.1 .94 3 13
north NO Val Shultz 4.5 .89 5 9
central CT Sheri Watson 5.7 .94 5 13
```

# Shell Metacharacters for Pattern Matching for File Names

E 

Table E-1 lists the Bourne and Korn shell metacharacters that perform pattern matching for file names.

**Table E-1** Bourne and Korn Metacharacters for Pattern Matching

| Metacharacter                         | Meaning                                                                      |
|---------------------------------------|------------------------------------------------------------------------------|
| <code>?</code>                        | Matches any one character                                                    |
| <code>[char1 char2 ... charn]</code>  | Matches any one character from the list                                      |
| <code>[!char1 char2 ... charn]</code> | Matches any one character not in the list                                    |
| <code>[char1-charn]</code>            | Matches any one character from <i>char1</i> through <i>charn</i> inclusive   |
| <code>[!char1-charn]</code>           | Matches any one character except <i>char1</i> through <i>charn</i> inclusive |
| <code>*</code>                        | Matches any single character or group of characters                          |

Table E-2 lists the additional Korn shell metacharacters that perform pattern matching.

**Table E-2** Korn Shell Metacharacters for Pattern Matching

| Metacharacter                                           | Meaning                                              |
|---------------------------------------------------------|------------------------------------------------------|
| <code>?(<i>pat1</i> <i>pat2</i> ... <i>patn</i>)</code> | Matches zero or one of the specified patterns        |
| <code>@(<i>pat1</i> <i>pat2</i> ... <i>patn</i>)</code> | Matches exactly one of the specified patterns        |
| <code>*(<i>pat1</i> <i>pat2</i> ... <i>patn</i>)</code> | Matches zero, one, or more of the specified patterns |
| <code>+(<i>pat1</i> <i>pat2</i> ... <i>patn</i>)</code> | Matches one or more of the specified patterns        |
| <code>!(<i>pat1</i> <i>pat2</i> ... <i>patn</i>)</code> | Matches any pattern except the specified patterns    |

## Metacharacter Examples

Change the directory to /etc for the following examples.

```
$ cd /etc
```

The following command lists all two character file names.

```
$ ls -d ??
dt ff fn fs lp tm
```

The following command lists all three character file names.

```
$ ls -d ???
ami dmi lib nca nfs rc0 rc2 rc5 rcS rpc tar
dfs gss log net opt rc1 rc3 rc6 rmt saf
```

The following command lists all three character file names that begin with rc.

```
$ ls -d rc?
rc0 rc1 rc2 rc3 rc5 rc6 rcS
```

The following command lists all three character file names that begin with rc and that end in a 1, 3, or 5.

```
$ ls -d rc[135]
rc1 rc3 rc5
```

The following command lists all three character file names that begin with rc and end with a character other than a 1, 3, or 5.

```
$ ls -d rc[!135]
rc0 rc2 rc6 rcS
```

The following command lists all three character file names that begin with rc and end with a character in the range 0 through 3 inclusive.

```
$ ls -d rc[0-3]
rc0 rc1 rc2 rc3
```

The following command lists all three character file names that begin with rc and that end with a character other than a character in the range 0 through 3 inclusive.

```
$ ls -d rc[!0-3]
rc5 rc6 rcS
```

The following command lists filenames that begin with r.

```
$ ls -d r*
rc0 rc2 rc5 reboot rmt
rc0.d rc2.d rc6 release rpc
rc1 rc3 rcS remote rpcsec
rc1.d rc3.d rcS.d rmmount.conf rpld.conf
```



## More Metacharacter Examples

Change directories to `/usr/bin` for the following examples.

```
$ cd /usr/bin
```

The following command lists all the file names that begin with `rm`.

```
$ ls rm*
rm rmail rmdir rmic rmid
rmiregistry
```

The following command lists all the file names that begin with `rm` and that contain zero or any one of the specified patterns.

```
$ ls rm?(ic|id|ir|egistry)
rm rmic rmid
```

The following command lists all the file names that begin with `rm` and that contain zero or more occurrences of the specified patterns.

```
$ ls rm*(ic|id|ir|egistry)
rm rmic rmid rmiregistry
```

The following command lists all the file names that begin with `rm` and that contain one or more occurrences of the specified patterns.

```
$ ls rm+(ic|id|ir|egistry)
rmic rmid rmiregistry
```

The following command lists all the file names that begin with `rm` and that contain exactly one of the specified patterns.

```
$ ls rm@(ic|id|ir|egistry)
rmic rmid
```

The following command lists all the file names that begin with `rm` and that do not contain one of the specified patterns.

```
$ ls rm!(ic|id|ir|egistry)
rm rmail rmdir rmiregistry
```



## *UNIX Commands and Utilities*

---

*F* 

This appendix a briefly describes and gives examples of some frequently used commands.

## *Status Commands*

The status commands are UNIX commands, not specific shell commands.

|                     |                                                                             |
|---------------------|-----------------------------------------------------------------------------|
| <code>date</code>   | Displays the current (system) date and time                                 |
| <code>ps</code>     | Displays information about system processes                                 |
| <code>who</code>    | Display which users are logged in to the system                             |
| <code>rusers</code> | Displays the users on local area network (LAN) systems                      |
| <code>finger</code> | Displays information about logged-in users                                  |
| <code>uptime</code> | Displays how long the system has been up                                    |
| <code>rup</code>    | Displays how long LAN systems have been up (uptime for all network systems) |

### *The date Command*

If you create a script that writes a report, you might want the date and time to appear as an entry in the file. The `date` command prints a one-line output of the current date and time (system date and time).

