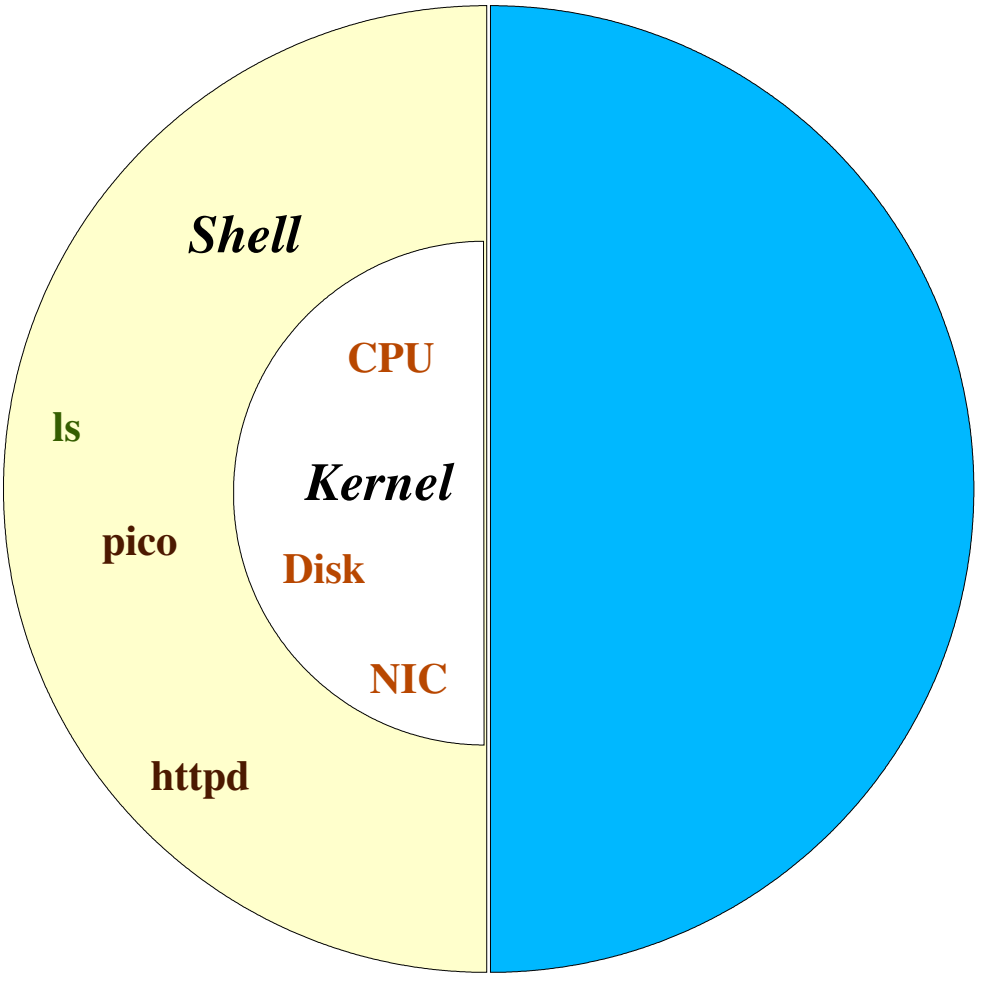
Basic UNIX

Processes and Shells



Basic UNIX

Processes and Shells

Processes

Processes are tasks run by you or the OS.

Processes can be:

- shells
- commands
- programs
- daemons
- scripts

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Processes and Shells

Shells

Processes operate in the context of a *shell*.

The shell is a command interpreter which:

- Interprets built-in characters, variables and commands
- Passes the results on to the kernel

The *kernel* is the lowest level of software running. It controls access to all hardware in the computer.

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Processes and Shells

Shells

Types of shells:

- /bin/sh – Bourne shell
- /bin/csh – C shell
- /bin/tcsh - Enhanced C shell
- /bin/bash – Bourne “again” shell
- /bin/zsh – Z shell
- /bin/ksh – Korn shell

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Processes and Shells

Shell Scripts

Shell scripts are files which contain commands to be interpreted and executed by a shell.

