



Bash Shell

Lecturer: Prof. Andrzej (AJ) Bieszczad

Email: andrzej@csun.edu

Phone: 818-677-4954

The shell of Linux

- Linux has a variety of different shells:
 - Bourne shell (sh), C shell (csh), Korn shell (ksh), TC shell (tcsh), Bourne Again shell (bash).
 - Certainly **the most popular shell is “bash”**. Bash is an **sh-compatible** shell that **incorporates useful features from the Korn shell (ksh) and C shell (csh)**.
 - It is intended to **conform** to the **IEEE POSIX P1003.2/ISO 9945.2 Shell and Tools standard**.
 - It offers functional **improvements** over sh for both **programming and interactive use**.
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Programming or Scripting ?

- bash is not only an **excellent command line shell**, but a **scripting language** in itself. Shell scripting allows us to use the shell's abilities and to **automate a lot of tasks** that would otherwise require a lot of commands.
- Difference between **programming and scripting languages**:
 - **Programming languages** are generally a lot **more powerful and a lot faster than scripting languages**. Programming languages generally start from source code and are compiled into an **executable**. This executable is **not easily ported** into different operating systems.
 - A **scripting language** also starts from source code, but **is not compiled into an executable**. Rather, an **interpreter** reads the instructions in the source file and **executes each instruction**. Interpreted programs are **generally slower than compiled programs**. The main advantage is that you can **easily port** the source file to any operating system. bash is a scripting language. Other examples of scripting languages are Perl, Lisp, and Tcl.

The first bash program

- There are two major text editors in Linux:
 - vi, emacs (or xemacs).
- So fire up a text editor; for example:

```
$ vi &
```

and type the following inside it:

```
#!/bin/bash  
echo "Hello World"
```

- The first line tells Linux to use the bash interpreter to run this script. We call it hello.sh. Then, make the script executable:

```
$ chmod 700 hello.sh  
$ ./hello.sh  
Hello World
```

The second bash program

- We write a program that copies all files into a directory, and then deletes the directory along with its contents. This can be done with the following commands:

```
$ mkdir trash  
$ cp * trash  
$ rm -rf trash  
$ mkdir trash
```

- Instead of having to type all that interactively on the shell, write a shell program instead:

```
$ cat trash.sh  
#!/bin/bash  
# this script deletes some files  
cp * trash  
rm -rf trash  
mkdir trash  
echo "Deleted all files!"
```

Variables

- We can use **variables** as in any programming languages. Their values are **always stored as strings**, but there are mathematical operators in the shell language that will **convert variables to numbers for calculations**.
- We have **no need to declare a variable**, just assigning a value to its reference will create it.
- Example

```
#!/bin/bash  
STR="Hello World!"  
echo $STR
```

- Line 2 creates a variable called STR and assigns the string "Hello World!" to it. Then the value of this variable is retrieved by putting the '\$' in at the beginning.

Warning !

- The shell programming language **does not type-cast** its variables. This means that a variable can hold number data or character data.

```
count=0
```

```
count=Sunday
```

- Switching the TYPE of a variable can lead to confusion for the writer of the script or someone trying to modify it, so **it is recommended to use a variable for only a single TYPE of data** in a script.
- **** is the bash escape character and it preserves the literal value of the next character that follows.

```
$ ls \*
```

```
ls: *: No such file or directory
```

Single and Double Quote

- When assigning character data containing spaces or special characters, the data must be enclosed in either single or double quotes.
- Using **double quotes** to show a string of characters will allow any variables in the quotes to be resolved

```
$ var="test string"  
$ newvar="Value of var is $var"  
$ echo $newvar  
Value of var is test string
```

- Using **single quotes** to show a string of characters will not allow variable resolution

```
$ var='test string'  
$ newvar='Value of var is $var'  
$ echo $newvar  
Value of var is $var
```


The export command

- The export command puts a variable into the environment so it will be accessible to child processes. For instance:

```
$ x=hello
$ bash      # Run a child shell.
$ echo $x   # Nothing in x.
$ exit      # Return to parent.
$ export x
$ bash
$ echo $x
hello      # It's there.
```

- If the child modifies x, it will not modify the parent's original value. Verify this by changing x in the following way:

```
$ x=ciao
$ exit
$ echo $x
hello
```

