Shell Scripting

Week 2

The Shell and OS

- The shell is the user’s interface to the OS
- From it you run programs.

Scripting Languages Versus Compiled Languages

- Compiled Languages
  - Ex: C/C++, Java
  - Programs are translated from their original source code into object code that is executed by hardware
  - Efficient
  - Work at low level, dealing with bytes, integers, floating points, etc
- Scripting languages
  - Interpreted
  - Interpreter reads program, translates it into internal form, and execute programs

Why Use a Shell Script

- Simplicity: It’s a direct approach to a problem
- Portability: Can be run in many environments without change, including (usually) OS X, Windows, and BSD.
- Ease of development: You already know how to shell script.

Example

```
$ who
george          pts/2   Dec 31 16:39 (valley-forge.example.com)
betsy           pts/3   Dec 27 11:07 (flags-r-us.example.com)
benjamin        dtlocal Dec 27 17:55 (kites.example.com)
jhancock        pts/5   Dec 27 17:55 (:32)
Camus           pts/6   Dec 31 16:22
tolstoy         pts/14  Jan 2 06:42

$ who | wc -l                Count users
6
```

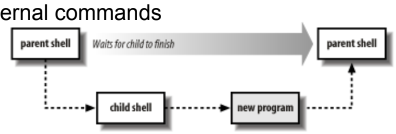
Self-Contained Scripts: The #! First Line

- When the shell runs a program, it asks the kernel to start a new process and run the given program in that process.
- It knows how to do this for compiled programs but for a script, the kernel will fail, returning a “not executable format file” error so it’ll start a new copy of /bin/sh (the standard shell) to run the program.
- But if there is more than one shell installed on the system, we need a way to tell the kernel which shell to use for a script

```
#! /bin/csh –f
#! /bin/awk –f
#! /bin/sh
```

Basic Shell Constructs

- Shell recognizes three fundamental kinds of commands
  - Built-in commands: Commands that the shell itself executes
  - Shell functions: Self-contained chunks of code, written in shell language
  - External commands



Variables

- Start with a letter or underscore and may contain any number of following letters, digits, or underscores
- Hold string variables

```
    $ myvar=this_is_a_long_string_that_does_not_mean_much       Assign a value
    $ echo $myvar                                               Print the value
    this_is_a_long_string_that_does_not_mean_much

first=isaac middle=bashevis last=singer           Multiple assignments allowed on one line
fullname="isaac bashevis singer"                  Use quotes for whitespace in value
oldname=$fullname                                 Quotes not needed to preserve spaces in value

fullname="$first $middle $last"                   Double quotes required here, for concatenating
```

Simple Output with echo

```
$ echo Now is the time for all good men
Now is the time for all good men
$ echo to come to the aid of their country.
to come to the aid of their country.
```

There is also fancier output with printf, which can refer to its man page for

Basic I/O Redirection

- Most programs read from stdin
- Write to stdout
- Send error messages to stderr

```
$ cat                                 With no arguments, read
                                      standard input, write
                                      standard output
now is the time                       Typed by the user
now is the time                       Echoed back by cat
for all good men
for all good men
to come to the aid of their country
to come to the aid of their country
^D                                    Ctrl-D, End of file
```

Redirection and Pipelines

- Use *program* < *file* to make *program*'s standard input be *file*:

```
tr -d '\r' < dos-file.txt
```

- Use *program* > *file* to make *program*'s standard output be *file*:

```
tr -d '\r' < dos-file.txt > unix-file.txt
```

- Use *program* >> *file* to send *program*'s standard output to the end of *file*.

```
for f in dos-file*.txt
do
      tr -d '\r' < $f >> big-unix-file.txt

done
```

- Use *program1* | *program2* to make the standard output of *program1* become the standard input of *program2*.

```
tr -d '\r' < dos-file.txt | sort > unix-file.txt
```

