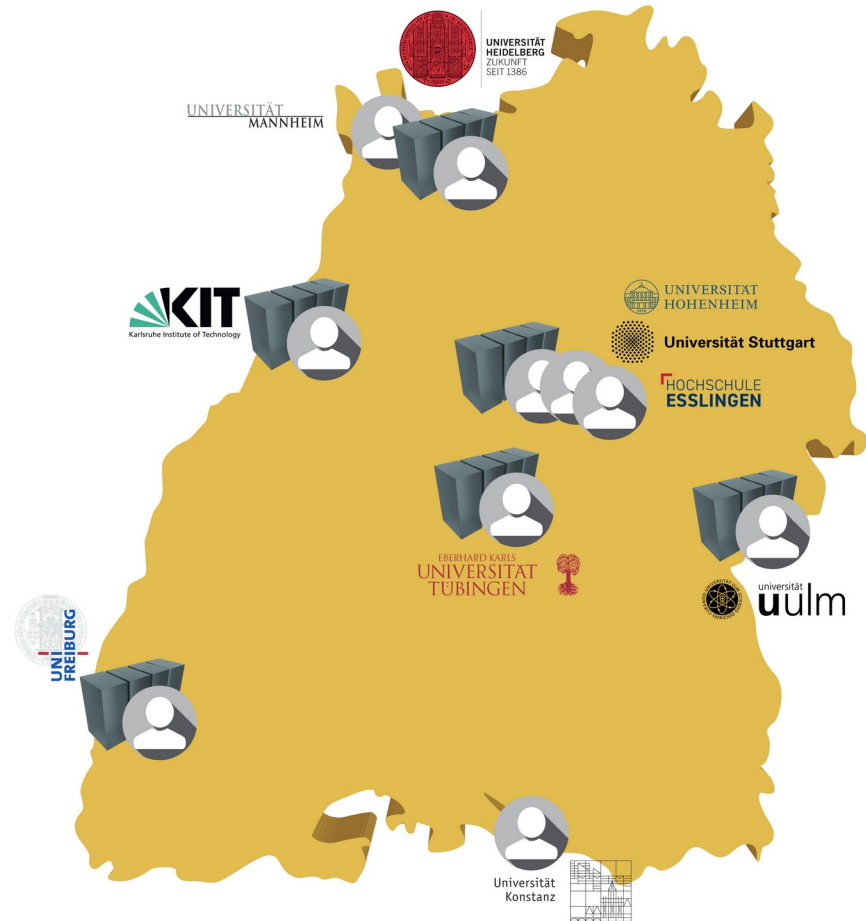


Advanced Bash Scripting

Robert Barthel, SCC, KIT



How to read the following slides

Abbreviation	Full meaning
<code>\$ command -opt value</code>	<code>\$</code> = prompt of the interactive shell The full prompt may look like: <code>user@machine:path \$</code> The command has been entered in the interactive shell session
<code><integer></code> <code><string></code>	<code><></code> = Placeholder for integer, string etc
<code>foo, bar</code>	Metasyntactic variables
<code>\${WORKSHOP}</code>	<code>@uc2:/opt/bwhpc/common/workshops/2023-03-30</code> <code>@hk:/software/all/workshops/2023-03-30</code>

Sources of this slides?

- <https://tldp.org/HOWTO/Bash-Prog-Intro-HOWTO.html> (intro)
- <https://tldp.org/LDP/abs/html> (advanced)
- `$ man bash`

Where to get the slides/exercises/reservation?

- https://indico.scc.kit.edu/e/hpc_course_2023-03-30 or

bwUniCluster: /opt/bwhpc/common/workshops/2023-03-30

horeka:/software/all/workshops/2023-03-30

- exercises
- slides

- Workshop reservation – mult inode:

- bwUniCluster 2.0

```
sbatch --reservation=ws
```

- HoreKa

```
sbatch --reservation=ws
```

Overview

Agenda

Registration

Contact

✉ courses@bwhpc.de

Das Steinbuch Centre for Computing (StCC) is a research and development center for high-performance computing (HPC) and data science. The center is located at the Steinbuch Institute for Applied Mathematics (SIAM) at the University of Karlsruhe (KIT). The center is responsible for the development and operation of the bwUniCluster (bwForCluster) and the Steinbuch Center for Computing (StCC) storage systems. The center also provides training and support for HPC users. The HPC course is aimed at providing information about advanced HPC applications and tutorials, and advanced HPC applications.

