



CSCI 330

THE UNIX SYSTEM

Bash Programming

BASIC SHELL PROGRAMMING

- A script is a file that contains shell commands
 - data structure: variables
 - control structure: sequence, decision, loop
- Shebang line for bash shell script:
 - #! /bin/bash**
 - #! /bin/sh**
- to run:
 - make executable: **% chmod +x script**
 - invoke via: **% ./script**

BASH SHELL PROGRAMMING

- Input
 - prompting user
 - command line arguments
- Decision:
 - if-then-else
 - case
- Repetition
 - do-while, repeat-until
 - for
 - select
- Functions
- Traps

USER INPUT

- shell allows to prompt for user input

Syntax:

```
read varname [more vars]
```

- or

```
read -p "prompt" varname [more vars]
```

- words entered by user are assigned to **varname** and “**more vars**”
- last variable gets rest of input line

USER INPUT EXAMPLE

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

```
read -p "enter your name: " first last
```

```
echo "First name: $first"
```

```
echo "Last name: $last"
```

SPECIAL SHELL VARIABLES

Parameter	Meaning
\$0	Name of the current shell script
\$1-\$9	Positional parameters 1 through 9
\$#	The number of positional parameters
\$*	All positional parameters, “\$*” is one string
@\$	All positional parameters, “@\$” is a set of strings
\$?	Return status of most recently executed command
\$\$	Process id of current process

EXAMPLES: COMMAND LINE ARGUMENTS

```
% set tim bill ann fred
      $1  $2  $3  $4
% echo $*
tim bill ann fred
% echo $#
4
% echo $1
tim
% echo $3 $4
ann fred
```

The 'set' command can be used to assign values to positional parameters

BASH CONTROL STRUCTURES

- if-then-else
- case
- loops
 - for
 - while
 - until
 - select

IF STATEMENT

```
if command  
then  
  statements  
fi
```

- statements are executed only if **command** succeeds, i.e. has return status “0”

TEST COMMAND

Syntax:

```
test expression
```

```
[ expression ]
```

- evaluates 'expression' and returns true or false

Example:

```
if test -w "$1"
```

```
then
```

```
echo "file $1 is write-able"
```

```
fi
```

THE SIMPLE IF STATEMENT

```
if [ condition ]; then
  statements
fi
```

- executes the statements only if **condition** is true

THE IF-THEN-ELSE STATEMENT

```
if [ condition ] ; then  
    statements-1  
else  
    statements-2  
fi
```

- executes statements-1 if condition is true
- executes statements-2 if condition is false

THE IF...STATEMENT

```
if [ condition ]; then
    statements
elif [ condition ]; then
    statement
else
    statements
fi
```

- The word **elif** stands for “else if”
- It is part of the if statement and cannot be used by itself

RELATIONAL OPERATORS

Meaning	Numeric	String
Greater than	-gt	
Greater than or equal	-ge	
Less than	-lt	
Less than or equal	-le	
Equal	-eg	= or ==
Not equal	-ne	!=
str1 is less than str2		str1 < str2
str1 is greater str2		str1 > str2
String length is greater than zero		-n str
String length is zero		-z str

COMPOUND LOGICAL EXPRESSIONS

! not

&& and

|| or

and, or
must be enclosed within
[[]]

EXAMPLE: USING THE ! OPERATOR

```
#!/bin/bash
```

```
read -p "Enter years of work: " Years
if [ ! "$Years" -lt 20 ]; then
    echo "You can retire now."
else
    echo "You need 20+ years to retire"
fi
```


EXAMPLE: USING THE && OPERATOR

```
#!/bin/bash
```

```
Bonus=500
```

```
read -p "Enter Status: " Status
```

```
read -p "Enter Shift: " Shift
```

```
if [[ "$Status" = "H" && "$Shift" = 3 ]]
```

```
then
```

```
    echo "shift $Shift gets \$$Bonus bonus"
```

```
else
```

```
    echo "only hourly workers in"
```

```
    echo "shift 3 get a bonus"
```

```
fi
```