Basic Command Searching

- $PATH variable is a list of directories in which commands are found

```
$ echo $PATH /bin:/usr/bin:/usr/X11R6/bin:/usr/
  local/bin
```

Accessing Shell Script Arguments

- Positional parameters represent a shell script's command-line arguments
- For historical reasons, enclose the number in braces if it's greater than 9. Not required on modern systems, but helps backwards compatibility.

```
echo first arg is $1
echo tenth arg is ${10}
```

Accessing Shell Script Arguments

Example:

```
$ who | grep betsy                          Where is betsy?
betsy pts/3 Dec 27 11:07 (flags-r-us.example.com)
```

Script:

```
#! /bin/sh
# finduser --- see if user named by first argument is logged in
who | grep $1
```

Run it:

```
$ chmod +x finduser                 Make it executable
$ ./finduser betsy                  Test it: find betsy
betsy pts/3 Dec 27 11:07 (flags-r-us.example.com)
$ ./finduser benjamin               Now look for Ben
 benjamin dtlocal Dec 27 17:55 (kites.example.com)
```

Simple Execution Tracing

- To get shell to print out each command as it's execute, precede it with "+"
- You can turn execution tracing within a script by using:

  `set -x`: to turn it on

  `set +x`: to turn it off

Searching for Text

- grep: Uses basic regular expressions (BRE)
- egrep: Extended grep that uses extended regular expressions (ERE)
- Fgrep: Fast grep that matches fixed strings instead of regular expressions.

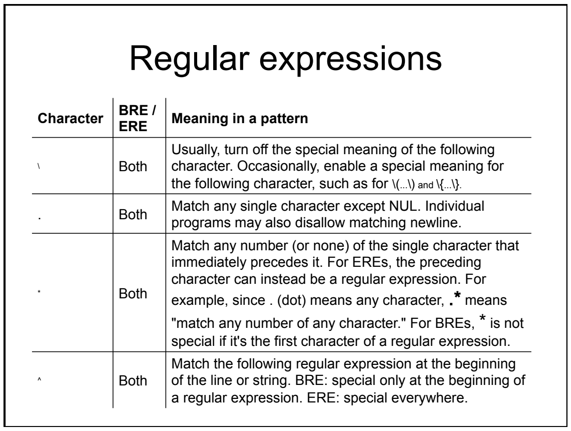
Simple grep

```
$ who                                        Who is logged on
tolstoy tty1 Feb 26 10:53
tolstoy pts/0 Feb 29 10:59
tolstoy pts/1 Feb 29 10:59
tolstoy pts/2 Feb 29 11:00
tolstoy pts/3 Feb 29 11:00
tolstoy pts/4 Feb 29 11:00
austen pts/5 Feb 29 15:39 (mansfield-park.example.com)
austen pts/6 Feb 29 15:39 (mansfield-park.example.com)

$ who | grep -F austen               Where is austen logged on?
austen pts/5 Feb 29 15:39 (mansfield-park.example.com)
austen pts/6 Feb 29 15:39 (mansfield-park.example.com)
```

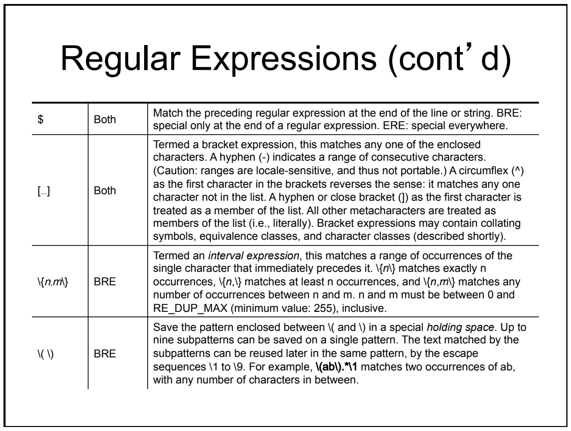
Regular Expressions

- Notation that lets you search for text that fits a particular criterion, such as "starts with the letter a"