```
$ date
Mon Feb 21 09:26:03 MST 2000
```

## Process Status

The `ps` command displays the current processes for the executing user.

```
$ ps
 PID TTY TIME CMD
 22373 pts/3 0:00 csh
```

**PID**      The numerical process ID number

**TTY**      The terminal number from which the process was initiated

**TIME**     Shows how much CPU time the process has consumed

**CMD**      The name of the command that the process is executing

Some options to the `ps` command expand the information that is displayed. The `-f` option displays the full listing and includes such information as the user's login name, the process identification number (PID), the parent's PID, and so on. The `-e` option displays all the processes on the system. You can combine these options.

```
$ ps -ef
 UID PID PPID C STIME TTY TIME CMD
 root 0 0 0 Oct 15 ? 0:00 sched
 root 1 0 0 Oct 15 ? 0:04 /etc/init -
 root 2 0 0 Oct 15 ? 0:02 pageout
 root 3 0 0 Oct 15 ? 8:46 fsflush
 milner 22359 22306 0 Nov 01 pts/2 0:04 /usr/dt/bin/dtsession
 root 619 1 0 Oct 15 ? 0:00 /usr/sbin/inetd -s
 root 793 1 0 Oct 15 ? 0:00 /usr/lib/saf/sac -t 300
 root 797 793 0 Oct 15 ? 0:00 /usr/lib/saf/ttymon
 root 107 1 0 Oct 15 ? 0:22 /usr/sbin/rpcbind
 root 109 1 0 Oct 15 ? 0:00 /usr/sbin/keyserv
 root 626 1 0 Oct 15 ? 0:00 /usr/lib/nfs/lockd
 daemon 624 1 0 Oct 15 ? 0:00 /usr/lib/nfs/statd
 root 120 1 0 Oct 15 ? 0:01 /usr/lib/netsvc/yp/ypbind
-broadcast
 root 643 1 0 Oct 15 ? 0:37 /usr/lib/autofs/automountd
-D CFS_Rw=fstype=cachefs,cachedir=/cache/cachefs,bac
 root 722 1 0 Oct 15 ? 0:00 /usr/lib/sendmail -bd -
q15m
 root 647 1 0 Oct 15 ? 0:02 /usr/sbin/syslogd
```

|      |     |   |   |          |                       |
|------|-----|---|---|----------|-----------------------|
| root | 660 | 1 | 0 | Oct 15 ? | 0:02 /usr/sbin/cron   |
| root | 725 | 1 | 0 | Oct 15 ? | 0:01 /usr/sbin/vold   |
| root | 677 | 1 | 0 | Oct 15 ? | 0:00 /usr/lib/lpsched |

|       |                                                     |
|-------|-----------------------------------------------------|
| UUID  | The name of the user the started the process        |
| PPID  | The parent process ID                               |
| C     | The processor utilization for scheduling (obsolete) |
| STIME | The day the process was started                     |

## Who Is on the System?

In preparation for system administration tasks, it is important to know who is currently working on the system.

### *The who Command*

The `who` command displays the list of currently logged-on users, at which terminal they are logged into, and the date and time they logged in.

```
$ who
milner console Nov 1 08:36 (:0)
milner pts/3 Nov 1 08:36 (:0.0)
milner pts/4 Nov 1 08:36 (:0.0)
```

### *The rusers Command*

The `rusers` command polls the LAN and prints a list of all currently logged-in users. If a system does not have any logged-in users, they are not displayed in the list. The `rusers` command, however, forces *all* systems to be displayed, whether they have current users. Options also control the order of the display (sorted by system, sorted by user, and so on). The `rusers` command sometimes takes a long time to terminate. The information is printed quickly, but then the command pauses as if it is still searching for more users. Nothing usually prints after this, so you can kill the command with a Control-C (interrupt character).

```
$ rusers
Sending broadcast for rusersd protocol version 3...
redvale pdonohue
pinecliff dnelson
mandan-qfe3 root jduvall
micmac-qfe3 rc80105 rc80938 rc81489 jduvall
thediver cindyle
```

## The finger Command

The `finger` command lists information about the users logged into the current system. The fields of information are:

- The *login name* of the user
- The *real name* of the user (as defined in the `/etc/passwd` file)
- The *terminal* to which the user is logged in
- The *idle time* (the amount of time since any keyboard activity was detected)
- *When the user logged in*
- *Where the user logged in from* (if the user has remotely logged in from another system on the network)

**\$ finger miller**

```
Login name: miller In real life: Wendy Miller
Directory: /home/miller Shell: /bin/csh
On since Nov 1 08:36:15 on console from :0
No unread mail
No Plan.
```

```
Login name: miller In real life: Wendy Miller
Directory: /home/miller Shell: /bin/csh
On since Nov 1 08:36:29 on pts/3 from :0.0
2 minutes 46 seconds Idle Time
```

```
Login name: miller In real life: Wendy Miller
Directory: /home/miller Shell: /bin/csh
On since Nov 1 08:36:29 on pts/4 from :0.0
4 days 2 hours Idle Time
```



## System Uptime

### *The uptime Command*

The `uptime` command displays information about the status of the system. The fields are:

- The current time
- How long the system has been up (time since the system was last booted)
- How many users are currently logged into the system
- The load average. The load average is the average number of jobs (processes) in the run queue over the last 1 minute, 5 minutes, and 15 minutes