EXAMPLE: USING THE || OPERATOR

```
#!/bin/bash
```

```
read -p "Enter calls handled:" CHandle
read -p "Enter calls closed: " CClose
if [[ "$CHandle" -gt 150 || "$CClose" -gt 50 ]]
    then
    echo "You are entitled to a bonus"
else
    echo "You get a bonus if the calls"
    echo "handled exceeds 150 or"
    echo "calls closed exceeds 50"
fi
```

FILE TESTING

Meaning

-d file	True if 'file' is a directory
-f file	True if 'file' is an ord. file
-r file	True if 'file' is readable
-w file	True if 'file' is writable
-x file	True if 'file' is executable
-s file	True if length of 'file' is nonzero

EXAMPLE: FILE TESTING

```
#!/bin/bash
echo "Enter a filename: "
read filename
if [ ! -r "$filename" ]
then
    echo "File is not read-able"
    exit 1
fi
```

EXAMPLE: FILE TESTING

```
#!/bin/bash

if [ $# -lt 1 ]; then
    echo "Usage: filetest filename"
    exit 1
fi

if [[ ! -f "$1" || ! -r "$1" || ! -w "$1" ]]
then
    echo "File $1 is not accessible"
    exit 1
fi
```

EXAMPLE: IF... STATEMENT

The following THREE *if*-conditions produce the same result

* DOUBLE SQUARE BRACKETS

```
read -p "Do you want to continue?" reply
if [[ $reply = "y" ]]; then
    echo "You entered " $reply
fi
```

* SINGLE SQUARE BRACKETS

```
read -p "Do you want to continue?" reply
if [ $reply = "y" ]; then
    echo "You entered " $reply
fi
```

* "TEST" COMMAND

```
read -p "Do you want to continue?" reply
if test $reply = "y"; then
    echo "You entered " $reply
fi
```

EXAMPLE: IF..ELIF... STATEMENT

```
#!/bin/bash

read -p "Enter Income Amount: " Income
read -p "Enter Expenses Amount: " Expense

let Net=$Income-$Expense

if [ "$Net" -eq "0" ]; then
    echo "Income and Expenses are equal -
    breakeven."
elif [ "$Net" -gt "0" ]; then
    echo "Profit of: " $Net
else
    echo "Loss of: " $Net
fi
```

THE CASE STATEMENT

- use the case statement for a decision that is based on multiple choices

Syntax:

```
case word in
    pattern1) command-list1
    ;;
    pattern2) command-list2
    ;;
    patternN) command-listN
    ;;
esac
```


CASE PATTERN

- checked against word for match
- may also contain:
 - *
?
[...]
[:class:]
- multiple patterns can be listed via:
 - |

EXAMPLE 1: THE CASE STATEMENT

```
#!/bin/bash
echo "Enter Y to see all files including hidden files"
echo "Enter N to see all non-hidden files"
echo "Enter q to quit"

read -p "Enter your choice: " reply

case $reply in
  Y|YES) echo "Displaying all (really...) files"
         ls -a ;;
  N|NO)  echo "Display all non-hidden files..."
         ls ;;
  Q)     exit 0 ;;

  *)     echo "Invalid choice!"; exit 1 ;;
esac
```

EXAMPLE 2: THE CASE STATEMENT

```
#!/bin/bash
ChildRate=3
AdultRate=10
SeniorRate=7
read -p "Enter your age: " age
case $age in
    [1-9]|[1][0-2])    # child, if age 12 and younger
        echo "your rate is" '$' "$ChildRate.00" ;;
    # adult, if age is between 13 and 59 inclusive
    [1][3-9]|[2-5][0-9])
        echo "your rate is" '$' "$AdultRate.00" ;;
    [6-9][0-9])      # senior, if age is 60+
        echo "your rate is" '$' "$SeniorRate.00" ;;
esac
```