The Steinbuch Centre for Computing (StCC) Performance Computing course is aimed at providing information about advanced HPC applications and tutorials, and advanced HPC applications.

Starts 21 Oct 2023
Ends 21 Oct 2023
Europe/Berlin

- exercises
- slides

How to do exercises?

- Login to cluster & Generate workspace „bwhpc-course“

```
$ ws_allocate bwhpc-course 30
Info: creating workspace
/pfs/work7/workspace/scratch/ab1234-bwhpc-course
remaining extensions : 3
remaining time in days: 30
```

- Copy examples to your workspace

```
$ WORKSHOP=/opt/bwhpc/common/workshops/2023-03-30
$ cd $(ws_find bwhpc-course)
$ mkdir -v 2023-03-30; cd 2023-03-30
$ cp -vpr ${WORKSHOP}/exercises/01 ./
```

- Submit jobs from your workspace

```
$ cd $(ws_find bwhpc-course)/2023-03-30/01
$ sbatch -p {single|cpuonly} --reservation=ws <jobscript>
```

Why (**not**) Bash?!

■ **Great at:**

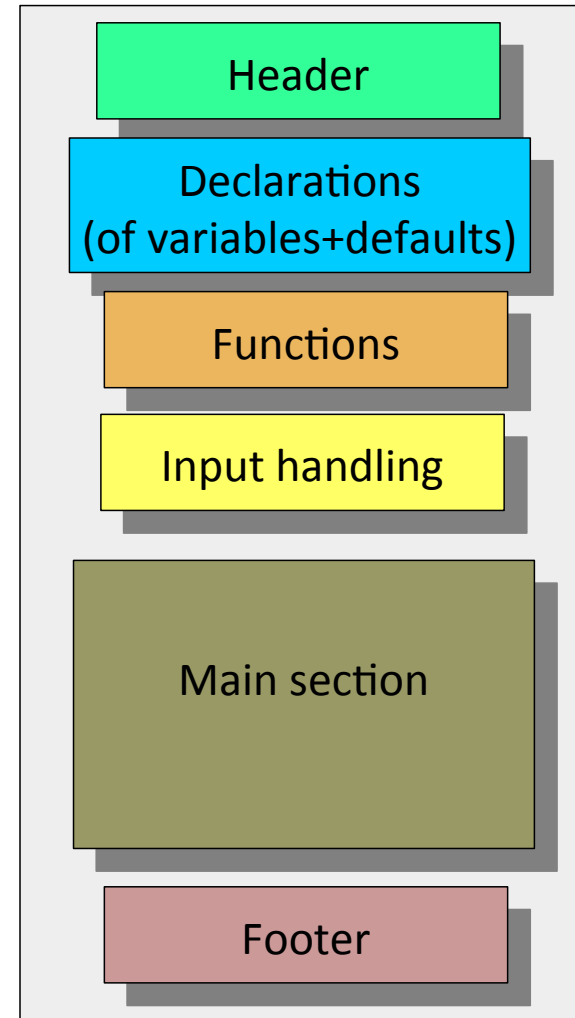
- **managing batch jobs**
- managing external programs
- invoking entire UNIX command stack & many builtins
- Powerful scripting language
- Portable and version-stable
- almost everywhere installed

■ **Less useful** when:

- Resource-intensive tasks (e.g. sorting, recursion, hashing)
- **Heavy-duty math operations**
- Extensive file operations
- Need for native support of **multi-dimensional arrays**

Goal

- Be descriptive!
 - **Comment your code**
 - e.g. via headers sections of script and functions.
 - **Decipherable names** for variables and functions
- Organise and structure!
 - Break complex scripts into **simpler blocks**
e.g. use functions
 - Use exit codes
 - Use **standardized parameter flags** for script invocation.



Header & Line format

- Hash-bang = '#!' (= activates interpreter directive)

→ at head of file = 1. line only!