```
$ uptime
11:27am up 21 day(s), 3:45, 1 user, load average: 0.09, 0.08, 0.10
```

### *The rup Command*

The `rup` command is similar to performing an `uptime` command for all systems on the LAN. The information is the same, except for these difference:

- The name of the system is listed first
- The date is not listed at all
- The number of users is not listed at all

```
$ rup
mandan-qfe3 up 7 days, 6:47, load average: 0.21, 0.21, 0.21
timberland up 4:20, load average: 0.21, 0.26, 0.26
kerala up 15:53, load average: 0.20, 0.16, 0.14
jedi-mojo up 2 days, 2:44, load average: 0.00, 0.00, 0.01
```

## The w Command

The w command first displays the output of the uptime command. Then the w command displays a list of the current activity on the system and what each user is doing. It gives the following information:

- The user's login name
- The terminal at which the user logged in
- The time the user logged in
- The amount of time the user has been idle
- The joint CPU (JCPU) time that all the process of that terminal have consumed
- The process CPU (PCPU) time that the currently active processes have consumed
- The name and arguments of the current process

%w

```
11:30am up 21 day(s), 3:48, 1 user, load average: 0.13, 0.11, 0.11
User tty login@ idle JCPU PCPU what
milner console Mon 8am 4days 3:13 6 /usr/dt/bin/sdt_shell
-c unseten
milner pts/3 Mon 8am 1 3 w
milner pts/4 Mon 8am 4days -csh
```

---

## *File Access*

The file access commands are UNIX commands, not specific shell commands.

|                                         |                                                       |
|-----------------------------------------|-------------------------------------------------------|
| <code>find</code>                       | Finds the location of a file                          |
| <code>sort</code>                       | Reads a file and sort the output                      |
|                                         | Selects fields of a file and output just those fields |
| <code>head</code> and <code>tail</code> | Looks at just the start or end of a file              |

## The `find` Command

The `find` command allows you to search for files and directories and to execute commands on those files.

The syntax of `find` has three general argument sections. The *paths* section is a list of path names (directories) to search. The *search\_criteria* section is a list of options that are considered a boolean (true or false) expression. Each option (condition) is tested in turn and if the result is true, the indicated *action* is taken.

A few of the possible criteria are:

- |                     |                                                                |
|---------------------|----------------------------------------------------------------|
| <code>-name</code>  | If the file name matches                                       |
| <code>-user</code>  | If the file belongs to a user (login name)                     |
| <code>-atime</code> | If the file was accessed the specified number of days ago      |
| <code>-mtime</code> | If the file was last modified the specified number of days ago |
| <code>-size</code>  | If the file is the specific block size                         |

A few of the possible actions are:

- |                     |                                                                       |
|---------------------|-----------------------------------------------------------------------|
| <code>-print</code> | Displays the path name of the file                                    |
| <code>-exec</code>  | Executes the command                                                  |
| <code>-ok</code>    | Executes the command only after receiving a y from <code>stdin</code> |

## Examples

You do not need to know the entire name of the file to find it. For example, log files tend to grow rather rapidly. As the system administrator, you might want to watch the size of log files. To search for the administrative log files (files in the `/var/adm` directory), use the following command:

```
$ find /var/adm -name "*.log" -print
/var/adm/log/asppp.log
/var/adm/vold.log
```

As part of a file system clean-up, you might want to search for core files and delete them. The following two commands find any file named `core`. The first command executes the `rm` command without operator input. The second command prints the `rm` command and requires operator input.

```
$ find / -name core -exec rm -f {} \;
$ find / -name core -ok rm -f {} \;
```

To find files that are larger than 1000 blocks, use the following command:

```
$ find / -size +1000 -print

$ find . -name core -print
$ find / -name "*core*" -print
$ find / -name core -exec rm -f {} \;
$ find / -name core -ok ls -l {} \;
```

## Sorting the File's Contents

A file, such as the password file, is frequently built by adding new users to the end of the file. The file is not in any particular order, yet, when you are looking for something or someone in the file, it is helpful if the file was sorted in some order. The `sort` command provides a way to sort through the file.

Some of the more commonly used `sort` options are:

- |                            |                                                                                                                  |
|----------------------------|------------------------------------------------------------------------------------------------------------------|
| <code>-r</code>            | Sorts in reverse order (z to a, instead of a to z)                                                               |
| <code>-n</code>            | Sorts the fields numerically (instead of as just ASCII strings)                                                  |
| <code>-t &lt;ch&gt;</code> | Sets the field separator character                                                                               |
| <code>+ num</code>         | Sets the field number from which to begin sorting (fields are numbered from 0 [zero])                            |
| <code>- num</code>         | Sets the field number to stop sorting before (this is the first field that is <i>not</i> considered for sorting) |
| <code>-b</code>            | Ignores leading blanks (they are normally considered part of the fields specified during keyed sorts)            |
| <code>-o file</code>       | Sets the file to be used to hold the output of sort (might be the same file that contains the original input)    |