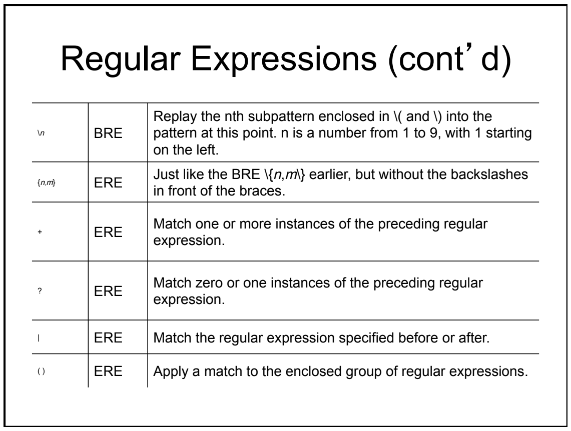
Regular expressions

Character	BRE / ERE	Meaning in a pattern
\	Both	Usually, turn off the special meaning of the following character. Occasionally, enable a special meaning for the following character, such as for \(...\) and \{...\}.
.	Both	Match any single character except NUL. Individual programs may also disallow matching newline.
*	Both	Match any number (or none) of the single character that immediately precedes it. For EREs, the preceding character can instead be a regular expression. For example, since . (dot) means any character, **.*** means "match any number of any character." For BREs, * is not special if it's the first character of a regular expression.
^	Both	Match the following regular expression at the beginning of the line or string. BRE: special only at the beginning of a regular expression. ERE: special everywhere.



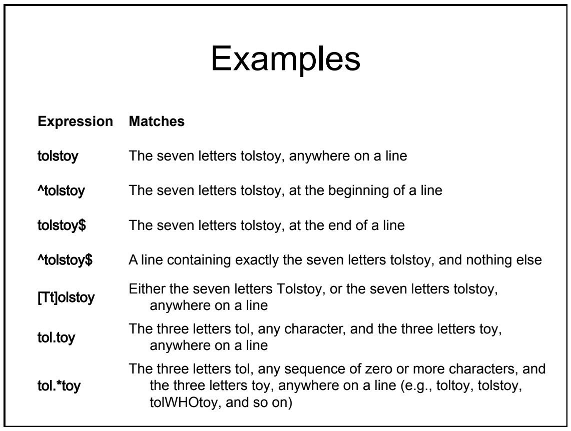
Regular Expressions (cont' d)

$	Both	Match the preceding regular expression at the end of the line or string. BRE: special only at the end of a regular expression. ERE: special everywhere.
[...]	Both	Termed a bracket expression, this matches any one of the enclosed characters. A hyphen (-) indicates a range of consecutive characters. (Caution: ranges are locale-sensitive, and thus not portable.) A circumflex (^) as the first character in the brackets reverses the sense: it matches any one character not in the list. A hyphen or close bracket (]) as the first character is treated as a member of the list. All other metacharacters are treated as members of the list (i.e., literally). Bracket expressions may contain collating symbols, equivalence classes, and character classes (described shortly).
\{*n*,*m*\}	BRE	Termed an *interval expression*, this matches a range of occurrences of the single character that immediately precedes it. \{*n*\} matches exactly n occurrences, \{*n*,\} matches at least n occurrences, and \{*n*,*m*\} matches any number of occurrences between n and m. n and m must be between 0 and RE_DUP_MAX (minimum value: 255), inclusive.
\(\)	BRE	Save the pattern enclosed between \(and \) in a special *holding space*. Up to nine subpatterns can be saved on a single pattern. The text matched by the subpatterns can be reused later in the same pattern, by the escape sequences \1 to \9. For example, **\(ab\).*\1** matches two occurrences of ab, with any number of characters in between.



