An Introduction to Shell Scripting

Anja Gerbes

Goethe University, Frankfurt am Main
Center for Scientific Computing

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Assumptions

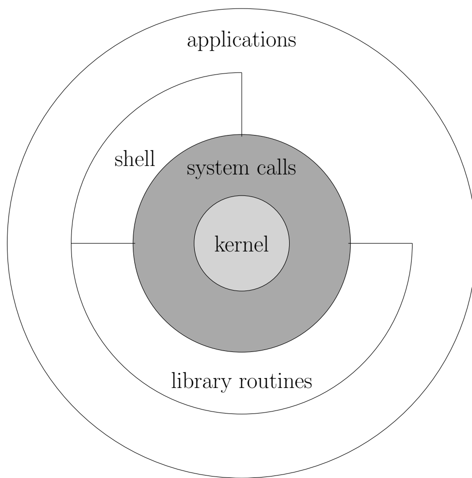
Before starting, you should...

... know how to use a text editiors like emacs or vi/vim

... have basic knowledge of UNIX:

- some basic commands like `ls`, `cd`, ...
- processes, kernel, etc

What is UNIX shell?



Welcome to a new world!

sh	Bourne-Shell
csh	C-Shell
ksh	Korn-Shell
bash	Bourne-Again-Shell

We will restrict ourselves to `bash`

To find all available shells in your system type following command:

```
$ cat /etc/shells
```

Note!

Each shell does more or less the same, with differences in command syntax, or built-in functions, ...

To find your current shell type the following command:

```
$ echo $SHELL
```

Why shell scripting?

- Need to manage computers remotely?
- Need to perform complex operations on lots of files?
- Need to repeat the same operations on a lot of machines?

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Shell scripting is the answer!!!

…or maybe not, BUT
Shell scripting glues together

- the power of UNIX and
- the power of programming

What is a shell script?

- A Text File
- With Instructions
- Executable, if wanted

Writing Bash Scripts

- Shebang

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

- Comments

```
#This text will be ignored
```

- Make script executable

```
chmod +x myscript.sh
```

- Execute Script

```
./myscript.sh
```

- Also (no need to turn on x bit)

```
bash myscript.sh
```

A simple example of shell script with arguments

```bash
#!/bin/bash

#This is a comment
echo "Hello, $1 $2"
echo "Greetings from $0"
echo "Welcome back!"
```

```
$ bash simple.sh
Hello,
Greetings from simple.sh
Welcome back!

$ bash simple.sh Hans
Hello, Hans
Greetings from simple.sh
Welcome back!

$ bash simple.sh Max Born
Hello, Max Born
Greetings from simple.sh
Welcome back!
```

Command Line and Exit Status

- The command line is the interface from the shell to an external command (executable).
- The exit value is the interface from the command to the shell.

```
$ ls aAa
ls: cannot access aAa: No such file or directory
$ echo $?
2
```

But

```
$ touch aAa
$ ls aAa
aAa
$ echo $?
0
```

Get Input

```
#!/bin/bash

echo "What is your name?"
read uname

echo "Welcome $uname"
```

Special Files

Possible startup files

- `/etc/profile` is executed automatically at login
- The first file found in the list
  - `~/.bash_profile`,
  - `~/.bash_login`, or
  - `~/.profile`

  is executed automatically at login
- `~/.bashrc` is executed by login and nonlogin shells.

Filename Metacharacters

`*`	match any string of zero or more characters
`?`	match any single character
`[abc...]`	match any of the enclosed chars; hypens for ranges (`[a-z]`)
`[!abc...]`	match any chars *not* enclosed
`~`	home directory of current user
`~name`	home directory of *name*
`~+`	current working dir
`~-`	previous working dir

Quoting

Tricky issue: see `man bash`, under QUOTING

Double quotes: "

Everything between the initial " and the closing " is taken literally, except for

- $ variable substitution will occur
- ` command substitution will occur
- \ it will escape the next character (can also escape ")

Single quotes: '

Everything between the initial ' and the closing ' is taken literally

- another ' cannot be embed a single quoted strings

Quoting

` or $()

Command substitution: expands to what is inside

Examples of quoting

```
$ echo 'Single quotes "protect" double quotes'
Single quotes "protect" double quotes

$ echo "Well, isn't that \"special\"?"
Well, isn't that "special"?

$ echo "You have `ls | wc -l` files in `pwd`"
You have 84 files in /home/gerbes

$ x=100
$ echo "The value of \$x is $x"
The value of $x is 100

$ echo '$a'
$a
```

I/O Redirection

fd	Name	Abbr.	Default
0	standard input	`stdin`	Keyboard
1	standard output	`stdout`	Screen
2	standard error	`stderr`	Screen