```
$ cat /etc/passwd
root:x:0:1:Super-User:/:/sbin/sh
daemon:x:1:1:/:
smtp:x:0:0:Mail Daemon User:/:
bin:x:2:2:/:usr/bin:
sys:x:3:3:/:
adm:x:4:4:Admin:/var/adm:
lp:x:71:8:Line Printer Admin:/usr/spool/lp:
uucp:x:5:5:uucp Admin:/usr/lib/uucp:
listen:x:37:4:Network Admin:/usr/net/nls:
```

To sort the file by the login name, use the following command:

```
$ sort /etc/passwd
adm:x:4:4:Admin:/var/adm:
bin:x:2:2::/usr/bin:
daemon:x:1:1::/:
listen:x:37:4:Network Admin:/usr/net/nls:
lp:x:71:8:Line Printer Admin:/usr/spool/lp:
root:x:0:1:Super-User:/:/sbin/sh
smtp:x:0:0:Mail Daemon User:/:
sys:x:3:3::/:
uucp:x:5:5:uucp Admin:/usr/lib/uucp:
```

To sort the file by the third field (the UID) where fields are separated by the colon, use the following command:

```
$ sort -t: +2n /etc/passwd
root:x:0:1:Super-User:/:/sbin/sh
smtp:x:0:0:Mail Daemon User:/:
daemon:x:1:1::/:
bin:x:2:2::/usr/bin:
sys:x:3:3::/:
adm:x:4:4:Admin:/var/adm:
uucp:x:5:5:uucp Admin:/usr/lib/uucp:
listen:x:37:4:Network Admin:/usr/net/nls:
lp:x:71:8:Line Printer Admin:/usr/spool/lp:
```

## *File Sorting*

You can put the output of a sort into a file. You can even output the sort into the original file; for example:

```
$ cat names
Big Ape 415
Roger Rabbit 408
Jessica Rabbit 510
Easter Rabbit 408
Doctor Doom 415
Easter Rabbit 408
Peter Wolf 510
Roger Rabbit 408
Peter Rabbit 510
```

```
$ sort names -o names
Big Ape 415
Doctor Doom 415
Easter Rabbit 408
Easter Rabbit 408
Jessica Rabbit 510
Peter Rabbit 510
Peter Wolf 510
Roger Rabbit 408
Roger Rabbit 408
```

If you have multiple files, already sorted, that you want to merge into a single file, use the following command:

```
$ sort file1 file2 file3 -o file4
```

Merging files might give you duplicate entries. To output only the unique lines of the file, use the following command:

```
$ sort -u names -o names
Big Ape 415
Doctor Doom 415
Easter Rabbit 408
Jessica Rabbit 510
Peter Rabbit 510
Peter Wolf 510
Roger Rabbit 408
```



## *Reading Part of a File*

Frequently, you do not want to review an entire file. You might want to browse the beginning of the file to determine if it is the correct one, or look at the end of a file to review what was last entered in the file.

### *The Head Command*

To review the start of a file, use the `head` command:

```
$ head -5 /etc/passwd
root:x:0:1:Super-User:/:/sbin/sh
daemon:x:1:1:/:
bin:x:2:2:/:usr/bin:
sys:x:3:3:/:
adm:x:4:4:Admin:/var/adm:
```

### *The Tail Command*

When reviewing log files, you are probably only interested in the last few entries of that file. You can use the `tail` command to look at the end of the file.

```
$ tail -5 /etc/passwd
nuucp:x:9:9:uucp Admin:/var/spool/uucppublic:/usr/lib/uucp/uucico
listen:x:37:4:Network Admin:/usr/net/nls:
nobody:x:60001:60001:Nobody:/:
noaccess:x:60002:60002:No Access User:/:
nobody4:x:65534:65534:SunOS 4.x Nobody:/:
```

## Translate Characters

The `tr` command stands for **t**ranslate characters. It maps a set of input characters to a set of output characters. Both sets of characters should be of the same length, as the mapping is one-to-one.

**\$ cat tr.info:**

The `tr` utility copies the standard input to the standard output with substitution or deletion of selected characters. The options specified and the `string1` and `string2` operands control translations that occur while copying characters and single-character collating elements.

**\$ tr 'abc' 'xyz' < tr.info**

The `tr` utility copies the standard input to the standard output with substitution or deletion of selected characters. The options specified and the `string1` and `string2` operands control translations that occur while copying characters and single-character collating elements.

**\$ tr '[a-z]' '[A-Z]' < tr.info**

or

**\$ tr 'a-z' 'A-Z' < tr.info**

or

**\$ tr a-z A-Z < tr.info**

THE TR UTILITY COPIES THE STANDARD INPUT TO THE STANDARD OUTPUT WITH SUBSTITUTION OR DELETION OF SELECTED CHARACTERS. THE OPTIONS SPECIFIED AND THE `STRING1` AND `STRING2` OPERANDS CONTROL TRANSLATIONS THAT OCCUR WHILE COPYING CHARACTERS AND SINGLE-CHARACTER COLLATING ELEMENTS.

**\$ tr -d ' ' < tr.info**

The `tr` utility copies the standard input to the standard output with substitution or deletion of selected characters. The options specified and the `string1` and `string2` operands control translations that occur while copying characters and single-character collating elements.

## The cut Command

You use the `cut` command to extract portions of each line of a file. The only tricky part is that what you specify in the command is the part to *keep*, not the part to discard. To help you specify the portions to keep, `cut` has three options: `-c`, `-f`, and `-d`.

|                          |                                                                        |
|--------------------------|------------------------------------------------------------------------|
| <code>-cnumber</code>    | Prints the character at <i>number</i> position                         |
| <code>-fnumber</code>    | Prints field numbered <i>number</i>                                    |
| <code>-dcharacter</code> | Uses <i>character</i> to separate fields (if it is other than a <tab>) |
| <code>,</code> (comma)   | Lists multiple fields or characters                                    |
| <code>-</code> (hyphen)  | Lists a range of fields or character                                   |

This file is used in the following examples:

```
$ cat phonefile
```

```
John Robinson:Koren Inc.:978 Commonwealth Ave.:Boston:MA 01760:696-0987
Phyllis Chapman:GVE Associates:34 Seville Drive:Amesbury:MA 01881:879-
0900
Jeffrey Willis:Burns Medical Group:22 Altair Drive:Yonkers:NY 10701:914-
636-0000
Bill Gold:George Menkins:1100 Fan Drive:Santa Rosa:CA 95470:1-707-724-
0000
Alice Gold:George Menkins:1100 Fan Drive:Santa Rosa:CA 95470:(707) 724-
4568
Alice Silver:GTE Associates:123 Crescent:Artesia:NM 88210:505 746-2231
```

To print the first character and the sixth through tenth characters:

```
$ cut -c1,6-10 phonefile
```

```
JRobin
Pis Ch
Jey Wi
BGold:
A Gold
A Silv
```

To use the colon as a field separator and print the first and third through fifth fields:

```
$ cut -d: -f1,3-5 phonefile
```

```
John Robinson:978 Commonwealth Ave.:Boston:MA 01760
```

```
Phyllis Chapman:34 Seville Drive:Amesbury:MA 01881
```

```
Jeffrey Willis:22 Altair Drive:Yonkers:NY 10701
```

```
Bill Gold:1100 Fan Drive:Santa Rosa:CA 95470
```

```
Alice Gold:1100 Fan Drive:Santa Rosa:CA 95470
```

```
Alice Silver:123 Crescent:Artesia:NM 88210
```

## The paste Command

The paste command appends lines of files as is shown in the following examples:

```
$ paste data1 data2
```

```
abcd 1
efgh 2
ijkl 3
mnop 4
qrst 5
uvwx 6
 7
 8
 9
```

```
$ paste data1 data2 data1
```

```
abcd 1 abcd
efgh 2 efgh
ijkl 3 ijkl
mnop 4 mnop
qrst 5 qrst
uvwx 6 uvwx
 7
 8
 9
```

```
$ paste -d":-" data1 data2 data1
```

```
abcd:1-abcd
efgh:2-efgh
ijkl:3-ijkl
mnop:4-mnop
qrst:5-qrst
uvwx:6-uvwx
:7-
:8-
:9-
```

```
$ paste -s -d":-" data2
```

```
1:2-3:4-5:6-7:8-9
```

```
$ paste -s -d":\n" data2
```

```
1:2
3:4
5:6
7:8
9
```

## Comparing Files

You can compare files in several ways. The `cmp` command compares files byte-by-byte. The `diff` and `sdiff` commands compare the characters of a file.

```
$ paste data1 data3
```

```
abcd abc
efgh efgh
ijkl ijk
mnop mnop
qrst qrst
uvwX
```

```
$ diff data1 data3
```

```
1c1
< abcd

> abc
3c3
< ijkl

> ijk
6d5
< uvwX
```

```
$ sdiff data1 data3
```

```
abcd | abc
efgh | efgh
ijkl | ijk
mnop | mnop
qrst | qrst
uvwX | <
```

## Combining Commands

You can take the output of one command and use that as the input to another command rather than having to put the output into a file first. There are several ways to do this.

### *Pipes*

Pipes work when a command is expecting input from `stdin`. You run one command that outputs to `stdout` (the display) and pipe the output to another command that is expecting input from `stdin` (the keyboard). Frequently, a command accepts input from either a file or `stdin`.

For example, the `date` command outputs more data than just the date. To obtain just the date from the `date` command, you can *pipe* the output of `date` to the `cut` command and cut just the information you want.

```
$ date
Thu Apr 4 17:00:36 PST 1996
```

```
$ date | cut -d" " -f2,4,7
Apr 4 1996
```

To output just the user name from the `who` command:

```
$ who
milner console Nov 1 08:36 (:0)
milner pts/6 Nov 9 14:34 (:0.0)
$ who | cut -d " " -f1
milner
milner
```

## *Redirection*

Redirection was shown in the `tr` command, earlier in this appendix.

```
$ tr 'a-z' 'A-Z' < tr.info
```

The `<` character specifies that the input is coming from a file.

You can also redirect a command's output to a file.

```
ls > listing
```



## *User-Defined File Descriptors*

The following command creates a new file descriptor and attaches it to `filename` for output.

```
$ exec 3> filename
```

The following command reassigns standard out to the same destination as File Descriptor 3.

```
$ exec 1>& 3
```

This is permanent until changed back with the following command:

```
$ exec 1> /dev/tty
```

One of the built-in commands in the Bourne shell is `exec`. Use this command to assign a file descriptor to a file. The syntax is:

```
$ exec fd> filename
$ exec fd< filename
```

Spaces are not allowed between the file descriptor number (`fd`) and the redirection symbol (`>` for output, `<` for input).

After a file descriptor has been assigned to a file, the descriptor can be used with the Bourne shell redirection operators. On output, if the file did not exist, it is created. If it did exist, it is emptied. On input, if the file did not exist, it is an error.