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

- *Options: e.g. debugging shell):*

```
#!/bin/bash -x
```

- *#!/bin/sh → invokes default shell interpreter → mostly Bash*

- *If path of bash shell varies:*

```
#!/usr/bin/env bash
```

- Line ends with no special character!

- But multiple statements in one line to be separated by:

```
;
```

Semicolon

```
$ echo hello; echo World; echo bye
```

- *Group commands*

- *In current shell:*

```
$ echo $BASHPID; { echo $BASHPID; sleep 10; }
```

- *In subshell:*

```
$ echo $BASHPID; ( echo $BASHPID; sleep 10 )
```

Bash Output

■ echo

a) trails every output with a „newline“

```
$ echo hello; echo World
hello
World
```

b) prevent newline:

```
$ echo -n hello; echo World
helloWorld
```

c) parsing „escape sequences“

```
$ echo -e "hello\nWorld"
hello
World
```

■ printf = „enhanced“ echo

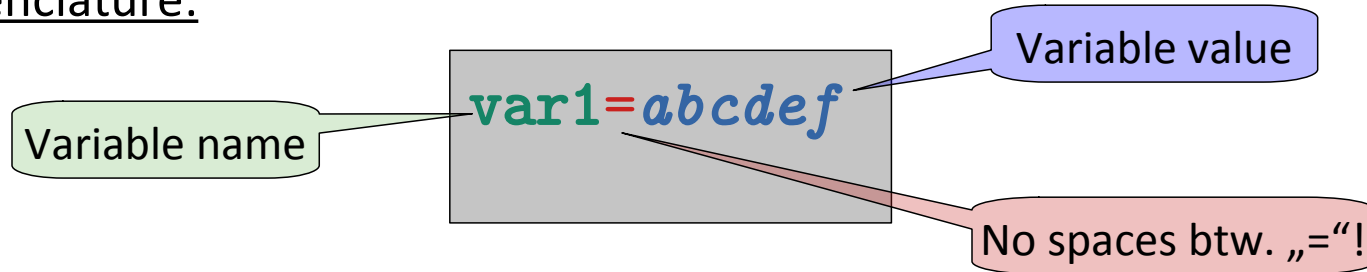
- by default no „newline“ trailing
- formatted output

```
$ printf hello; printf World
helloWorld$
```

```
$ printf "%-9.9s: %03d\n" "Integer" "5"
Integer : 005
```


Variables (1)

■ Nomenclature:



■ Brace protect your variables!

→ check difference:

```
var2=01_${var1}_gh
vs
var3=01_${var1}_gh
```

```
$ echo ${var2}
01_abcdef_gh
$ echo ${var3}
01_
```

■ Values can be generated by commands:

```
var4=$(date)
```

■ Variables are untyped

→ essentially strings,

→ depending on content arithmetics permitted

```
$ a=41; echo $((a+1))
42
```

```
$ a=BB; echo $((a+1))
1
```

→ string has an integer value of 0

Variables (2)

■ Declare

- Set variable to integer, readonly, **array** etc.

```
$ declare -r a=1
$ let a+=1
bash: a: readonly variable
```

```
$ declare -a arr=( '1 2' 3) ← space is
$ echo ${arr[0]}          separator
1 2
```

- *Arrays: e.g. store file content in array:*

a) *1 element per string*

```
a=( $(< file) )
```

```
= a=( $(cat file) )
```

b) *1 element for whole file*

```
a=( "$(cat file)" )
```

c) *1 element per line*

```
while read -r line; do
    a+=( "${line}" )
done < file
```

■ Usage only **without \$** when:

assign
declare
export
unset

```
a="value"
declare -i a=41
export a
unset a
```

Special bash characters (1)

Chars with meta-meaning

Comments

- at beginning
- at the end
- **exception:** escaping, quotes, substitution

```
# This line is not executed
```

```
echo 'something' # Comment starts here
```

\ Escape = Quoting mechanism for single characters

```
echo \#
```

' Full Quotes = Preserves all special characters within

```
echo '#'
```

" Partial Quotes = Preserves some of the special characters, but not `${var}`

```
var=42  
echo "\${var} = ${var}"; echo '\${var} = ${var}'
```