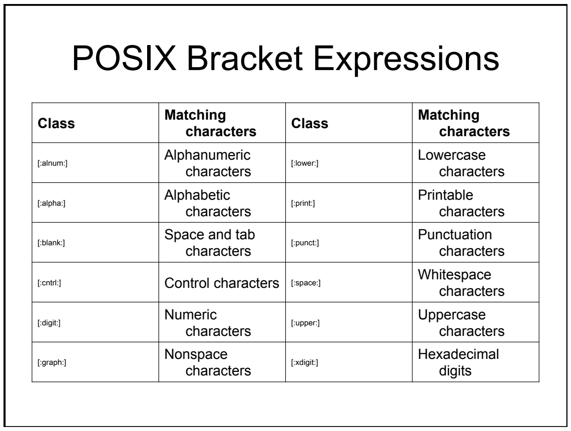
Regular Expressions (cont' d)

\n	BRE	Replay the nth subpattern enclosed in \(and \) into the pattern at this point. n is a number from 1 to 9, with 1 starting on the left.
{*n*,*m*}	ERE	Just like the BRE \{*n*,*m*\} earlier, but without the backslashes in front of the braces.
+	ERE	Match one or more instances of the preceding regular expression.
?	ERE	Match zero or one instances of the preceding regular expression.
|	ERE	Match the regular expression specified before or after.
( )	ERE	Apply a match to the enclosed group of regular expressions.



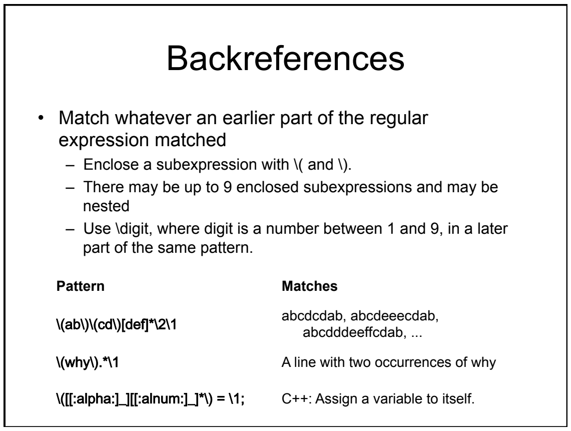
Examples

Expression	Matches
tolstoy	The seven letters tolstoy, anywhere on a line
^tolstoy	The seven letters tolstoy, at the beginning of a line
tolstoy$	The seven letters tolstoy, at the end of a line
^tolstoy$	A line containing exactly the seven letters tolstoy, and nothing else
[Tt]olstoy	Either the seven letters Tolstoy, or the seven letters tolstoy, anywhere on a line
tol.toy	The three letters tol, any character, and the three letters toy, anywhere on a line
tol.*toy	The three letters tol, any sequence of zero or more characters, and the three letters toy, anywhere on a line (e.g., toltoy, tolstoy, tolWHOtoy, and so on)



POSIX Bracket Expressions

Class	Matching characters	Class	Matching characters
[:alnum:]	Alphanumeric characters	[:lower:]	Lowercase characters
[:alpha:]	Alphabetic characters	[:print:]	Printable characters
[:blank:]	Space and tab characters	[:punct:]	Punctuation characters
[:cntrl:]	Control characters	[:space:]	Whitespace characters
[:digit:]	Numeric characters	[:upper:]	Uppercase characters
[:graph:]	Nonspace characters	[:xdigit:]	Hexadecimal digits



Backreferences

- Match whatever an earlier part of the regular expression matched
  - Enclose a subexpression with \(and \).
  - There may be up to 9 enclosed subexpressions and may be nested
  - Use \digit, where digit is a number between 1 and 9, in a later part of the same pattern.

Pattern	Matches
\(ab\)\(cd\)[def]*\2\1	abcdcdab, abcdeeecdab, abcdddeeffcdab, ...
\(why\).*\1	A line with two occurrences of why
\([[:alpha:]_][[:alnum:]_]*\) = \1;	C++: Assign a variable to itself.