```
$ command >& fd
$ command <& fd
```

The file descriptor assigned to the file is valid in the current shell only.

You can use the `exec` command to replace standard input or standard output with a file. The syntax is:

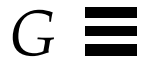
```
$ exec < file
$ exec > file
```

Use caution in replacing standard output or error—this is *not* a temporary change. It is in effect until explicitly changed back with the commands:

```
$ exec > /dev/tty
$ exec 2> /dev/tty
```

## *Shell Comparison*

---



This appendix compares the C, Bourne, and Korn shells. It also briefly describes the Desktop Korn (dtksh) shell.

## Shell Comparison

**Table G-1** Shell Comparison

| Feature                         | C                                                 | Bourne                                           | Korn                                                                                                |
|---------------------------------|---------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| <b>Variables</b>                |                                                   |                                                  |                                                                                                     |
| Shell variables                 | set num = 21                                      | num=21                                           | num=21                                                                                              |
| Environmental variables         | setenv NUM 1                                      | NUM=1<br>export NUM                              | export NUM=1                                                                                        |
| Variables manipulation          | set NAME = Rob<br>echo \$NAME<br>echo \${NAME}ert | NAME=Rob<br>echo \$NAME<br>echo \${NAME}ert      | NAME=Rob<br>echo \$NAME or<br>print \${NAME}<br>echo \${NAME}ert or<br>print \${NAME}ert<br>typeset |
| <b>Special shell variables</b>  |                                                   |                                                  |                                                                                                     |
| PID of current process          | \$\$                                              | \$\$                                             | \$\$                                                                                                |
| Exit status                     | \$status                                          | \$?                                              | \$?                                                                                                 |
| Last background job             |                                                   | #!                                               | #!                                                                                                  |
| <b>Arrays</b>                   |                                                   |                                                  |                                                                                                     |
| Assigning array values          | set arr = ( ksh sh csh )                          | N/A                                              | arr[0]=ksh; arr[1]=sh<br>arr[2]=csh<br>set -A arr1 ksh sh csh                                       |
| Printing array elements         | echo \$arr[0] \$arr[1]                            | N/A                                              | print \${arr[0]} \${arr[1]}                                                                         |
| Printing all elements           | echo \$arr or \$arr[*]                            | N/A                                              | print \${arr[*]}                                                                                    |
| Number of elements              | echo \$#arr                                       | N/A                                              | print \${#arr[*]}                                                                                   |
| <b>Command substitution</b>     |                                                   |                                                  |                                                                                                     |
| Assigning to variables          | set d = `date`                                    | d=`date`                                         | d=\$(date) or d=`date`                                                                              |
| Printing values                 | echo \$d<br>echo \$d[1] \$d[2]<br>echo \$#d       | echo \$d                                         | print \$d                                                                                           |
| <b>Command-line arguments</b>   |                                                   |                                                  |                                                                                                     |
| Printing arguments              | echo \$argv[1] \$argv[2]<br>or echo \$1 \$2       | echo \$1 \$2 ... \$9                             | print \$1 \$2 \${10}...                                                                             |
| Resetting positional parameters | N/A                                               | set red white blue<br>set `date`<br>echo \$1 \$2 | set red white blue<br>set \$(date)<br>print \$1 \$2                                                 |
| Number of positional parameters | \$#argv                                           | \$#                                              | \$#                                                                                                 |

**Table G-1** Shell Comparison (Continued)

| <b>Feature</b>                                   | <b>C</b>                                                        | <b>Bourne</b>                                                   | <b>Korn</b>                                                     |
|--------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| <b>File name expansion</b>                       |                                                                 |                                                                 |                                                                 |
| Single character                                 | <code>?</code>                                                  | <code>?</code>                                                  | <code>?</code>                                                  |
| Zero or more characters                          | <code>*</code>                                                  | <code>*</code>                                                  | <code>*</code>                                                  |
| One character from the set                       | <code>[aeiou]</code>                                            | <code>[aeiou]</code>                                            | <code>[aeiou]</code>                                            |
| One character from a range                       | <code>[a-m]</code>                                              | <code>[a-m]</code>                                              | <code>[a-m]</code>                                              |
| One character not in the set                     | N/A                                                             | <code>[!aeiou]</code>                                           | <code>[!aeiou]</code>                                           |
| Zero or one occurrence of the specified patterns | N/A                                                             | N/A                                                             | <code>?(pat1 pat2 pat3)</code>                                  |
| One occurrence of patterns                       | N/A                                                             | N/A                                                             | <code>@(pat1 pat2 pat3)</code>                                  |
| Zero, one, or more occurrences of the patterns   | N/A                                                             | N/A                                                             | <code>*(pat1 pat2 pat3)</code>                                  |
| One or more occurrences of the patterns          | N/A                                                             | N/A                                                             | <code>+(pat1 pat2 pat3)</code>                                  |
| Any pattern except the specified patterns        | N/A                                                             | N/A                                                             | <code>!(pat1 pat2 pat3)</code>                                  |
| <b>I/O redirection and pipes</b>                 |                                                                 |                                                                 |                                                                 |
| Input redirection                                | <code>cmd &lt; filey</code>                                     | <code>cmd &lt; filey</code><br><code>cmd 0&lt; filey</code>     | <code>cmd &lt; filey</code><br><code>cmd 0&lt; filey</code>     |
| Output redirection                               | <code>cmd &gt; filex</code>                                     | <code>cmd &gt; filex</code><br><code>cmd 1&gt; filex</code>     | <code>cmd &gt; filex</code><br><code>cmd 1&gt; filex</code>     |
| Error redirection                                | <code>(cmd &gt; out) &gt;&amp; errors</code>                    | <code>cmd 2&gt; errors</code>                                   | <code>cmd 2&gt; errors</code>                                   |
| Append to a file                                 | <code>cmd &gt;&gt; filex</code>                                 | <code>cmd &gt;&gt; filex</code>                                 | <code>cmd &gt;&gt; filex</code>                                 |
| Output and errors redirected to the same file    | <code>cmd &gt;&amp; both</code>                                 | <code>cmd &gt; both 2&gt;&amp;1</code>                          | <code>cmd &gt; both 2&gt;&amp;1</code>                          |