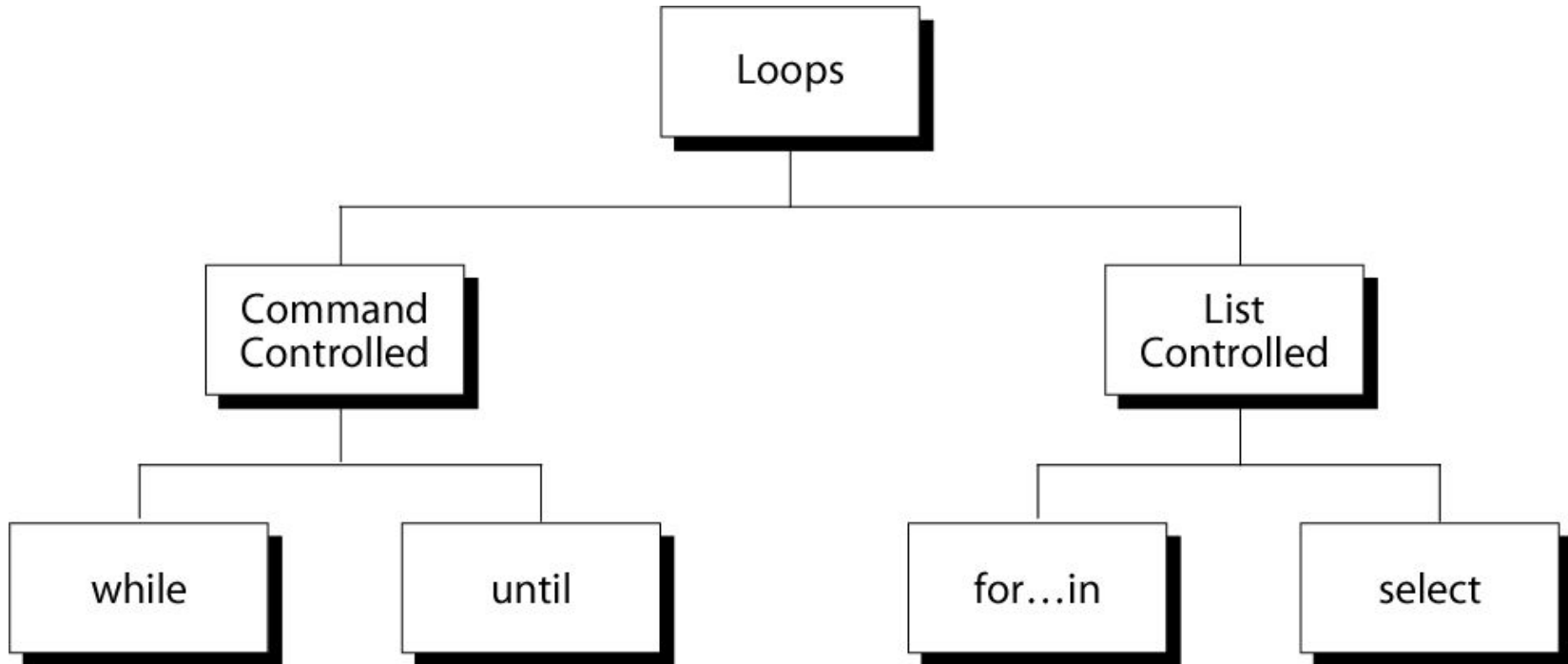
BASH PROGRAMMING: SO FAR

- Data structure
 - Variables
 - Numeric variables
 - Arrays
- User input
- Control structures
 - if-then-else
 - case

BASH PROGRAMMING: STILL TO COME

- Control structures
 - Repetition
 - do-while, repeat-until
 - for
 - select
- Functions
- Trapping signals

REPETITION CONSTRUCTS



THE WHILE LOOP

□ Purpose:

To execute commands in “command-list” as long as “expression” evaluates to true

Syntax:

```
while [ expression ]  
do  
    command-list  
done
```

EXAMPLE: USING THE WHILE LOOP

```
#!/bin/bash
COUNTER=0
while [ $COUNTER -lt 10 ]
do
    echo The counter is $COUNTER
    let COUNTER=$COUNTER+1
done
```