Environmental Variables

- There are two types of variables:
 - Local variables
 - Environmental variables
- Environmental variables are set by the system and can usually be found by using the `env` command. Environmental variables hold special values. For instance:

```
$ echo $SHELL
```

```
/bin/bash
```

```
$ echo $PATH
```

```
/usr/X11R6/bin:/usr/local/bin:/bin:/usr/bin
```

- Environmental variables are defined in `/etc/profile`, `/etc/profile.d/` and `~/.bash_profile`. These files are the **initialization files** and they are read when bash shell is invoked.
 - When a login shell exits, bash reads `~/.bash_logout`
 - The startup is more complex; for example, if bash is used **interactively**, then `/etc/bashrc` or `~/.bashrc` are read. See the man page for more details.
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Environmental Variables

- **HOME**: The default argument (home directory) for `cd`.
- **PATH**: The search path for commands. It is a colon-separated list of directories that are searched when you type a command.

- Usually, we type in the commands in the following way:

```
$ ./command
```

- By setting **PATH=\$PATH:.** our working directory is included in the search path for commands, and we simply type:

```
$ command
```

- If we type in

```
$ mkdir ~/bin
```

- and we include the following lines in the `~/.bash_profile`:

```
PATH=$PATH:$HOME/bin  
export PATH
```

- we obtain that the directory `/home/userid/bin` is included in the search path for commands.

Environment Variables

- **LOGNAME**: contains the user name
- **HOSTNAME**: contains the computer name.
- **PS1**: sequence of characters shown before the prompt

\t hour
\d date
\w current directory
\W last part of the current directory
\u user name
\\$ prompt character

Example:

```
[userid@homelinux userid]$ PS1='hi \u *'  
hi userid* _
```

Exercise ==> Design your own new prompt. Show me when you are happy with it.

- **RANDOM**: random number generator
- **SECONDS**: seconds from the beginning of the execution

Read command

- The read command allows you to prompt for input and store it in a variable.

- Example:

```
#!/bin/bash
echo -n "Enter name of file to delete: "
read file
echo "Type 'y' to remove it, 'n' to change your mind ..."
rm -i $file
echo "That was YOUR decision!"
```

- Line 2 prompts for a string that is read in line 3. Line 4 uses the interactive remove (`rm -i`) to ask the user for confirmation.

Command Substitution

- The **backquote** “```” is different from the **single quote** “`'`”. It is used for **command substitution**:
``command``

```
$ LIST=`ls`  
$ echo $LIST  
hello.sh read.sh
```

```
$ PS1="`pwd`>"  
/home/userid/work> _
```

- We can perform the command substitution by means of **\$(command)**

```
$ LIST=$(ls)  
$ echo $LIST  
hello.sh read.sh
```

```
$ rm $( find / -name "*.tmp" )
```

```
$ cat > backup.sh  
#!/bin/bash  
BCKUP=/home/userid/backup-$(date +%d-%m-%y).tar.gz  
tar -czf $BCKUP $HOME
```

Arithmetic Evaluation

- The **let** statement can be used to do **mathematical functions**:

```
$ let X=10+2*7
```

```
$ echo $X
```

```
24
```

```
$ let Y=X+2*4
```

```
$ echo $Y
```

```
32
```

- An **arithmetic expression** can be evaluated by **\$(expression)** or **`\${expression}`**

```
$ echo “`${123+20}`”
```

```
143
```

```
$ VALORE=${123+20}
```

```
$ echo “`${123*$VALORE}`”
```

```
17589
```

Arithmetic Evaluation

- Available operators: **+**, **-**, **/**, *****, **%**

- Example

```
$ cat arithmetic.sh
#!/bin/bash
echo -n "Enter the first number: "; read x
echo -n "Enter the second number: "; read y
add=$(( $x + $y ))
sub=$(( $x - $y ))
mul=$(( $x * $y ))
div=$(( $x / $y ))
mod=$(( $x % $y ))
# print out the answers:
echo "Sum: $add"
echo "Difference: $sub"
echo "Product: $mul"
echo "Quotient: $div"
echo "Remainder: $mod"
```