Special bash characters (2)

Chars with meta-meaning

`$()`

Command substitution

old version: ``` (backticks) → do not use anymore

```
$ echo "today = $(date)"  
today = Wed Oct 11 02:03:40 CEST 2017
```

`()`

Group commands in a subshell

```
$ (ls -l; date)
```

`(())`

Double-parentheses construct

→ arithmetic expansion and evaluation

```
$ echo $((1 + 3))  
4
```

\$ prefixing of `(())` to return the value it holds

`[]`

Test builtin (cf. slide 25)

or

Array element (cf. slide 12)

Globbering

- = filename expansion
→ recognices and expands „wildcards“
- but this is **not** a Regular Expression interpretation (for such use awk/sed)

■ wildcards:

* = any multiple characters

? = any single character

[] = to list specific character

e.g. list all files starting with a or b

```
$ ls [a,b]*
```

^ = to negate the wildcard match

e.g. list all files not starting with a

```
$ ls [^a]*
```

Manipulation of Variables (1)

Syntax	Does?	Examples
<code>\${#var}</code>	String length	<code>\$ A='abcdef_abcd'; echo \${#A}</code> 11
<code>\${var:pos:len}</code>	Substring extraction:	
	a) via Parameterisation	<code>\$ POS=3; echo \${A:\${POS}:2}</code> de
	b) Indexing from right	<code>\$ echo \${A:(-2)}</code> cd
<code>\${var#sstr}</code>	Strip shortest match of \$sstr from front of \$var	<code>\$ sstr=a*b; echo \${A#\${sstr}}</code> cdef_abcd
<code>\${var%sstr}</code>	Strip shortest match of \$sstr from back of \$var	<code>\$ sstr=c*d; echo \${A%\${sstr}}</code> abcdef_ab
<code>\${var/sstr/repl}</code>	Replace first match of \$sstr with \$repl	<code>\$ sstr=ab; rp=AB; echo \${A/\${sstr}/\${rp}}</code> ABcdef_abcd
<code>\${var//sstr/repl}</code>	Replace all matches of \$sstr with \$repl	<code>\$ echo \${A//\${sstr}/\${rp}}</code> ABcdef_ABcd
<code>\${var/#sstr/repl}</code>	If \$sstr matches front-end, replace by \$repl	<code>\$ sstr=a; rp=z_; echo \${A/#\${sstr}/\${rp}}</code> z_bcdef_abcd
<code>\${var/%sstr/repl}</code>	If \$sstr matches back-end, replace by \$repl	<code>\$ sstr=d; rp=_z; echo \${A/%\${sstr}/\${rp}}</code> abcdef_abc_z

Manipulation of Arrays

Syntax	Does?	Examples
<code>\${#array[@]}</code>	Number of elements	<pre>\$ dt=(\$(date)); echo \${#dt[@]} 6</pre>
<code>\${array[@]:p1:p2}</code>	Print elements from no. p1 to p2 :	<pre>\$ echo \${dt[@]:1:2} Feb 25</pre>
<code>\${array[@]#sstr}</code>	Strip shortest match of <code>\$sstr</code> from front of all elements of Array	<pre>\$sstr=W*d; echo \${dt[@]#\${sstr}} Feb 25 10:18:22 CET 2015</pre>

■ Adding elements to an array:

a) at the end:

```
$ dt+=( "AD" )  
$ echo ${dt[@]}  
Wed Feb 25 17:18:22 CET 2015 AD
```

b) in-between

```
$ dt=( ${dt[@]:0:2} ':-)' ${dt[@]:2} )  
$ echo ${dt[@]}  
Wed Feb 25 :-) 17:18:22 CET 2015
```

Exercise 1: Variables and Arrays

- Write a bash script that:
 - Has a **variable** named **outputfile** which:
 - Is readonly and consists of 3 strings:
 1. Environment variable \$LOGNAME
 2. Arbitrary string of 4 characters generated in subshell via:
`mktemp -u XXXX`
 3. First 2 characters of the current month (→ use „date“) using a bash array
- Hint:
- ```
array=$(date))
```