EXAMPLE: USING THE WHILE LOOP

```
#!/bin/bash
```

```
Cont="Y"
```

```
while [ $Cont = "Y" ]; do
```

```
    ps -A
```

```
    read -p "want to continue? (Y/N)" reply
```

```
    Cont=`echo $reply | tr [:lower:] [:upper:]`
```

```
done
```

```
echo "done"
```

EXAMPLE: USING THE WHILE LOOP

```
#!/bin/bash
# copies files from home- into the webserver- directory
# A new directory is created every hour

PICSDIR=/home/carol/pics
WEBDIR=/var/www/carol/webcam
while true; do
    DATE=`date +%Y%m%d`
    HOUR=`date +%H`
    mkdir $WEBDIR/"$DATE"
    while [ $HOUR -ne "00" ]; do
        DESTDIR=$WEBDIR/"$DATE"/"$HOUR"
        mkdir "$DESTDIR"
        mv $PICSDIR/*.jpg "$DESTDIR"/
        sleep 3600
        HOUR=`date +%H`
    done
done
```

THE UNTIL LOOP

□ Purpose:

To execute commands in “command-list” as long as “expression” evaluates to false

Syntax:

```
until [ expression ]  
do  
    command-list  
done
```

EXAMPLE: USING THE UNTIL LOOP

```
#!/bin/bash
```

```
COUNTER=20
```

```
until [ $COUNTER -lt 10 ]
```

```
do
```

```
    echo $COUNTER
```

```
    let COUNTER-=1
```

```
done
```

EXAMPLE: USING THE UNTIL LOOP

```
#!/bin/bash
```

```
Stop="N"
```

```
until [ $Stop = "Y" ]; do
```

```
    ps -A
```

```
    read -p "want to stop? (Y/N)" reply
```

```
    Stop=`echo $reply | tr [:lower:] [:upper:]`
```

```
done
```

```
echo "done"
```

THE FOR LOOP

□ Purpose:

To execute commands as many times as the number of words in the “argument-list”

Syntax:

```
for variable in argument-list  
do  
    commands  
done
```

EXAMPLE 1: THE FOR LOOP

```
#!/bin/bash
```

```
for i in 7 9 2 3 4 5
```

```
do
```

```
    echo $i
```

```
done
```

EXAMPLE 2: USING THE FOR LOOP

```
#!/bin/bash
# compute the average weekly temperature

for num in 1 2 3 4 5 6 7
do
    read -p "Enter temp for day $num: " Temp
    let TempTotal=TempTotal+Temp
done

let AvgTemp=TempTotal/7
echo "Average temperature: " $AvgTemp
```


LOOPING OVER ARGUMENTS

- simplest form will iterate over all command line arguments:

```
#!/bin/bash
for parm
do
    echo $parm
done
```

SELECT COMMAND

- Constructs simple menu from word list
- Allows user to enter a number instead of a word
- User enters sequence number corresponding to the word

Syntax:

```
select WORD in LIST  
do  
    RESPECTIVE-COMMANDS  
done
```

- Loops until end of input, i.e. ^d (or ^c)

SELECT EXAMPLE

```
#!/bin/bash
select var in alpha beta gamma
do
    echo $var
done
```

□ Prints:

```
1) alpha
2) beta
3) gamma
#? 2
beta
#? 4
#? 1
alpha
```

SELECT DETAIL

- ❑ PS3 is select sub-prompt
- ❑ \$REPLY is user input (the number)

```
#!/bin/bash
PS3="select entry or ^D: "
select var in alpha beta
do
    echo "$REPLY = $var"
done
```

```
Output:
select ...
1) alpha
2) beta
? 2
2 = beta
? 1
1 = alpha
```

SELECT EXAMPLE

```
#!/bin/bash
echo "script to make files private"
echo "Select file to protect:"

select FILENAME in *
do
    echo "You picked $FILENAME ($REPLY) "
    chmod go-rwx "$FILENAME"
    echo "it is now private"
done
```

BREAK AND CONTINUE

- Interrupt for, while or until loop
- The break statement
 - transfer control to the statement AFTER the done statement
 - terminate execution of the loop
- The continue statement
 - transfer control to the statement TO the done statement
 - skip the test statements for the current iteration
 - continues execution of the loop