| Assign output and ignore noclobber               | <code>cmd &gt;! filex</code>                                    | N/A                                                             | <code>cmd &gt;  filex</code>                                    |
| Output and errors to cmd                         | <code>cmd1  &amp; cmd2</code>                                   | <code>cmd1 2&gt;&amp;1   cmd2</code>                            | <code>cmd1 2&gt;&amp;1   cmd2</code>                            |
| Here document                                    | <code>cmd &lt;&lt; EOF</code><br><i>input statements</i><br>EOF | <code>cmd &lt;&lt; EOF</code><br><i>input statements</i><br>EOF | <code>cmd &lt;&lt; EOF</code><br><i>input statements</i><br>EOF |
| Pipe the output                                  | <code>cmd1   cmd2</code>                                        | <code>cmd1   cmd2</code>                                        | <code>cmd1   cmd2</code>                                        |
| Conditional statement                            | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code>      | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code>      | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code>      |

**Table G-1 Shell Comparison (Continued)**

| Feature                                      | C                                                                                                                   | Bourne                                                     | Korn                                                                                                                 |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <b>I/O redirection and pipes (continued)</b> |                                                                                                                     |                                                            |                                                                                                                      |
| Read from standard input                     | <code>set var = \$&lt;</code>                                                                                       | <code>read var1</code><br><code>read var1 var2</code>      | <code>read var1</code><br><code>read var1 var2</code><br><code>read</code><br><code>read var?"Enter value"</code>    |
| <b>Arithmetic</b>                            |                                                                                                                     |                                                            |                                                                                                                      |
| Perform calculation                          | <code>@ var =\$x + \$y</code>                                                                                       | <code>var='expr 5 + 1'</code>                              | <code>(( var = 5 + 1 ))</code><br><code>let var=5 + 1</code>                                                         |
| <b>Relational condition test</b>             | <code>if ( \$x &lt; \$y )</code>                                                                                    | <code>if [ \$x -le \$y ]</code>                            | <code>(( var = x + y ))</code><br><code>let var=x+y</code>                                                           |
| <b>Boolean conditional test</b>              | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code>                                                          | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code> | <code>cmd &amp;&amp; cmd</code><br><code>cmd    cmd</code>                                                           |
| <b>Tilde expansion</b>                       |                                                                                                                     |                                                            |                                                                                                                      |
| Home directory of any user                   | <code>~username</code>                                                                                              | N/A                                                        | <code>~username</code>                                                                                               |
| Home directory of current user               | <code>~</code>                                                                                                      | N/A                                                        | <code>~</code>                                                                                                       |
| Current working directory                    | N/A                                                                                                                 | N/A                                                        | <code>~+</code>                                                                                                      |
| Previous directory                           | N/A                                                                                                                 | N/A                                                        | <code>~-</code>                                                                                                      |
| <b>Aliases</b>                               |                                                                                                                     |                                                            |                                                                                                                      |
| Create an alias                              | <code>alias name value</code>                                                                                       | N/A                                                        | <code>alias name=value</code>                                                                                        |
| List aliases                                 | <code>alias</code>                                                                                                  | N/A                                                        | <code>alias</code>                                                                                                   |
| Remove an alias                              | <code>unalias name</code>                                                                                           | N/A                                                        | <code>unalias name</code>                                                                                            |
| <b>History</b>                               |                                                                                                                     |                                                            |                                                                                                                      |
| Set the history                              | <code>set history = 25</code>                                                                                       | N/A                                                        | automatic or<br><code>HISTSIZE=25</code>                                                                             |
| Display a numbered history list              | <code>history</code>                                                                                                | N/A                                                        | <code>history, fc -l</code>                                                                                          |
| Display a portion of the list                | <code>history 5</code>                                                                                              | N/A                                                        | <code>history 5 10</code><br><code>history -5</code>                                                                 |
| Re-execute a command                         | <code>!! (last command)</code><br><code>!5 (fifth command)</code><br><code>!v (last command starting with v)</code> | N/A                                                        | <code>r (last command)</code><br><code>r 5 (fifth command)</code><br><code>r v (last command starting with v)</code> |
| Set the interactive editor                   | N/A                                                                                                                 | N/A                                                        | <code>set -o vi</code><br><code>set -o emacs</code>                                                                  |
| <b>Signals</b>                               |                                                                                                                     |                                                            |                                                                                                                      |
| Command                                      | <code>onintr</code>                                                                                                 | <code>trap</code>                                          | <code>trap</code>                                                                                                    |

**Table G-1** Shell Comparison (Continued)

| Feature                                  | C                              | Bourne                                     | Korn                                                                        |
|------------------------------------------|--------------------------------|--------------------------------------------|-----------------------------------------------------------------------------|
| <b>Initialization files</b>              |                                |                                            |                                                                             |
| Executed at login                        | .login                         | .profile                                   | .profile                                                                    |
| Executed every time the shell is invoked | .cshrc                         | N/A                                        | file specified in .profile with ENV variable<br>ENV=\$HOME/.kshrc           |