Conditional Statements

- **Conditionals** let us decide whether to perform an action or not, this decision is taken by evaluating an expression. The most basic form is:

```
if [ expression ];  
then  
    statements  
elif [ expression ];  
then  
    statements  
else  
    statements  
fi
```

- the **elif** (else if) and **else** sections are optional
 - Put **spaces** after **[** and **before]**, and **around the operators** and **operands**.
-

Expressions

- An **expression** can be: **String comparison**, **Numeric comparison**, **File operators** and **Logical operators** and it is represented by **[expression]**:

- String Comparisons:

= compare if two strings are **equal**
!= compare if two strings are **not equal**
-n evaluate if string **length is greater than zero**
-z evaluate if string **length is equal to zero**

- Examples:

[s1 = s2] (true if **s1** same as **s2**, else false)
[s1 != s2] (true if **s1** not same as **s2**, else false)
[s1] (true if **s1** is not empty, else false)
[-n s1] (true if **s1** has a length greater than 0, else false)
[-z s2] (true if **s2** has a length of 0, otherwise false)

Expressions

- Number Comparisons:

- eq compare if two numbers are equal
- ge compare if one number is greater than or equal to a number
- le compare if one number is less than or equal to a number
- ne compare if two numbers are not equal
- gt compare if one number is greater than another number
- lt compare if one number is less than another number

- Examples:

- [n1 -eq n2] (true if n1 same as n2, else false)
- [n1 -ge n2] (true if n1 greater then or equal to n2, else false)
- [n1 -le n2] (true if n1 less then or equal to n2, else false)
- [n1 -ne n2] (true if n1 is not same as n2, else false)
- [n1 -gt n2] (true if n1 greater then n2, else false)
- [n1 -lt n2] (true if n1 less then n2, else false)

Examples

\$ cat user.sh

```
#!/bin/bash
echo -n "Enter your login name: "
read name
if [ "$name" = "$USER" ];
then
    echo "Hello, $name. How are you today ?"
else
    echo "You are not $USER, so who are you ?"
fi
```

\$ cat number.sh

```
#!/bin/bash
echo -n "Enter a number 1 < x < 10: "
read num
if [ "$num" -lt 10 ]; then
    if [ "$num" -gt 1 ]; then
        echo "$num*$num=$(($num*$num))"
    else
        echo "Wrong insertion !"
    fi
else
    echo "Wrong insertion !"
fi
```

Expressions

- Files operators:

- d check if path given is a **directory**
- f check if path given is a **file**
- e check if file name **exists**
- r check if **read permission** is set for file or directory
- s check if a file has a **length greater than 0**
- w check if **write permission** is set for a file or directory
- x check if **execute permission** is set for a file or directory

- Examples:

- [-d fname] (true if **fname is a directory**, otherwise false)
- [-f fname] (true if **fname is a file**, otherwise false)
- [-e fname] (true if **fname exists**, otherwise false)
- [-s fname] (true if **fname length is greater than 0**, else false)
- [-r fname] (true if **fname has the read permission**, else false)
- [-w fname] (true if **fname has the write permission**, else false)
- [-x fname] (true if **fname has the execute permission**, else false)

Example

```
#!/bin/bash
if [ -f /etc/fstab ];
then
    cp /etc/fstab .
    echo "Done."
else
    echo "This file does not exist."
    exit 1
fi
```

Exercise.

- Write a shell script which:
 - accepts a file name
 - checks if file exists
 - if file exists, copy the file to the same name + .bak + the current date (if the backup file already exists ask if you want to replace it).
- When done you should have the original file and one with a .bak at the end.

Expressions

- Logical operators:

- ! negate (**NOT**) a logical expression
- a logically **AND** two logical expressions
- o logically **OR** two logical expressions

Example:

```
#!/bin/bash
echo -n "Enter a number 1 < x < 10:"
read num
if [ "$num" -gt 1 -a "$num" -lt 10 ];
then
    echo "$num*$num=$(($num*$num))"
else
    echo "Wrong insertion !"
fi
```

Expressions

- Logical operators:

&& logically **AND** two logical expressions

|| logically **OR** two logical expressions

Example:

```
#!/bin/bash
echo -n "Enter a number 1 < x < 10: "
read num
if [ "$number" -gt 1 ] && [ "$number" -lt 10 ];
then
    echo "$num*$num=$(($num*$num))"
else
    echo "Wrong insertion !"
fi
```