A shell is its own programming environment. Shells contain:

- Variables
- Loops
- Conditional statements
- Input and Output
- Built-in commands
- Ability to write functions

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Shell Scripts

Specifying the shell to be used:

On the first line of the file:

- Implicitly

  - blank line – Bourne shell
  - # in column 1 – C shell

- Explicitly

  - #!/bin/sh – Bourne shell
  - #!/bin/csh – C shell

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Processes and Shells

Exercise

Which shell are you using?

echo $SHELL

(Don't worry about what these mean, we'll come back to them later)

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An Interlude

How to be “Cool”

All UNIX people pronounce EVERYTHING. If you don't you aren't cool.

Examples:

- **!** - bang
- # - pound
- awk – awk as in “awkward”
- grep – grrrrrrr ep
- chmod – chaaa mod
- chown – chaa own
- www – wu wu wu

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Processes and Shells

echo

Using **echo** is very useful for debugging scripts. The e**cho** command prints the value of an expression (to the screen by default)

```
<lister> echo Hello World!
Hello World!
```

The **-n** option suppresses newlines

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Processes and Shells

Exercise

Run the following script:

cd /opt/exercises/Shells

./progress.sh

```
#!/bin/sh
i=1
while [ $i < 12 ]
do
   echo -n '.'
   sleep 1
   i=`expr $i + 1`
done
```

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Processes and Shells

echo

Echoing in a script prints each shell script line to the screen before it is executed. Use the command

set -x

to turn this on

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Processes and Shells

Exercise

Run this script:

./echotoggle.sh

```
#!/bin/sh
set -x
echo
echo Here is a listing of the files
echo
ls -l
```

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Processes and Shells

Shell Variables

Variables hold strings that can be used later

Two Types of Variables:

- Local (local scope)
- Environment (global scope)

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Processes and Shells

Shell Variable Assignment

- Local Variables

  variable=<value>

- Environment

  variable=<value>
  export *variable*

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Processes and Shells

Accessing Variables

All variables are *dereferenced* by placing a **$** in front of the variable name

```
<lister> echo $PATH
```

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Processes and Shells

Exercise

Run this script:

./variables1.sh

```
#!/bin/sh
GREETING=Hello
export GREETING
there=there
friends='Kevin Lisa Joanne'
echo $GREETING $there $friends
```

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Processes and Shells

Blanks and Quotes

Blanks and other *white space* are ignored by the shell. If you want them included, you must use quotes.

Two types of quotes:

- ' '
- “ “

Each has a different behaviour when using variables.

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Processes and Shells

Quotes and Substitution

When a shell *interprets* each line, it performs variable substitution before executing commands.

If a variable is within double quotes, “ “, it will be substituted.

If a variable is within single quotes, it will not be substituted. It will take on its literal value

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Processes and Shells

Exercise

Run this script:

./variables2.sh

```
#!/bin/sh
GREETING=Hello
there=there
friend1=Kevin
friend2=Lisa
friend3=Joanne
friends="$friend1 $friend2 $friend3"
echo $GREETING $there $friends
echo $GREETING '$friends'
```

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Processes and Shells

Listing Defined Variables For Your Current Shell

To list all variables, use the **set** command with no argument

For environement variables, use **export** with no variables

Exercise

Get listings of the current shell variables

set
export

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Processes and Shells

Some Common Shell Variables

- **PATH** – directory paths to search for commands
- **HOSTNAME** – the name of the computer
- **USER** – the user id of the user running this shell
- **SHELL** – the shell currently being used
- **TERM** – the type of terminal being used
- **PS1** – the prompt to print when then shell is ready for another command

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Processes and Shells

Deassigning Variables

For all variables, use the **unset** command

unset *variable*

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Processes and Shells

Command Line Arguments

Powerful feature – passing values to your shell script.

- **$1..$9 –** first nine arguments
- **$0 –** name of the file/command
- **$*** - everything on the command line
- **$#** returns the number of arguments on the command line

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Processes and Shells

Exercise

Run the following script:

./clargs.sh Hello World
./clargs.sh Hello

```
#!/bin/sh
echo $#
echo $0
echo $1
```

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Processes and Shells

The *$$* Variable

The *$?* variable returns the exit value of the most recently called command.

This is useful to detect successful completion of a program before continuing to a program which relies on the output of that command.