# Exercise 1: Variables and Arrays - Solution

- Write a bash script that:
  - Has a **variable** named **outputfile** which:
    - Is **readonly** and consists of 3 strings:
      1. Environment variable **\$LOGNAME**
      2. **Arbitrary string** generate in subshell via: (use „mktemp -u XXXX“)
      3. **First 2 characters** of the **current month** (→ use „date“) using a bash array

```
#!/bin/bash
${WORKSHOP}/solutions/01/exercise_1.sh

in case language is en_us.utf8, month is 2.element in "date"
array=$(date)
month=${array[1]:0:2}

declare -r outputfile="${LOGNAME}_$(mktemp -u XXXX)_${month}.log"
echo ${outputfile}

Try changing output file
outputfile="new"
```

# Output & Input Redirection (1)

| Syntax                                    | Does?                                                                             | Examples                                                                                                                         |
|-------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <code>exe &gt; log</code>                 | Standard output ( <b>stdout</b> ) of application exe is (over)written to file log | <code>\$ date &gt; log; cat log</code>                                                                                           |
| <code>exe &gt;&gt; log</code>             | Standard output ( <b>stdout</b> ) of application exe is append to file log        | <code>\$ date &gt;&gt; log; cat log</code>                                                                                       |
| <code>exe 2&gt; err</code>                | Standard output ( <b>stderr</b> ) of application exe is (over)written to file err | <code>\$ date 2&gt; err; cat err</code>                                                                                          |
| <code>exe 2&gt;&gt; log</code>            | Standard output ( <b>stderr</b> ) of application exe is append to file log        | <code>\$ date 2&gt;&gt; err; cat err</code>                                                                                      |
| <code>exe &gt;&gt; log 2&gt;&amp;1</code> | Redirects stderr to stdout                                                        | <code>\$ date &gt;&gt; log 2&gt;&amp;1</code>                                                                                    |
| <code>exe1   exe2</code>                  | Passes stdout of exe1 to standard input ( <b>stdin</b> ) of exe2 of next command  | <code># Print stdout &amp; stderr to screen and then append both to file</code><br><code>\$ date 2&gt;&amp;1   tee -a log</code> |
| <code>exe &lt; inp</code>                 | Accept stdin from file inp                                                        | <code>\$ wc -l &lt; file</code>                                                                                                  |

# Output & Input Redirection (2)

- **Bonus:** Take care of order when using redirecting

- e.g:

```
(ls -yz; date) >> log 2>&1
```

≠

```
(ls -yz; date) 2>&1 >> log2
```

→ Stdout (date) redirected to file „log“  
→ Stderr (invalid option of ls) redirected to file pointed to by stdout

→ Stderr (invalid option of ls) redirected to stdout (channel), but not written file  
→ Stdout (date) redirected to file

- Suppressing stderr

```
ls -yz >> log 2>/dev/null
```

Usage? Keep variable empty when error occurs

→ e.g. list of files with extension log

```
list_logs="$(ls *.log 2>/dev/null)"
```

→ if no files with extension log exist, \$list\_logs is empty

## Bonus: Output & Input Redirection (3)

- Redirection of „all“ output in shell script to one user file

→ generalise = define variable

```
#!/bin/bash
log="blah.log"
err="blah.err"

echo "value 1" >> ${log} 2>> ${err}
command >> ${log} 2>> ${err}
```

→ or use exec

```
#!/bin/bash

exec > "blah.log" 2> "blah.err"

echo "value 1"
command
```

→ all stdout and stderr after 'exec' will be written to blah.log and blah.err resp.