THE BREAK COMMAND

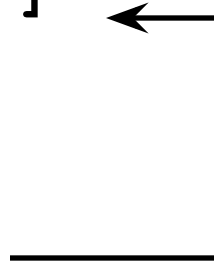
```
while [ condition ]  
do  
    cmd-1  
    break  
    cmd-n  
done  
echo "done"
```



This iteration is over
and there are no more
iterations

THE CONTINUE COMMAND

```
while [ condition ]  
do  
    cmd-1  
    continue  
    cmd-n  
done  
echo "done"
```



This iteration is over; do the next iteration

EXAMPLE:

```
for index in 1 2 3 4 5 6 7 8 9 10
do
    if [ $index -le 3 ]; then
        echo "continue"
        continue
    fi
    echo $index
    if [ $index -ge 8 ]; then
        echo "break"
        break
    fi
done
```

BASH SHELL PROGRAMMING

- Sequence
- Decision:
 - if-then-else
 - case
- Repetition
 - do-while, repeat-until
 - for
 - select

DONE !

- Functions
- Traps

still to come

SHELL FUNCTIONS

- A shell function is similar to a shell script
 - stores a series of commands for execution later
 - shell stores functions in memory
 - shell executes a shell function in the same shell that called it
- Where to define
 - In .profile
 - In your script
 - Or on the command line
- Remove a function
 - Use unset built-in

SHELL FUNCTIONS

- must be defined before they can be referenced
- usually placed at the beginning of the script

Syntax:

```
function-name () {  
    statements  
}
```

EXAMPLE: FUNCTION

```
#!/bin/bash
```

```
funky () {  
    # This is a simple function  
    echo "This is a funky function."  
    echo "Now exiting funky function."  
}
```

```
# declaration must precede call:
```

```
funky
```

EXAMPLE: FUNCTION

```
#!/bin/bash
fun () { # A somewhat more complex function.
    JUST_A_SECOND=1
    let i=0
    REPEATS=30
    echo "And now the fun really begins."
    while [ $i -lt $REPEATS ]
    do
        echo "-----FUNCTIONS are fun----->"
        sleep $JUST_A_SECOND
        let i+=1
    done
}
fun
```

FUNCTION PARAMETERS

- Need not be declared
- Arguments provided via function call are accessible inside function as \$1, \$2, \$3, ...

`$#` reflects number of parameters

`$0` still contains name of script
(not name of function)

EXAMPLE: FUNCTION WITH PARAMETER

```
#!/bin/sh
testfile() {
    if [ $# -gt 0 ]; then
        if [[ -f $1 && -r $1 ]]; then
            echo $1 is a readable file
        else
            echo $1 is not a readable file
        fi
    fi
}

testfile .
testfile funtest
```


EXAMPLE: FUNCTION WITH PARAMETERS

```
#!/bin/bash
checkfile() {
  for file
  do
    if [ -f "$file" ]; then
      echo "$file is a file"
    else
      if [ -d "$file" ]; then
        echo "$file is a directory"
      fi
    fi
  done
}
checkfile . funtest
```

LOCAL VARIABLES IN FUNCTIONS

- ❑ Variables defined within functions are global, i.e. their values are known throughout the entire shell program
- ❑ keyword “local” inside a function definition makes referenced variables “local” to that function

EXAMPLE: FUNCTION

```
#!/bin/bash
```

```
global="pretty good variable"
```

```
foo () {  
    local inside="not so good variable"  
    echo $global  
    echo $inside  
    global="better variable"  
}
```

```
echo $global
```

```
foo
```

```
echo $global
```

```
echo $inside
```

HANDLING SIGNALS

- Unix allows you to send a signal to any process
- -1 = hangup **kill -HUP 1234**
- -2 = interrupt with ^C **kill -2 1235**
- no argument = terminate **kill 1235**
- -9 = kill **kill -9 1236**
 - -9 cannot be blocked
- list your processes with
ps -u userid