Example

```
$ cat iftrue.sh
#!/bin/bash
echo "Enter a path: "; read x
if cd $x; then
    echo "I am in $x and it contains"; ls
else
    echo "The directory $x does not exist";
    exit 1
fi
```

```
$ iftrue.sh
Enter a path: /home
userid anotherid ...
$ iftrue.sh
Enter a path: blah
The directory blah does not exist
```

Shell Parameters

- **Positional parameters** are assigned from the shell's argument when it is invoked. Positional parameter “N” may be referenced as “**`${N}`**”, or as “**`$N`**” when “N” consists of a single digit.

- **Special parameters**

- `$#`** is the **number of parameters** passed
- `$0`** returns the **name of the shell script** running as well as its location in the file system
- `$*`** gives a single word containing **all the parameters** passed to the script
- `$@`** gives an **array of words** containing **all the parameters** passed to the script

```
$ cat sparameters.sh
#!/bin/bash
echo "$#; $0; $1; $2; $*; $@"
$ sparameters.sh arg1 arg2
2; ./sparameters.sh; arg1; arg2; arg1 arg2; arg1 arg2
```

Trash

```
$ cat trash.sh
#!/bin/bash
if [ $# -eq 1 ];
then
    if [ ! -d "$HOME/trash" ];
    then
        mkdir "$HOME/trash"
    fi
    mv $1 "$HOME/trash"
else
    echo "Use: $0 filename"
    exit 1
fi
```

Case Statement

- Used to execute statements based on specific values. Often used in place of an if statement if there are a large number of conditions.
- Value used can be an **expression**
- each set of statements must be ended by a **pair of semicolons**;
- a *****) is used to accept any value not matched with list of values

```
case $var in
    val1)
        statements;;
    val2)
        statements;;
    *)
        statements;;
esac
```

Example (case.sh)

```
$ cat case.sh
#!/bin/bash
echo -n "Enter a number 1 < x < 10: "
read x
case $x in
    1) echo "Value of x is 1.";;
    2) echo "Value of x is 2.";;
    3) echo "Value of x is 3.";;
    4) echo "Value of x is 4.";;
    5) echo "Value of x is 5.";;
    6) echo "Value of x is 6.";;
    7) echo "Value of x is 7.";;
    8) echo "Value of x is 8.";;
    9) echo "Value of x is 9.";;
    0 | 10) echo "wrong number.";;
    *) echo "Unrecognized value.";;
esac
```

Iteration Statements

- The **for structure** is used when you are looping through a range of variables.

```
for var in list
do
    statements
done
```

- statements are executed with **var set to each value in the list.**
- Example

```
#!/bin/bash
let sum=0
for num in 1 2 3 4 5
do
    let "sum = $sum + $num"
done
echo $sum
```

Iteration Statements

```
#!/bin/bash
for x in paper pencil pen
do
    echo "The value of variable x is: $x"
    sleep 1
done
```

- if the list part is left off, var is set to each parameter passed to the script (\$1, \$2, \$3,...)

```
$ cat for1.sh
#!/bin/bash
for x
do
    echo "The value of variable x is: $x"
    sleep 1
done
$ for1.sh arg1 arg2
The value of variable x is: arg1
The value of variable x is: arg2
```

Example (old.sh)

```
$ cat old.sh
#!/bin/bash
# Move the command line arg files to old directory.
if [ $# -eq 0 ] #check for command line arguments
then
    echo "Usage: $0 file ..."
    exit 1
fi
if [ ! -d "$HOME/old" ]
then
    mkdir "$HOME/old"
fi
echo The following files will be saved in the old directory:
echo $*
for file in $* #loop through all command line arguments
do
    mv $file "$HOME/old/"
    chmod 400 "$HOME/old/$file"
done
ls -l "$HOME/old"
```