# Output & Input Redirection (4)

## ■ Reading input e.g. file line by line

```
#!/bin/bash

declare -i i=1
while read -r line ; do
 echo "line ${i}: ${line}"
 let i+=1
done < 01_input_file
```

`${WORKSHOP}/exercises/01/01_read_input.sh`

## ■ Reading output of other commands line by line, e.g. „ls -l”

```
#!/bin/bash

declare -i i=1
while read -r line ; do
 echo "line ${i}: ${line}"
 let i+=1
done < <(ls -l *)
```

`${WORKSHOP}/exercises/01/02_read_input.sh`

### Process substitution:

a form of redirection;  
input/output of process = temp file

# Manipulation of Variables (2)

## ■ Example:

```
#!/bin/bash ${WORKSHOP}/exercises/01/03_var_manipulation.sh

Purpose: Define automatic output names for executables

exe="03_binary.x"

Assume: $exe contains extension .x or .exe etc
sstr=".*" ## substitution string
log="${exe%${sstr}}.log" ## replace extension with .log
err="${exe%${sstr}}.err" ## replace extension with .err

Define command: echo and run
echo "${exe} >> ${log} 2>> ${err}"
${exe} >> ${log} 2>> ${err}
```

## Bonus: Expansion of Variables

| Syntax                           | Does?                                                                                    | Examples                                                                                                           |
|----------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <code>\${var-<b>def</b>}</code>  | If \$var not set, set value of \$def                                                     | <pre>\$ unset var; def=new; echo \${var-<b>def</b>}<br/>new</pre>                                                  |
| <code><b>\${var:-def}</b></code> | If \$var not set or <i>is empty</i> , set value of \$def                                 | <pre>\$ var=''; def=new; echo <b>\${var:-def}</b><br/>new</pre>                                                    |
|                                  |                                                                                          | <pre><b># Job Id for interactive and Slurm runs</b><br/>jobID=<b>\${SLURM_JOB_ID:-BASHPID}</b></pre>               |
| <code><b>\${var:?err}</b></code> | If \$var not set or <i>is empty</i> , print \$err and abort script with exit status of 1 | <pre>\$ var=''; err='ERROR - var not set'<br/>\$ echo <b>\${var:?err}</b><br/>bash: var: ERROR - var not set</pre> |

# Exit & Exit Status

- Exit: terminates a script

```
#!/bin/bash
echo "printed line"
exit
echo "not printed line"
```

- Every command returns an exit status

- successfull = 0
- non-successfull > 0 (max 255)

**\$?** = the exit status of last command executed (of a pipe)

```
ls -xy 2>/dev/null; echo $?
2
```

Special meanings (avoid in user-specified definitions):

- 1 = Catchall for general errors
- 2 = Misuse of shell builtins
- 126 = *Command invoked cannot execute (e.g. /dev/null)*
- 127 = *"command not found"*
- 128 + n = *Fatal error signal "n" (e.g. kill -9 of cmd in shell returns 137)*



# (Conditional) Tests

```
if condition1 ; then
 do_if_cond1_true/0
elif condition2 ; then
 do_if_cond2_true/0
else
 do_the_default
fi
```

| Condition | Does?                                                                                              | Examples                                                                                                              |
|-----------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| (( ))     | Arithmetic evaluation                                                                              | <pre>\$ if (( 2 &gt; 0 )) ; then echo yes ; fi yes</pre>                                                              |
| [ ]       | Part of (file) test builtin,<br>arithmetic evaluation only<br>with -gt, -ge, -eq,<br>-lt, -le, -ne | <pre>\$ if [ 2 -gt 0 ] ; then echo yes ; fi yes \$ # existence of file \$ if [ -e "file" ] ; then echo yes ; fi</pre> |
| [[ ]]     | Extended test builtin;<br>allows usage of<br>&&,   , <, >                                          | <pre>\$ a=8; b=9 \$ if [[ \${a} &lt; \${b} ]]; then echo \$? ; fi 0</pre>                                             |

# Typical File Tests

- (not) exists:

```
if [! -e "file"]; then echo "file does not exist" ; fi
```

- file is not zero:

```
if [-s "file"]; then echo "file greater than zero" ; fi
```

- file is directory:

```
if [-d "file"]; then echo "This is a directory" ; fi
```

- readable:

```
[-r "file"]
```

- writeable:

```
[-w "file"]
```

- executable:

```
[-x "file"]
```

- newer than file2:

```
["file" -nt "file2"]
```

- Pitfalls when using variables:

wrong:

```
$ unset file_var; if [-e ${file_var}] ; then echo "yes" ; fi
yes
```

right:

```
$ unset file_var; if [-e "${file_var}"] ; then echo "yes" ; fi
```

# for Loops

```
for arg in list
do
 command
done
```

- Iterates command(s) until all arguments of *list* are passed
- list* may contain globbing wildcards