Simple redirection

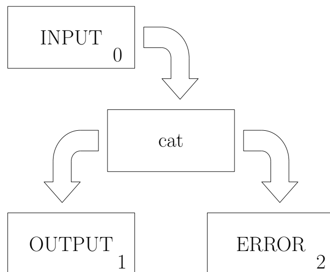
cmd > file	sends output to *file* (overwrite)
cmd >> file	sends output to *file* (append)
cmd < file	*cmd* takes input from *file*
cmd1 | cmd2	a *pipe*: output of *cmd1* is input of *cmd2*

I/O Redirection

More redirection

cmd << *text*	*here document*
cmd >& *n*	sends *cmd* output to file descriptor *n*
cmd m>& *n*	Same as previous, but output that would normally go to file descriptor *m* is sent to file descriptor *n* instead
cmd 2>*file*	sends standard error to *file*, standard output remains the same (screen)
cmd &> *file*	sends both standard output and standard error to *file*
cmd &>> *file*	appends both standard output and standard error to *file*

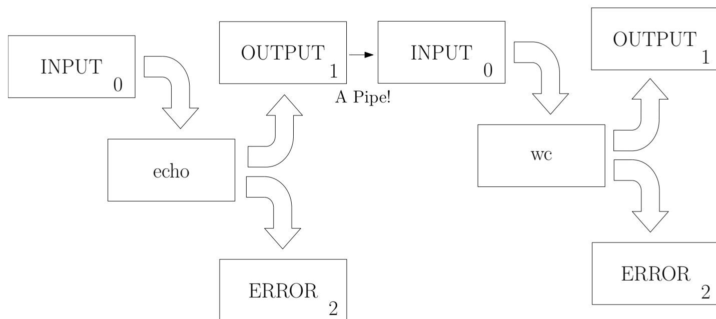
I/O Redirection



In practice

```
 $ cat # it takes input from keyboard and output goes to screen (also errors)
hello world
hello world
$ cat > my_dummy_file # now std output goes to a file
hello world, again
$ cat < my_dummy_file # input comes from file; no need to press ctrl-d to exit cat
hello world, again
```

Pipe



How does it look like in terms of commands?

```
$ echo "Hello world!" | wc -c
13
```

Continuing Lines with \

```
$ echo This \
is \
a \
very \
long \
command line.

This is a very long command line.
```

Variable Assignment

- letters, digits, underscores
- case sensitive
- may not start by a digit
- assignment of variables with the = operator
- no spaces between name and value
- multiple assignments in one line

  ```
  name=John lastname=Smith age=99
  ```
- Convention: uppercase names used/set by the shell
- default: all variables are strings
- `declare -i`

Variable Substitution

var=value	sets *var* to *value*
${var}	Use *value* of *var*
${var:-value}	Use *var* if set, otherwise, use *value*
${var:=value}	Use *var* if set, otherwise, use *value* and assign *value* to *var*
${#var}	Use the length of *var*
${!var}	Use value of *var* as name of variable whose value should be used (indirect reference)

```
$ a=CC b=DD A=a
$ echo ${!A}
CC
```

Some Variables

- **$HOME** absolute path of the home directory
- **$HOSTNAME** name of the computer
- **$PATH** list of paths where the executables are looked for
- **$PWD** current working directory
- **$OLDPWD** previous working directory

Some Special Shell-Variables

$0	first word (command name)
$n	individual positional arguments on command line
$*, $@	all arguments on command line
$#	number of command line arguments
$$	PID of the active shell
$!	PID of last background command
$?	Exit value of last executed command

Variables and the Environment

```
$ env
[...variables passed to sub-programs...]

$ NEW_VAR="Yes"

$ echo $NEW_VAR
Yes

$ env
[...PATH but not NEW_VAR...]

$ export NEW_VAR
$ environment
[...PATH and NEW_VAR...]
```

Arithmetics

- Only Integer Arithmetics
- `let` command:

```
let expressions
(( expressions ))
```

Examples:

```
$ let i=0# variables do not need preceeding "$"
$ let i=i+1# spaces not allowed
$ echo $i
1
$ let "i = i + 1" # quotes must be added if expression contains spaces
$ echo $i
2
$ (( i += 1 )) # (( ... )) does quoting for you
$ (( i *= 7 )) # Arithmetic operators taken from the C language
$ echo $i
21
```

`$(( ))` for Math

- `$(( ... ))` to assign to a variable the result

```
$ a=$(( 1 + 2 ))
$ echo $a
3

$ echo $(( 2 * 3 ))
6

$ echo $(( 1 / 3 ))
0
```

Several ways to get history

- `history` command
- line-edit mode
- `fc` command
- C-shell-style history

line-edit mode

- history treated like a file
- lines can be modified before executing
- `set -o emacs` or `set -o vi`

emacs	result
`up` or `ctrl+p`	previous command
`down` or `ctrl+n`	next command
`ctrl+r`	get previous command containing *string*
`ctrl+s`	get next command containing *string*

Control Constructs

- `if`
- `for`
- `while`

How do we write conditions in bash?