0 – usually a sign of success

non-zero – error of some sort

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Processes and Shells

Special Characters

Filename Wildcards (Globbing)

Wildcard characters allow you to *match* multiple file names

Two wildcard characters:

? - matches a single character

***** - matches one or more characters

Historical note: The jargon usage derives from **glob**, the name of a subprogram that expanded wildcards in archaic pre-Bourne versions of the Unix shell.

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Processes and Shells

Special Characters

Filename Wildcards (Globbing)

Example:

Four files named biffo, boffo, baffa and baffo

b?ffo matches biffo, boffo and baffo but not baffa

ff matches all four

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Processes and Shells

Special Characters

The \ and # Characters

\ performs two roles:

- It “escapes” characters from substitution
- It signals the continuation of a shell script line to the next line

before any characters imply that all following characters on the line make up a comment

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Processes and Shells

I/O Streams and Redirection

Very powerful feature of the shell. Not found in other operating systems.

Think of input and output as *streams* of data.

Three "standard" streams for a program:

- **Stdin** – input stream
- **Stdout** – output stream
- **Stderr** – stream for error output (on a terminal – same as stdout)

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Processes and Shells

I/O Streams and Redirection

You control the course of the data streams:

- **<** *file* – direct stdin from *file*
- **>** *file* – direct stdout to *file*
- **>>** file – append stdout to *file*
- *Command1* **|** *command2* – connects stdout of *command1* to stdin of *command2* via a **pipe**

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Processes and Shells

I/O Streams
File Descriptors

Open files are associated with numeric *file descriptors*

- **0** - stdin
- **1** – stdout
- **2** - stderr

You can direct output to multiple file descriptors simultaneously.
The most common is

1>&2 *file* – direct stdout AND stderr to *file*

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Processes and Shells

Exercise

Run the following script:

./redir.sh

```
#!/bin/sh
cd
ls -a > /tmp/ls
echo < /tmp/ls
cat /tmp/ls | grep csh
```

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Processes and Shells

Command Substitution

Any command contained within a pair of *backticks* `` is executed immediately. The output of the command replaces everything in the backticks.

This can be used to assign the output of a command to an array to be used later

```
#!/bin/sh
files=`ls`
echo $files
```

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Processes and Shells

Exercise

Run the following script:

./bt.sh

```
#!/bin/sh
files=`ls`
echo $files
```

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Processes and Shells

Expressions

Expressions are used in *statements* to control the flow of the shell

Expressions are made up of constants, variables and operators

Expressions always evaluate to strings. Numeric calculations can be performed but are translated back to strings

Commands can be executed and variable substitutions can take place before an expression is evaluated.

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Processes and Shells

Expressions

Most common expressions take on the form:

token **operator** *token*

where *token* is usually a variable or a constant.

Types of operators:

- Numeric
- Logical

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Processes and Shells

Numeric Expressions

Numeric expressions are evaluated using the **expr** command:

Numeric operators include +,-,*,/,% amongst others

Example:

```
#!/bin/sh
i=1
echo $i
i=`expr $i + 2`
echo $i
$i=`expr $i \* 3`
echo $i
```

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Processes and Shells

Exercise

Run this script:

./math.sh

```
#!/bin/sh
i=1
echo $i
i=`expr $i + 2`
echo $i
$i=`expr $i \* 3`
echo $i
```

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Processes and Shells

Logical Expressions

Logical expressions are almost always used with conditional statements.

Logical operators include

- |, &
- =, !=
- <=, >=, <, >

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Processes and Shells

Logical Operators

- | - Booean OR
- & - Boolean AND
- = - equivalent
- != - not equivalent
- <=, >=, <, > - lexical or numeric comparisons

Examples:

- expr $i <= 10
- expr “$1” = “dostats”

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Processes and Shells

Logical Expressions
test

Logical expressions are very often built using the **test** command.

Test allows the shell to test for various conditions

- **test -d** *file* – true if *file* is a directory
- **test -e** *file* – true if file exists
- **test** *$foo* **-eq** *$bar* – true if the *numbers $foo* and *$bar* are equal

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Processes and Shells

Logical Expressions
test

In fact, **test** is so useful, a shortcut has been created for it

[-e *file* **]**

is the same as

test -e *file*

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Processes and Shells

Control Statements

Logical expressions can be used with four *control* statements to direct the flow of execution:

- **if..then..elif..then..else..fi**
- **while..do..done**
- **for..in..do..done**
- **case..in..;;..esac**

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Processes and Shells

Control Statements

if statement

if *logical expression*
then
.
.
elif *logical expression*
then
.
.
else
.
.
fi

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Processes and Shells

Control Statements
statement order

Note that the pieces of the **if** statement needed to be on separate lines. They are each treated as commands.