## Example 1

```
#!/bin/bash
Example 1: Loop over generated integer sequence
counter=1
for i in {1..10} ; do
 echo "loop no. ${counter}: ${i}"
 let counter+=1
done
```

## Example 2

```
Example 2: Loop over space separated list of strings
list="file_1,file_2,file_3"
for x in ${list//,/ " "} ; do
 echo ${x}
done
```

## Bonus: while Loops

```
while condition
do
 command
done
```

- Iterates command(s) as long as *condition* is **true** (or exit status 0)
- Allows indefinite loops

### Example

```
#!/bin/bash

Purpose: Loop until max is reached
max=10
i=1
while ((${max} >= ${i})) ; do
 echo "${i}"
 let i+=1
done
```

# Positional parameters (1)

= Arguments passed to the script from the command line

| Special variable | Meaning, notes                                                    |
|------------------|-------------------------------------------------------------------|
| \$0              | Name of script itself                                             |
| \$1, \$2, \$3    | First, second, and third argument                                 |
| \${10}           | 10th argument, <b>but if not brace protected</b> : \$10 = \$1 + 0 |
| \$#              | Number of arguments                                               |
| \$*              | List of all arguments as one single string                        |
| @                | List of all arguments, each argument separately quoted            |

## Example:

Show differences between `${*}` and `@`

```
echo "Number PPs: #{#}" {WORKSHOP}/exercises/01/04_special_var.sh
i=1
for PP in "@" ; do
 printf "%3.3s.PP: %s\n" "${i}" "${PP}"
 let i+=1
done
i=1
for PP in "*" ; do
 printf "%3.3s.PP: %s\n" "${i}" "${PP}"
 let i+=1
done
```

## Positional parameters (2)

= Arguments passed to the script from the command line

| Special variable | Meaning, notes                                            |
|------------------|-----------------------------------------------------------|
| \$0              | Name of script itself                                     |
| \$1, \$2, \$3    | First, second, and third argument                         |
| \${10}           | 10th argument, but if not brace protected: \$10 = \$1 + 0 |
| \$#              | Number of arguments                                       |
| \$*              | List of all arguments as one single string                |
| @                | List of all arguments, each argument separately quoted    |

Shifting positions:

**shift**

Drops \$1 → shifts \$2 to \$1 → \$3 to \$2 and so → \$# is reduced by 1

## Bonus: Conditional evaluation - case

```
case variable in
 condition1)
 do_if_cond1_true/0
 ;;
 *)
 do_the_default
 ;;
esac
```

- analog to switch in C/C++
- **to simplify multiple if/then/else**
- each condition block ends with double semicolon
- If a condition tests true:
  - a) commands in that block are executed
  - b) case block terminates

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

```
/${WORKSHOP}/exercises/01/05_case.sh
```

```
Purpose: Color output red or blue
e0="\033[0m";eR="\033[31;1m";eB="\033[34;1m"
case ${1} in
 red)
 echo -e "${eR}This line is red${e0}"
 ;;
 blue)
 echo -e "${eB}This line is blue${e0}"
 ;;
 *)
 echo -e "Line wo color" ;;
esac
```

## Bonus: Exercise 2

- Write Script that processes options:

-h

-i <integer>

without shell build getopt combining „positional parameter“, „shift“, „tests“, „case“ and „while“

Template: `${WORKSHOP}/exercises/01/06_proc_input.sh`

→ Replace everything between ... and ... by code

```
#!/bin/bash

while ...test total num_positional parameter (PP) greater zero... ; do
 case "PP1" in
 ## script option: -h
 ...PP is option1...) ...echo something...
 ;;
 ...PP is option2...) ...echo PP2...
 ...do PP shift...
 ;;
 esac
 ...do PP shift...
done
```



