

An Introduction to Shell Scripting

Paul Brown

SBIDER & Bioinformatics Research Technology Platform

p.e.brown@warwick.ac.uk

What is the shell?

- A command line user interface for Unix-like operating systems.
- Interactive and scripting modes

What is the Bash Shell?

- Bourne Again SHell, replacing the older Bourne shell in 1989
- Default shell on most Linux systems and MacOS
- Now available on Windows

<https://www.howtogeek.com/249966/how-to-install-and-use-the-linux-bash-shell-on-windows-10/>

Features

- User customisable
- Wildcard matching
- Re-direction
- Command substitution
- Control structures

When to use the shell

- As a wrapper for a workflow
- When launching other processes
- When doing lots of filesystem access
- When low level access to hardware is required

When not to use the shell

Shell scripting is of much less use when any of the following are required

- Complex calculations
- A graphical user interface
- Any kind of debugging beyond very basic

Starting up

- Often opened via the graphical desktop
- Startup files are read to provide user customisations, eg `.bash_profile`, `.bashrc`

Some useful commands

```
paulbrosmacbook:var paulbrown$ cd $HOME
```

```
paulbrosmacbook:~ paulbrown$ pwd
```

```
/Users/paulbrown
```

```
paulbrosmacbook:~ paulbrown$ ls -l
```

```
total 104240
```

```
drwxr-xr-x    2 paulbrown  staff   64 19 Jun  2017 Anaconda
```

```
drwxr-xr-x   29 paulbrown  staff  928 30 Nov  2017 Android
```

```
drwx-----+ 93 paulbrown  staff 2976  1 Nov 12:34 Documents
```

```
-rw-r--r--    1 paulbrown  staff    8 22 Feb  2018 README.md
```

```
-rw-r--r--    1 paulbrown  staff    0 14 Jul  2015 mcmc.csv
```

```
lrwxr-xr-x    1 paulbrown  staff   25 20 Sep  2016 meme -> /
```

```
Users/paulbrown/meme4.11
```

```
paulbrosmacbook:~ paulbrown$ chmod 755 Documents
```

```
paulbrosmacbook:~ paulbrown$ cp -r Android Android.backup
```

```
paulbrosmacbook:~ paulbrown$ rm -r Android
```


Environment Variables

```
Nero:~paulbrown$ echo $PATH
/bin:/usr/bin:/usr/sbin:/sbin:/usr/local/bin:~/bin
Nero:~paulbrown$ meme
-bash: meme: command not found
Nero:~paulbrown$ export PATH=$PATH:/usr/local/meme/bin
Nero:~paulbrown$ echo $PATH
/bin:/usr/bin:/usr/sbin:/sbin:/usr/local/bin:~/bin:/usr/local/meme/bin
Nero:~paulbrown$ meme
USAGE:
    meme <dataset> [optional arguments]
```

More variables

- There are no variable types
- VARNAME is a reference
- \$VARNAME is the value held there

```
Nero:~paulbrown$ echo PATH  
PATH
```

- Use \${...} to access substrings

```
paul-browns-macbook:~ paulbrown$ STR="Hello world"  
paul-browns-macbook:~ paulbrown$ echo ${STR:6}  
world  
paul-browns-macbook:~ paulbrown$ echo ${STR/w/W}  
Hello World
```

Using quotation marks

- Important to know the difference between single and double quotes
- Expressions are evaluated inside "...", but not inside `...`

```
paul-browns-macbook:~ paulbrown$ NAME="Paul"  
paul-browns-macbook:~ paulbrown$ echo "Hello $NAME"  
Hello Paul  
paul-browns-macbook:~ paulbrown$ echo 'Hello $NAME'  
Hello $NAME
```

Arrays

- Declaring an array

```
fruits=('Apple' 'Banana' 'Orange')
```

- Accessing elements

```
echo ${fruits[0]}
```

Reading files

cat, head, tail, more

```
nero:~ paulbrown$ grep "paulbrown" /var/log/secure
```

...