The easiest way: use the `test` command

Logic `test`

```
test condition
[ condition ]
[[ condition ]]
```

- `[ .. ]` and `[[ .. ]` must be surrounded by spaces
- `[[ .. ]]` word splitting and filename expansion disabled

```
$ test 1 -lt 10
$ echo $?
0

$ test 1 == 10
$ echo $?
1
```

- `test`
- `[]`

  `[1 -lt 10]`
- `[[]]`

  `[[ "this string" != "this" ]]`
- `(())`

  `((1 < 10))`
- `[ -e filename ]`
- Much more!
  - see: `man test`

Decision Control Constructs — `if` Statements

- `if` allows the programmer to make a decision in the program based on conditions he specified
- If the condition is met, the program will execute certain lines of code
- otherwise the program will execute other tasks the programmer specified
- different types of conditional statements: file-based, string-based and arithmetic-based conditions
- e.g. file-based conditions are unary expressions and often used to examine a status of a file (`-e file` returns true is file exists)

```
# see if a file exists

if [ -e /etc/passwd ]
then
  echo "/etc/passwd exists"
else
  echo "/etc/passwd not found!"
fi
```

Looping Control Constructs

- simplify recursive tasks
- optimize any code by providing a way to minimize code
- easier to troubleshoot than unstructured code providing the same output
- types of looping statements: the `for` and `while` loops

Looping Control Constructs

`for` Loops

```
# for-in structure

for i in 1 2 3
do
  echo $i
done
```

```
# list directory recursivly

for i in /*
do
  echo "Listing $i:"
  ls -l $i
  read
done
```

C-like Syntax

for Loops

```
# syntax of C-style for-loop

for ((initialization; boolean_test; increment/decrement))
do
  <code>
done
```

```
# example for C-style for-loop

LIMIT=10
for (( a=1 ; a<=LIMIT; a++ ))
do
  echo -n "$a"
done
```

Looping Control Constructs — `while` Loops

- `while` separates the initialization, Boolean test and the increment/decrement statement

```
# syntax of while-loop

<initialization>
while(condition)
do
  <code>
<increment/decrement>
done
```

```
# example for while-loop

a=0; LIMIT=10
while [ "$a" -lt "$LIMIT" ]
do
  echo -n "$a"
  a=$(( a+1 ))
done
```

Functions

```
# syntax of functions

name () {
   function's body
} [redirections]
```

```
# example for functions

fatal () {
   echo "$0: fatal error:", "$@" > &2
   exit 1
}

...

if [ $# = 0 ]
then
   fatal not enough arguments
fi
```

- `return` to return and exit value to the calling program
- `exit` to really exit

Easy exercises

Exercise 1: back me up!

Write a shell script that backs itself up. The backup's name should be the original name with a `.back` suffix.

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```
cat "$0" > "$0.back"
```

Easy exercises

Exercise 2: reverse

Write a script that reverses the content of a given file given as first argument and writes it to a file appending the `.kcab` suffix to the original file name.

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```
rev $1| tac > $1.kcab
```

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Exercise 3: basic argument parsing

Write a shell script that takes 3 arguments and prints them in reverse order. If `-h` is given, print also a help message.

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```
echo "$3 $2 $1"
if [ "$1" = "-h" -o "$2" = "-h" -o "$3" = "-h" ]
then
  echo "Some help"
fi
```

Intermediate exercises

Exercise 4: implement a trash

Write a shell script that acts as a *safe delete*. Call it `srm.sh`. Filenames passed as command-line arguments to this script are not deleted, but instead moved to a directory called `~/TRASH`. Add the following features:

- Upon invocation the script checks the `~/TRASH` directory for files older than 7 days and permanently removes them.
- If the files are not `gzipped`, the script compresses each file before moving it to the trash.
- decouple the initial check to another script that should be executed regularly by `cron`.

Intermediate exercises

Exercise 5: process monitor

Given a process ID (PID) as an argument, this script will check, at user-specified intervals, whether the given process is still running. You may use the ps and sleep commands.

Write to

- `hpc-support@csc.uni-frankfurt.de`
- `support@csc.uni-frankfurt.de`

in case of general questions about the cluster.

Or directly to us for comments or questions about this course:

`frankfurt@hpc-hessen.de`

THANK YOU!