Example (args.sh)

```
$ cat args.sh
#!/bin/bash
# Invoke this script with several arguments: "one two three"
if [ ! -n "$1" ]; then
    echo "Usage: $0 arg1 arg2 ..." ; exit 1
fi
echo ; index=1 ;
echo "Listing args with \"\$*\":"
for arg in "$*" ;
do
    echo "Arg $index = $arg"
    let "index+=1" # increase variable index by one
done
echo "Entire arg list seen as single word."
echo ; index=1 ;
echo "Listing args with \"\$@":"
for arg in "$@" ; do
    echo "Arg $index = $arg"
    let "index+=1"
done
echo "Arg list seen as separate words." ; exit 0
```

Using Arrays with Loops

- In the bash shell, we may use **arrays**. The simplest way to create one is using one of the two subscripts:

```
pet[0]=dog
pet[1]=cat
pet[2]=fish
pet=(dog cat fish)
```

- We may have **up to 1024 elements**. To **extract** a value, type **`${arrayname[i]}`**

```
$ echo ${pet[0]}
dog
```

- To **extract all the elements**, use an asterisk as:

```
echo ${arrayname[*]}
```

- We can **combine arrays with loops** using a for loop:

```
for x in ${arrayname[*]}
do
    ...
done
```

A C-like for loop

- An **alternative** form of the **for** structure is

```
for (( EXPR1 ; EXPR2 ; EXPR3 ))  
do  
    statements  
done
```

- First, the arithmetic expression EXPR1 is evaluated. EXPR2 is then evaluated repeatedly until it evaluates to 0. Each time EXPR2 is evaluates to a non-zero value, statements are executed and EXPR3 is evaluated.

```
$ cat for2.sh  
#!/bin/bash  
echo -n "Enter a number: "; read x  
let sum=0  
for (( i=1 ; $i<$x ; i=$i+1 )) ; do  
    let "sum = $sum + $i"  
done  
echo "the sum of the first $x numbers is: $sum"
```

Debugging

- Bash provides two options which will give useful information for debugging
 - x : displays each line of the script with variable substitution and before execution
 - v : displays each line of the script as typed before execution
- Usage:

`#!/bin/bash -v` or `#!/bin/bash -x` or `#!/bin/bash -xv`

\$ `cat for3.sh`

```
#!/bin/bash -x
echo -n "Enter a number: "; read x
let sum=0
for (( i=1 ; $i<$x ; i=$i+1 )) ; do
    let "sum = $sum + $i"
done
echo "the sum of the first $x numbers is: $sum"
```

Debugging

```
$ for3.sh
+ echo -n 'Enter a number: '
Enter a number: + read x
3
+ let sum=0
+ (( i=0 ))
+ (( 0<=3 ))
+ let 'sum = 0 + 0'
+ (( i=0+1 ))
+ (( 1<=3 ))
+ let 'sum = 0 + 1'
+ (( i=1+1 ))
+ (( 2<=3 ))
+ let 'sum = 1 + 2'
+ (( i=2+1 ))
+ (( 3<=3 ))
+ let 'sum = 3 + 3'
+ (( i=3+1 ))
+ (( 4<=3 ))
+ echo 'the sum of the first 3 numbers is: 6'
the sum of the first 3 numbers is: 6
```

While Statements

- The while structure is a looping structure. Used to **execute a set of commands while a specified condition is true**. The loop terminates as soon as the condition becomes false. If condition never becomes false, loop will never exit.

```
while expression
do
    statements
done
```

```
$ cat while.sh
#!/bin/bash
echo -n "Enter a number: "; read x
let sum=0; let i=1
while [ $i -le $x ]; do
    let "sum = $sum + $i"
    i=$((i+1))
done
echo "the sum of the first $x numbers is: $sum"
```

Menu

```
$ cat menu.sh
#!/bin/bash
clear ; loop=y
while [ "$loop" = y ] ;
do
    echo "Menu"; echo "===="
    echo "D: print the date"
    echo "W: print the users who are currently log on."
    echo "P: print the working directory"
    echo "Q: quit."
    echo
    read -s choice          # silent mode: no echo to terminal
    case $choice in
        D | d) date ;;
        W | w) who ;;
        P | p) pwd ;;
        Q | q) loop=n ;;
        *) echo "Illegal choice." ;;
    esac
    echo
done
```