Matching Multiple Characters with One Expression

*	Match zero or more of the preceding character
\{*n*\}	Exactly n occurrences of the preceding regular expression
\{*n*,\}	At least n occurrences of the preceding regular expression
\{*n*,*m*\}	Between n and m occurrences of the preceding regular expression

Anchoring text matches

Pattern	**Text matched (in bold) / Reason match fails**
ABC	Characters 4, 5, and 6, in the middle: abc**ABC**defDEF
^ABC	Match is restricted to beginning of string
def	Characters 7, 8, and 9, in the middle: abcABC**def**DEF
def$	Match is restricted to end of string
[[:upper:]]\{3\}	Characters 4, 5, and 6, in the middle: abc**ABC**defDEF
[[:upper:]]\{3\}$	Characters 10, 11, and 12, at the end: abcDEFdef**DEF**
^[[:alpha:]]\{3\}	Characters 1, 2, and 3, at the beginning: **abc**ABCdefDEF

Operator Precedence (High to Low)

Operator	**Meaning**
[. .] [= =] [: :]	Bracket symbols for character collation
\metacharacter	Escaped metacharacters
[ ]	Bracket expressions
\(\) \\digit	Subexpressions and backreferences
* \{ \}	Repetition of the preceding single-character regular expression
no symbol	Concatenation
^ $	Anchors

sed

- Now you can extract, but what if you want to replace parts of text?
- Use sed!

```
sed ‘s/regExpr/replText/’
```

- Example

```
sed 's/:.*//' /etc/passwd     Remove everything
                              after the first colon
```

Text Processing Tools

- sort: sorts text
- wc: outputs a one-line report of lines, words, and bytes
- lpr: sends files to print queue
- head: extract top of files
- tail: extracts bottom of files

More on Variables

- Read only command

```
hours_per_day=24 seconds_per_hour=3600 days_per_week=7      Assign values
readonly hours_per_day seconds_per_hour days_per_week       Make read-only
```

- Export: puts variables into the environment, which is a list of name-value pairs that is available to every running program

```
PATH=$PATH:/usr/local/bin                Update PATH
export PATH                              Export it
```

- env: used to remove variables from a program’s environment or temporarily change environment variable values
- unset: remove variable and functions from the current shell

Parameter Expansion

- Process by which the shell provides the value of a variable for use in the program

```
reminder="Time to go to the dentist!"        Save value in
                                             reminder
sleep 120                                    Wait two minutes
echo $reminder                               Print message
```

Pattern–matching operators

path=/home/tolstoy/mem/long.file.name

Operator	**Substitution**
${*variable*#*pattern*}	If the pattern matches the beginning of the variable's value, delete the shortest part that matches and return the rest.
Example: ${path#/*/}	Result: tolstoy/mem/long.file.name
${*variable*##*pattern*}	If the pattern matches the beginning of the variable's value, delete the longest part that matches and return the rest.
Example: ${path##/*/}	Result: long.file.name
${*variable*%*pattern*}	If the pattern matches the end of the variable's value, delete the shortest part that matches and return the rest.
Example: ${path%.*}	Result: /home/tolstoy/mem/long.file
${*variable*%%*pattern*}	If the pattern matches the end of the variable's value, delete the longest part that matches and return the rest.
Example: ${path%%.*}	Result: /home/tolstoy/mem/long

String Manipulation

- ${string:position}: Extracts substring from $string at $position
- ${string:position:length} Extracts $length characters of substring $string at $position
- ${#string}: Returns the length of $string