SIGNALS ON LINUX

```
% kill -l
```

```
1) SIGHUP      2) SIGINT      3) SIGQUIT     4) SIGILL
5) SIGTRAP     6) SIGABRT    7) SIGBUS      8) SIGFPE
9) SIGKILL     10) SIGUSR1   11) SIGSEGV    12) SIGUSR2
13) SIGPIPE    14) SIGALRM   15) SIGTERM    16) SIGSTKFLT
17) SIGCHLD    18) SIGCONT   19) SIGSTOP    20) SIGTSTP
21) SIGTTIN    22) SIGTTOU   23) SIGURG     24) SIGXCPU
25) SIGXFSZ    26) SIGVTALRM 27) SIGPROF    28) SIGWINCH
29) SIGIO      30) SIGPWR    31) SIGSYS     34) SIGRTMIN
35) SIGRTMIN+1 36) SIGRTMIN+2 37) SIGRTMIN+3 38) SIGRTMIN+4
39) SIGRTMIN+5 40) SIGRTMIN+6 41) SIGRTMIN+7 42) SIGRTMIN+8
43) SIGRTMIN+9 44) SIGRTMIN+10 45) SIGRTMIN+11 46) SIGRTMIN+12
47) SIGRTMIN+13 48) SIGRTMIN+14 49) SIGRTMIN+15 50) SIGRTMAX-14
51) SIGRTMAX-13 52) SIGRTMAX-12 53) SIGRTMAX-11 54) SIGRTMAX-10
55) SIGRTMAX-9  56) SIGRTMAX-8  57) SIGRTMAX-7  58) SIGRTMAX-6
59) SIGRTMAX-5  60) SIGRTMAX-4  61) SIGRTMAX-3  62) SIGRTMAX-2
63) SIGRTMAX-1  64) SIGRTMAX
```

□ ^C is 2 - SIGINT

HANDLING SIGNALS

- Default action for most signals is to end process
 - term: signal handler
- Bash allows to install custom signal handler

Syntax:

```
trap 'handler commands' signals
```

Example:

```
trap 'echo do not hangup' 1 2
```

EXAMPLE: TRAP HANGUP

```
#!/bin/bash
# kill -1 won't kill this process
# kill -2 will

trap 'echo dont hang up' 1

while true
do
    echo "try to hang up"
    sleep 1
done
```

EXAMPLE: TRAP MULTIPLE SIGNALS

```
#!/bin/sh
# plain kill or kill -9 will kill this
trap 'echo 1' 1
trap 'echo 2' 2

while true; do
    echo -n .
    sleep 1
done
```


EXAMPLE: REMOVING TEMP FILES

```
#!/bin/bash
trap 'cleanup; exit' 2

cleanup () {
    /bin/rm -f /tmp/tempfile.$$.*
}

for i in 1 2 3 4 5 6 7 8
do
    echo "$i.iteration"
    touch /tmp/tempfile.$$.$i
    sleep 1
done
cleanup
```

RESTORING DEFAULT HANDLERS

- ❑ **trap** without a command list will remove a signal handler
- ❑ Use this to run a signal handler once only

```
#!/bin/sh
trap 'justonce' 2
justonce() {
    echo "not yet"
    trap 2          # now reset it
}

while true; do
    echo -n "."
    sleep 1
done
```

DEBUG SHELL PROGRAMS

- Debugging is troubleshooting errors that may occur during the execution of a program/script
- The following two commands can help you debug a bash shell script:
 - echo
 - use explicit output statements to trace execution
 - set

DEBUGGING USING “SET”

- The “set” command is a shell built-in command
 - has options to allow flow of execution
 - v option prints each line as it is read
 - x option displays the command and its arguments
 - n checks for syntax errors
 - options can turned on or off
 - To turn on the option: `set -xv`
 - To turn off the options: `set +xv`
 - Options can also be set via she-bang line
- ```
#! /bin/bash -xv
```

# SUMMARY: BASH SHELL PROGRAMMING

- Sequence
- Decision:
  - if-then-else
  - case
- Repetition
  - do-while, repeat-until
  - for
  - select
- Functions
- Traps

DONE !