Find a Pattern and Edit

```
$ cat grepedit.sh
#!/bin/bash
# Edit argument files $2 ..., that contain pattern $1
if [ $# -le 1 ]
then
    echo "Usage: $0 pattern file ..." ; exit 1
else
    pattern=$1          # Save original $1
    shift              # shift the positional parameter to the left by 1
    while [ $# -gt 0 ]  # New $1 is first filename
    do
        grep "$pattern" $1 > /dev/null
        if [ $? -eq 0 ] ; then # If grep found pattern
            vi $1             # then vi the file
        fi
        shift
    done
fi
$ grepedit.sh while ~
```


Continue Statements

- The `continue` command causes a jump to the next iteration of the loop, skipping all the remaining commands in that particular loop cycle.

```
$ cat continue.sh
```

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

```
LIMIT=19
```

```
echo
```

```
echo "Printing Numbers 1 through 20 (but not 3 and 11)"
```

```
a=0
```

```
while [ $a -le "$LIMIT" ]; do
```

```
    a=$((a+1))
```

```
    if [ "$a" -eq 3 ] || [ "$a" -eq 11 ]
```

```
    then
```

```
        continue
```

```
    fi
```

```
    echo -n "$a "
```

```
done
```

Break Statements

- The **break** command **terminates the loop** (breaks out of it).

```
$ cat break.sh
```

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

```
LIMIT=19
```

```
echo
```

```
echo "Printing Numbers 1 through 20, but something happens after 2 ... "
```

```
a=0
```

```
while [ $a -le "$LIMIT" ]
```

```
do
```

```
  a=$((a+1))
```

```
  if [ "$a" -gt 2 ]
```

```
  then
```

```
    break
```

```
  fi
```

```
  echo -n "$a "
```

```
done
```

```
echo; echo; echo
```

```
exit 0
```

Until Statements

- The **until** structure is very similar to the while structure. The until structure **loops until the condition is true**. So basically it is “until this condition is true, do this”.

```
until [expression]
do
    statements
done
```

```
$ cat countdown.sh
#!/bin/bash
echo "Enter a number: "; read x
echo ; echo Count Down
until [ "$x" -le 0 ]; do
    echo $x
    x=$((x - 1))
    sleep 1
done
echo ; echo GO !
```

Manipulating Strings

- Bash supports a number of **string manipulation operations**.

`${#string}` gives the string **length**

`${string:position}` extracts **sub-string** from **\$string** at **\$position**

`${string:position:length}` extracts **\$length** characters of **sub-string** from **\$string** at **\$position**

- Example

```
$ st=0123456789
```

```
$ echo ${#st}
```

```
10
```

```
$ echo ${st:6}
```

```
6789
```

```
$ echo ${st:6:2}
```

```
67
```

Parameter Substitution

- Manipulating and/or expanding variables

`${parameter-default}`, if parameter not set, use default.

```
$ echo ${username-`whoami`}
alice
$ username=bob
$ echo ${username-`whoami`}
bob
```

`${parameter=default}`, if parameter not set, set it to default.

```
$ unset username
$ echo ${username=`whoami`}
$ echo $username
alice
```

`${parameter+value}`, if parameter set, use value, else use null string.

```
$ echo ${username+bob}
bob
```

Parameter Substitution

`${parameter?msg}`, if parameter set, use it, else print msg

```
$ value=${total?'total is not set'}
total: total is not set
$ total=10
$ value=${total?'total is not set'}
$ echo $value
10
```

Example

```
#!/bin/bash
OUTFILE=symlinks.list          # save file
directory=${1-`pwd`}
for file in "$( find $directory -type l )"
    # -type l == symbolic links
do
    echo "$file"
done | sort >> "$HOME/$OUTFILE"
exit 0
```

Functions

- Functions make scripts easier to maintain. Basically it breaks up the program into smaller pieces. A function performs an action defined by you, and it can return a value if you wish.

```
#!/bin/bash
hello()
{
echo "You are in function hello()"
}

echo "Calling function hello()..."
hello
echo "You are now out of function hello()"
```

- In the above, we called the hello() function by name by using the line: hello .
When this line is executed, bash searches the script for the line hello(). It finds it right at the top, and executes its contents.