POSIX Built-in Shell Variables

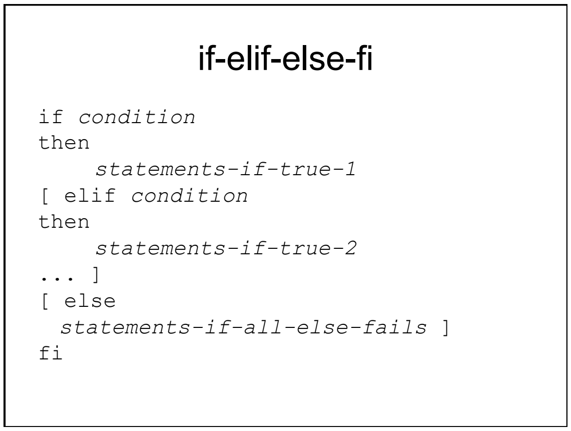
Variable	**Meaning**
#	Number of arguments given to current process.
@	Command-line arguments to current process. Inside double quotes, expands to individual arguments.
*	Command-line arguments to current process. Inside double quotes, expands to a single argument.
- (hyphen)	Options given to shell on invocation.
?	Exit status of previous command.
$	Process ID of shell process.
0 (zero)	The name of the shell program.
!	Process ID of last background command. Use this to save process ID numbers for later use with the *wait* command.
ENV	Used only by interactive shells upon invocation; the value of $ENV is parameter-expanded. The result should be a full pathname for a file to be read and executed at startup. This is an XSI requirement.
HOME	Home (login) directory.
IFS	Internal field separator; i.e., the list of characters that act as word separators. Normally set to space, tab, and newline.
LANG	Default name of current locale; overridden by the other LC_* variables.
LC_ALL	Name of current locale; overrides LANG and the other LC_* variables.
LC_COLLATE	Name of current locale for character collation (sorting) purposes.
LC_CTYPE	Name of current locale for character class determination during pattern matching.
LC_MESSAGES	Name of current language for output messages.
LINENO	Line number in script or function of the line that just ran.
NLSPATH	The location of message catalogs for messages in the language given by $LC_MESSAGES (XSI).
PATH	Search path for commands.
PPID	Process ID of parent process.
PS1	Primary command prompt string. Default is "$ ".
PS2	Prompt string for line continuations. Default is "> ".
PS4	Prompt string for execution tracing with set -x. Default is "+ ".
PWD	Current working directory.

Arithmetic Operators

Operator	**Meaning**	**Associativity**
++ --	Increment and decrement, prefix and postfix	Left to right
+ - ! ~	Unary plus and minus; logical and bitwise negation	Right to left
* / %	Multiplication, division, and remainder	Left to right
+ -	Addition and subtraction	Left to right
<< >>	Bit-shift left and right	Left to right
< <= > >=	Comparisons	Left to right
= = !=	Equal and not equal	Left to right
&	Bitwise AND	Left to right
^	Bitwise Exclusive OR	Left to right
|	Bitwise OR	Left to right
&&	Logical AND (short-circuit)	Left to right
||	Logical OR (short-circuit)	Left to right
?:	Conditional expression	Right to left
= += -= *= /= %= &= ^= <<= >>= |=	Assign ment opera tor s	Right to left

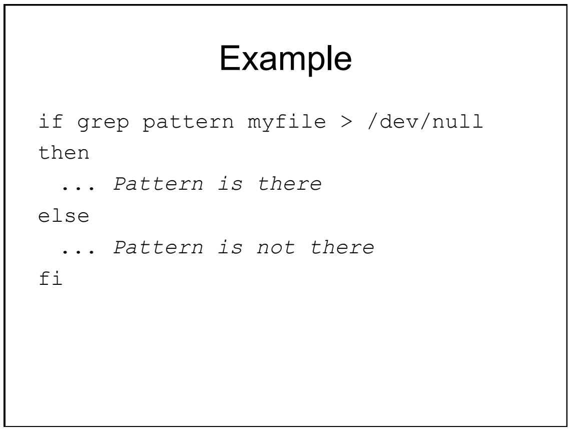
Exit: Return value

Value	**Meaning**
0	Command exited successfully.
> 0	Failure during redirection or word expansion (tilde, variable, command, and arithmetic expansions, as well as word splitting).
1-125	Command exited unsuccessfully. The meanings of particular exit values are defined by each individual command.
126	Command found, but file was not executable.
127	Command not found.
> 128	Command died due to receiving a signal.