| <b>Functions</b>                         |                                |                                            |                                                                             |
| Define a function                        | N/A                            | func1() { <i>commands</i> ; }              | function <i>func1</i> { <i>commands</i> ;}<br>func1() { <i>commands</i> ; } |
| Use a function                           | N/A                            | <i>func1</i><br><i>func1 param1 param2</i> | <i>func1</i><br><i>func1 param1 param2</i>                                  |
| <b>Programming constructs</b>            |                                |                                            |                                                                             |
| if conditional                           | if ( <i>expression</i> ) then  | if [ <i>expression</i> ]                   | if [[ <i>stringexpression</i> ]]                                            |
|                                          | <i>commands</i>                | then                                       | then                                                                        |
|                                          | endif                          | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          |                                | fi                                         | fi                                                                          |
|                                          | if { ( <i>command</i> ) } then |                                            |                                                                             |
|                                          | <i>commands</i>                | if <i>command</i>                          | if (( <i>numericexpression</i> ))                                           |
|                                          | endif                          | then                                       | then                                                                        |
|                                          |                                | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          |                                | fi                                         | fi                                                                          |
| if/else conditional                      | if ( <i>expression</i> ) then  | if <i>command</i>                          | if <i>command</i>                                                           |
|                                          | <i>commands</i>                | then                                       | then                                                                        |
|                                          | else                           | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          | <i>commands</i>                | else                                       | else                                                                        |
|                                          | endif                          | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          |                                | fi                                         | fi                                                                          |
| if/else/elseif conditional               | if ( <i>expression</i> ) then  | if <i>command</i>                          | if <i>command</i>                                                           |
|                                          | <i>commands</i>                | then                                       | then                                                                        |
|                                          | else if ( <i>expression</i> )  | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          | <i>commands</i>                | elif <i>command</i>                        | elif <i>command</i>                                                         |
|                                          | else                           | then                                       | then                                                                        |
|                                          | <i>commands</i>                | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          | endif                          | else                                       | else                                                                        |
|                                          |                                | <i>commands</i>                            | <i>commands</i>                                                             |
|                                          |                                | fi                                         | fi                                                                          |
| goto                                     | goto <i>label</i>              | N/A                                        | N/A                                                                         |
|                                          | <i>commands</i>                |                                            |                                                                             |
|                                          | <i>label</i> :                 |                                            |                                                                             |
|                                          |                                |                                            |                                                                             |

**Table G-1** Shell Comparison (Continued)

| Feature                                   | C                                                                                                                                                   | Bourne                                                                                               | Korn                                                                                                 |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| <b>Programming constructs (continued)</b> |                                                                                                                                                     |                                                                                                      |                                                                                                      |
| switch and case                           | <pre>switch ( value ) case pattern1:     commands     breaksw case pattern2:     commands     breaksw default:     commands     breaksw endsw</pre> | <pre>case value in pattern1) commands     ;; pattern2) commands     ;; *) commands     ;; esac</pre> | <pre>case value in pattern1) commands     ;; pattern2) commands     ;; *) commands     ;; esac</pre> |
| <b>Loops</b>                              |                                                                                                                                                     |                                                                                                      |                                                                                                      |
| while loops                               | <pre>while ( expression )     commands end</pre>                                                                                                    | <pre>while command do     command done</pre>                                                         | <pre>while command do     commands done</pre>                                                        |
| for/foreach                               | <pre>foreach var ( wordlist )     commands end</pre>                                                                                                | <pre>for var in wordlist do     commands done</pre>                                                  | <pre>for var in wordlist do     commands done</pre>                                                  |
| until                                     | N/A                                                                                                                                                 | <pre>until command do     commands done</pre>                                                        | <pre>until command do     commands done</pre>                                                        |
| repeat                                    | repeat 3 <i>command</i>                                                                                                                             | N/A                                                                                                  | N/A                                                                                                  |
| select                                    | N/A                                                                                                                                                 | N/A                                                                                                  | <pre>PS3="Select a menu item" select var in wordlist do     commands done</pre>                      |



## *The dtksh Shell*

The dtksh shell is a version of the Korn shell extended to support X, Xt, and Motif facilities from within a shell script. Therefore, you can open windows with text fields, buttons, labels, scroll bars, menus, and so on from within a dtksh shell script. These windows are limited to a CDE windowing environment.

The dtksh utility is a version of the Korn shell extended to support:

- Fully localized shell scripts
- Access to the CDE application help system
- Customization of script-based graphical user interface (GUI) attributes (such as font and colors) using the CDE customization tool
- Response to session-management save state directives
- Response to window-management close directives
- Access to most of the CDE Desktop Services Message Set
- Access to many of the CDE Data Typing API functions
- Access to the CDE Action API functions

You can find examples of dtksh CDE scripts in `/usr/dt/examples/dtksh`.



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