Functions

```
$ cat function.sh
#!/bin/bash
function check() {
if [ -e "/home/$1" ]
then
    return 0
else
    return 1
fi
}
echo "Enter the name of the file: " ; read x
if check $x
then
    echo "$x exists !"
else
    echo "$x does not exists !"
fi.
```


Example: Picking a random card from a deck

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

```
# Count how many elements.
```

```
Suites="Clubs Diamonds Hearts Spades"
```

```
Denominations="2 3 4 5 6 7 8 9 10 Jack Queen King Ace"
```

```
# Read into array variable.
```

```
suite=($Suites)
```

```
denomination=($Denominations)
```

```
# Count how many elements.
```

```
num_suites=${#suite[*]}
```

```
num_denominations=${#denomination[*]}
```

```
echo -n "${denomination[$((RANDOM%num_denominations))]} of "
```

```
echo ${suite[$((RANDOM%num_suites))]}
```

```
exit 0
```

Example: Changes all filenames to lowercase

```
#!/bin/bash
for filename in *
do
    # Traverse all files in directory.

    # Get the file name without the path.
    fname=`basename $filename`
    # Change name to lowercase.
    n=`echo $fname | tr A-Z a-z`
    if [ "$fname" != "$n" ]
    then
        # Rename only files not already lowercase.
        mv $fname $n
    fi
done
exit 0
```

Example: Compare two files with a script

```
#!/bin/bash
ARGS=2          # Two args to script expected.
if [ $# -ne "$ARGS" ]; then
    echo "Usage: `basename $0` file1 file2" ; exit 1
fi
if [[ ! -r "$1" || ! -r "$2" ]] ; then
    echo "Both files must exist and be readable." ; exit 2
fi
                # /dev/null buries the output of the "cmp" command.
cmp $1 $2 &> /dev/null
                # Also works with 'diff', i.e., diff $1 $2 &> /dev/null
if [ $? -eq 0 ]      # Test exit status of "cmp" command.
then
    echo "File \"$1\" is identical to file \"$2\"."
else
    echo "File \"$1\" differs from file \"$2\"."
fi
exit 0
```

Example: Suite drawing statistics

```
$ cat cardstats.sh
#!/bin/sh # -xv
N=100000
hits=(0 0 0 0) # initialize hit counters
if [ $# -gt 0 ]; then # check whether there is an argument
    N=$1
else # ask for the number if no argument
    echo "Enter the number of trials: "
    TMOUT=5 # 5 seconds to give the input
    read N
fi
i=$N
echo "Generating $N random numbers... please wait."
SECONDS=0 # here is where we really start
while [ $i -gt 0 ]; do # run until the counter gets to zero
    case $((RANDOM%4)) in
        0) let "hits[0]+=1";; # count the hits
        1) let "hits[1]=${hits[1]}+1";;
        2) let hits[2]=$(( ${hits[2]}+1 ));;
        3) let hits[3]=$(( ${hits[3]}+1 ));;
    esac
    let "i=i-1" # count down
done
echo "Probabilities of drawing a specific color:"
# use bc - bash does not support fractions
echo "Clubs: " `echo ${hits[0]}*100/$N | bc -l`
echo "Diamonds: " `echo ${hits[1]}*100/$N | bc -l`
echo "Hearts: " `echo ${hits[2]}*100/$N | bc -l`
echo "Spades: " `echo ${hits[3]}*100/$N | bc -l`
echo "======"
echo "Execution time: $SECONDS"
```

Challenge/Project: collect

- Write a utility to collect “well-known” files into convenient directory holders.

`collect <directory>*`

- The utility should `collect` all executables, libraries, sources and includes from each directory `given on the command line or entered by the user` (if no arguments were passed) into separate directories. By default, the allocation is as follows:
 - `executables` go to `~/bin`
 - `libraries` (`lib*.*`) go to `~/lib`
 - `sources` (`*.c`, `*.cc`, `*.cpp`, `*.cxx`) go to `~/src`
 - `includes` (`*.h`, `*.hxx`) go to `~/inc`
- The utility should ask whether another directory should be used in place of these default directories.
- Each move should be `recorded in a log file` that may be used to reverse the moves (extra points for writing a `reverse` utility!). The user should have an option to use a log file other than the default (`~/organize.log`).
- At the end, `the utility should print statistics on file allocation`: how many directories were processed, how many files in each category were moved and how long the reorganization was (the `processing time in seconds`).
- The utility should wait only limited time for user input; if no input, then use defaults.