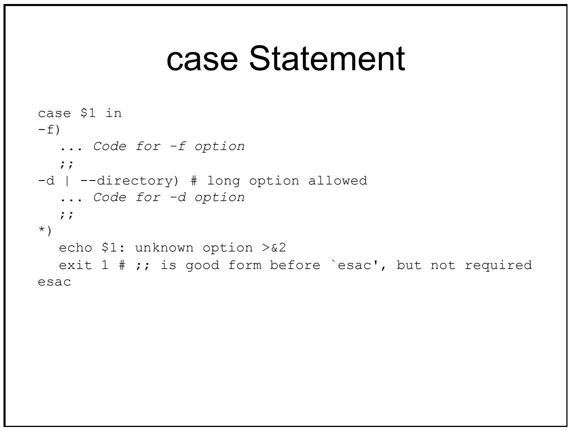
if-elif-else-fi

```
if condition
then
    statements-if-true-1
[ elif condition
then
    statements-if-true-2
... ]
[ else
  statements-if-all-else-fails ]
fi
```



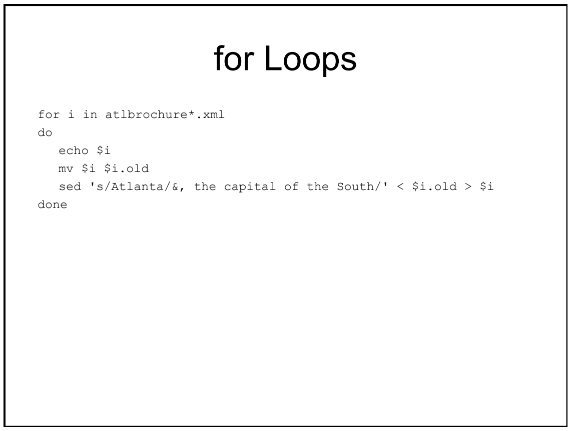
Example

```
if grep pattern myfile > /dev/null
then
  ... Pattern is there
else
  ... Pattern is not there
fi
```



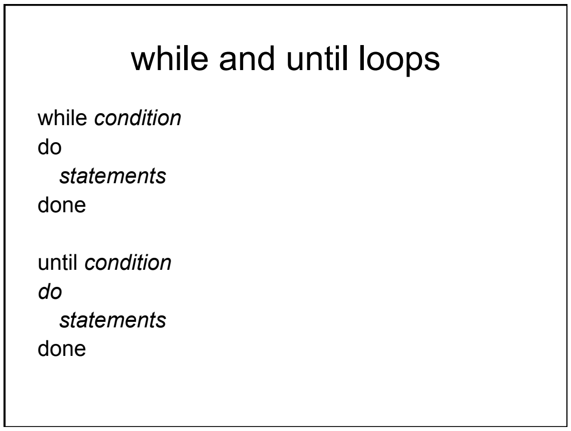
case Statement

```
case $1 in
-f)
   ... Code for -f option
   ;;
-d | --directory) # long option allowed
   ... Code for -d option
   ;;
*)
   echo $1: unknown option >&2
   exit 1 # ;; is good form before `esac', but not required
esac
```



for Loops

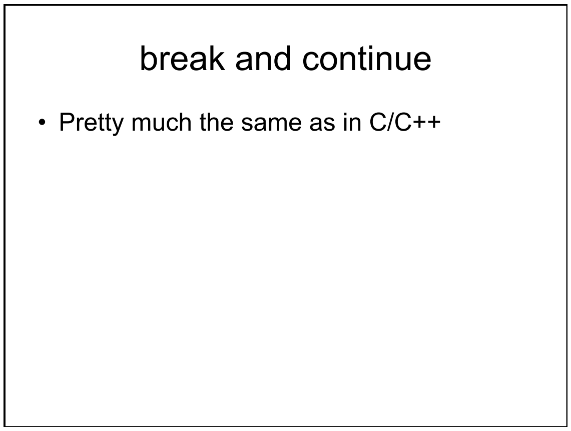
```
for i in atlbrochure*.xml
do
   echo $i
   mv $i $i.old
   sed 's/Atlanta/&, the capital of the South/' < $i.old > $i
done
```