...

```
Nov  4 23:10:33 nero sshd[44146]:
```

```
pam_unix(sshd:session): session opened for user
```

```
paulbrown by (uid=0)
```

Writing files

- A number of interactive text editors, eg vi, nano
- Also use re-direction `>`, `>>`
- `echo "some content" >> script.sh`

Redirection

- Input to and output from command can be re-directed away from stdin and stdout
- Re-direct output to file

```
ls -l > dircontent.txt
```

Re-direct input from file

```
sort -k5 -n < dircontent.txt
```

Redirection

Pipes are used to chain commands together so the output of one becomes the input of the next

```
tail -n 1000 logfile.log | sort | more
```

```
ls -l | sort -k5 -n
```


Command substitution

- This allows the output of a command to be captured and used piped back to be used as an argument for something else, or to be captured in a variable
- Preferred way is to use `$(...)`

```
rm -f $(find . -name "*.txt")
```

Arithmetic expansion

Use command substitution

```
paul-browns-macbook:~ paulbrown$ echo 2+3  
2+3
```

```
paul-browns-macbook:~ paulbrown$ echo $((2+3))  
5
```

```
paul-browns-macbook:~ paulbrown$ echo $(2+3)  
-bash: 2+3: command not found
```

```
paul-browns-macbook:~ paulbrown$ a=$((2+3))  
paul-browns-macbook:~ paulbrown$ echo $a  
5
```

Bash handles only integer types. Use bc to perform calculations with floating point types

```
paul-browns-macbook:~ paulbrown$ echo 'scale=3;4/3' | bc  
1.333
```

Remote Shells

- rsh (remote shell). Do not use, insecure
- ssh (secure shell, port 22)

```
paul-browns-macbook:~ paulbrown$ ssh nero.wsbc.warwick.ac.uk
paulbrown@nero.wsbc.warwick.ac.uk's password:
Last login: Mon Nov  4 23:10:34 2019 from 95.149.133.253
-sh-4.1$ hostname
nero.wsbc.warwick.ac.uk
```

- Also sftp and scp

```
scp /local/stuff paulbrown@nero.wsbc.warwick.ac.uk:/home/paulbrown
```

Shell scripting

- Conventionally, files have .sh extension
- Remember to set execute permission
- Script begins with

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

Input arguments

- Referred to as \$1, \$2 etc..
- \$# is the number of inputs
- Same applies to functions
- Use read to request user input

Conditionals

- Surround an expression with `[[...]]`
- String operators : `-z, -n, ==, !=, <, >, =~`
- Numerical operators: `-eq, -ne, -lt, -le, -gt, -ge`
- File operators: `-e, -f, -d, -r, -w, -x`

Conditionals

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

```
if [[ $# -lt 3 ]] ; then
    echo "Not enough input arguments"
    exit 0
elif [[ $# -gt 5 ]] ; then
    echo "Too many input arguments"
    exit 0
else
    echo "OK"
fi
```

Conditionals

- Can be chained together using logical operators &&, ||

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

```
if [[ $# -lt 3 ]] || [[ $# -gt 5 ]]; then
    echo "Wrong number of input arguments"
    exit 0
else
    echo "OK"
fi
```

- These operators allow conditional execution

```
mkdir newdir || echo "Cannot create directory"
mkdir newdir && touch newdir/newfile
```


While Loops

```
while read line; do
    fields=(${line}) #expand to array
    ...
done < infile
```

break and continue can be used within the loop body

For loops

A for loop iterates a series of words in a string

```
for i in $(ls); do
    echo $i
done
```

A C-style for loop can be created using arithmetic expressions

```
for ((i = 0; i < 100; i++)); do
    echo $i
done
```

Range expression

```
for i in {1..10}; do
    echo $i
done
```

Functions

```
myFunc() {  
    local localVar="Hello "$1;  
    echo localVar;  
}
```

```
myFunc "Paul"
```

Return values can be captured by command substitution

Getting help

- man pages for most commands
- Huge amount on online resources, eg a good cheat sheet at <https://devhints.io/bash>