You can place them on the same line by separating them with a semicolon. This holds for all flow control

if *logical expression* ; **then**

.

elif *logical expression* ; **then**

.

fi

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Processes and Shells

Exercise

Run the following script:

./if.sh

Enter a CTRL-C and then CTRL-D

Then run it again with just CTRL-D

```
#!/bin/sh
/bin/sh
st=$?
if [ $st -eq 0 ]
then
   echo "Success!"
elif [ $st -eq 1 ]
then
   echo "I'm a failure!"
fi
```

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Processes and Shells

Control Statements

case statment

case *string* **in**
pattern1)
.
.
;;
pattern2)
.
.
;;
*)
.
.
;;
esac

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Processes and Shells

Exercise

Run this script:

./case.sh -d

```
#!/bin/sh
case $1 in
   '-d')
     echo debugging
     set debug
      ;;
   '-c')
     echo compiling
     set compile
     ;;
   *)
     file=$2
     echo $2
esac
```

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Processes and Shells

Control Statements

foreach statment

for *variable* **in** *wordlist*
do
.
.
done

This statement ***loops*** over all of the values in *wordlist* and assigns them to *variable* one at a time until all values have been exhausted.

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Processes and Shells

Exercise

Run this script:

./for.sh

```
#!/bin/sh
files=`ls -a`
for file in $files
do
   echo $file
done
```

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Processes and Shells

Control Statements

while statment

while *logical expression*
do
.
.
end

This statement ***loops*** **until** the logical expression is false, that is, it continues to loop **while** the logical expression is true.

Make sure that logical expression can evaluate to false at some point or you will have an *infinite loop*.

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Processes and Shells

Exercise

Run this script:

./while.sh

```
#!/bin/sh
n=1
echo 'Look. I can count!'
while [ $n <= 10 ]
do
   echo -n " $n"
   sleep 1
   n=`expr $n + 1`
done
echo " "
exit
```

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Processes and Shells

Executing Shell Scripts

There are two ways to execute a shell script:

- *Source* the script – as if you typed in the commands yourself into the current shell
- Make the file executable – a new shell is *spawned* and the new processs is a *child* of the current (*parent*) shell

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Processes and Shells

Executing Shell Scripts
Source

. *file* (Note – that is a "dot" and a space)

Each command in the script is interpreted by the current shell.

All variables created are incorporated into the current shell.

All variables modified affect the current shell

Very useful for *start-up* scripts

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Processes and Shells

Executing Shell Scripts

Execute

chmod 755 *file*
./file

A new process is started with a new shell.

Variables created by this *child* will never be available to the *parent*.

Variables from the parent, however, are *inherited* by the child.

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Processes and Shells

Processes Encore

Processes can be run in the *background* or the *foreground* of a shell.

Background processes are *batch* processes that must not require terminal input.

Foreground processes run interactively and will block any other input to your current shell until they finish

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Processes and Shells

Processes Encore

By default, commands or scripts started from the terminal start in the foreground

To background a process, place an ampersand (&) after the command when you run it.

Exercise

Start a clock in the background

xclock &

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Processes and Shells

Processes Encore

In the **bash** shell, the **jobs** command will show you the list of background processes associated with the current shell

To bring a background process to the foreground, use the **fg** command with the *jobid* number given by the jobs command:

<lister> fg %1

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Processes and Shells

Exercise

Bring your clock process back to the foreground and kill it

jobs
fg %1 (*or whatever job number it is)*

Enter a CTRL-C

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Processes and Shells

Start-up Scripts

Start-up scripts are useful scripts you can place in all user's home directories to create a common environment.

Typically, a start-up script will call other scripts to create variables:

Excerpt from */etc/profile*

```
for i in /etc/profile.d/*.sh; do
     if [ -r $i ]; then
         . $i
     fi
done
unset i
```

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Processes and Shells

The **ps** Command

The **ps** command shows processes currently running on your computer. Which processes are shown depends on the options used with the command:

- No options – show only processes associated with the current shell
- -A – show all processes
- -l – long listing
- -aux – the options I use the most