while and until loops

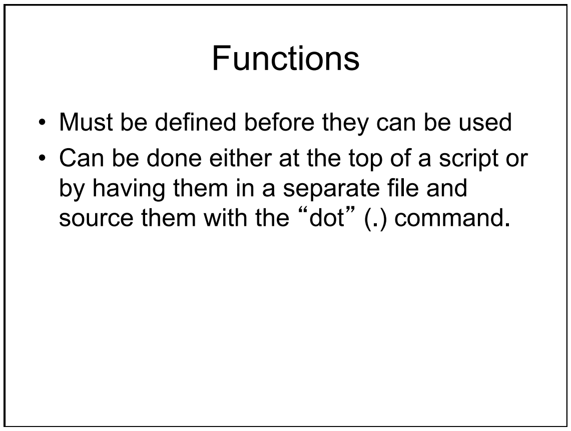
while *condition*
do
  statements
done

until *condition*
do
  statements
done



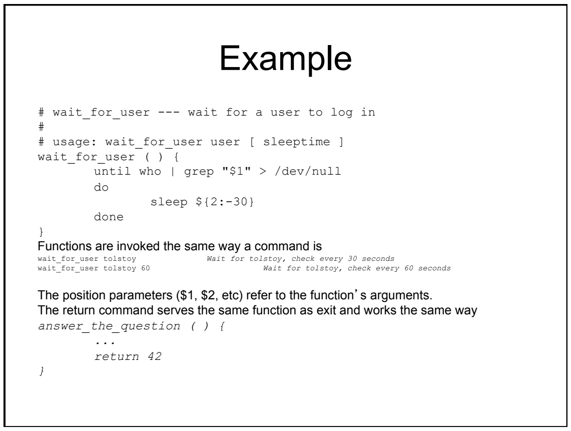
break and continue

- Pretty much the same as in C/C++



Functions

- Must be defined before they can be used
- Can be done either at the top of a script or by having them in a separate file and source them with the “dot” (.) command.



Example

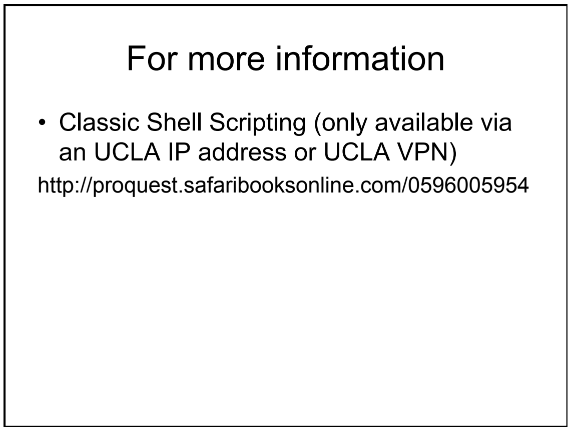
```
# wait_for_user --- wait for a user to log in
#
# usage: wait_for_user user [ sleeptime ]
wait_for_user ( ) {
        until who | grep "$1" > /dev/null
        do
                sleep ${2:-30}
        done
}
```

Functions are invoked the same way a command is

```
wait_for_user tolstoy              Wait for tolstoy, check every 30 seconds
wait_for_user tolstoy 60                      Wait for tolstoy, check every 60 seconds
```

The position parameters ($1, $2, etc) refer to the function’s arguments.
The return command serves the same function as exit and works the same way

```
answer_the_question ( ) {
        ...
        return 42
}
```



For more information

- Classic Shell Scripting (only available via an UCLA IP address or UCLA VPN)

http://proquest.safaribooksonline.com/0596005954