# Bonus: Solution of Exercise 2

## Processing Input without *getopts*

- Combining: Positional parameter + shift + tests + case + while

```
#!/bin/bash
Purpose: Processing positional parameters

while ((${#} > 0)) ; do
 case "${1}" in

 ## script option: -h
 -h) echo "${1}: This option is for HELP" ;;

 ## script option: -i + argument
 -i) echo "${1}: This option contains the argument ${2}"
 shift ;;

 ## default
 *) echo "${1}: This is non-defined PP" ;;

 esac
 ## Shifting positional parameter one to the left: $1 <-- $2 <-- $3
 shift
done
```

`${WORKSHOP}/solutions/01/06_proc_input.sh`

# awk & sed: Command substitution

## ■ awk

→ full-featured text processing language with a syntax reminiscent of C

→ use for complicated arithmetics or text or *regular expression* processing

### ■ Examples:

a) logarithm of variable:

```
a=10; echo ${a} | awk '{print log($1)}'
```

b) **print first col. reformated:**

```
awk '{printf "%20.20s\n", $1}' file
```

■ One-liners: <https://github.com/jweslley/dotfiles/blob/master/docs/awk1line.txt>

## ■ sed

→ non-interactive stream editor

→ use for deleting blank or commented lines etc

■ Example: **delete all blank lines of a file:**

```
sed '/^$/d' file
```

■ One-liners: <http://sed.sourceforge.net/sed1line.txt>

# Functions (1)

```
function my_name ()
{
 commands
}
```

- Stores a series of commands for *later* or *repetitive* execution
- Functions are called by writing the **name**
- Functions also process positional parameters
- Example:

```
#!/bin/bash

Purpose: Demonstrating features of functions
Add to printf command the date string
function my_printf ()
{
 printf "${0}: $(date): ${@}"
}

my_printf "Hello World\n"
```

```
./10_fct.sh: Mon Oct 25 11:57:40 CEST 2021: Hello World
```

# Functions (2)

- **local** variables: values do not exist outside function, example:

```
#!/bin/bash
Purpose: Demonstrating features of functions

var1="global value"

Function: assign to global var1 temporarily a local value
function locally_mod_var ()
{
 local var1=${1}
 if [-z "${var1}"] ; then
 return 1
 fi
 echo "fct: local \${var1} = ${var1}"
 var1="new value in fct"
 echo "fct: local \${var1} = ${var1}"
}

echo "main: global \${var1} = ${var1}"
locally_mod_var "${var1}"
echo "main: global \${var1} = ${var1}"
```

`${WORKSHOP}/exercises/01/11_fct.sh`

- **return**: Terminates a function, optionally takes integer = „exit status of the function“, do not use „exit“ integers above 255 (cf. slide 24).

# Trap

- Catch abort signals, e.g.
  - SIGHUP = Hangup
  - SIGINT = Interrupt (Ctrl + C)
  - SIGTERM = Termination signal (kill -15)and do something (e.g. cleanup) before abort

- Example:

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

```
${WORKSHOP}/exercises/01/12_trap.sh
```

```
cleanup(){
 echo "Cleanup before interrupt and exit"
 exit 0
}

Trap interrupt with function cleanup
trap "cleanup" SIGINT

Loop forever doing not really anything
while true ; do
 echo "sleep 10"; sleep 10
done
```

# Lifetime of Variables (1)

- During **script** execution:

- assigned variables only known during runtime
- assigned variables not known in „worker“ scripts until „exported“
- Example:

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

```
${WORKSHOP}/exercises/01/07_master_parse_var.sh
${WORKSHOP}/exercises/01/08_worker_get_var.sh
```

```
Purpose: Demonstrate parsing of assigned variables
```

```
var1="Non-exported value of var1"
```

```
export var2="Exported value of var2"
```

```
worker_sh="./08_worker_get_var.sh"
```

```
check if $worker_sh is executable for user
```

```
echo "${0}: \${var1} = $var1"
```

```
echo "${0}: \${var2} = $var2"
```

```
if [-x "${worker_sh}"] ; then
```

```
 "${worker_sh}"
```

```
fi
```

- **But:** export of variables in script to interactive shell session only via:

```
$ source script.sh (compare ~/.bashrc)
```

## Bonus: Lifetime of Variables (2)

### ■ Environmental variables

a) can be read in e.g. `my_workDIR=${PWD}`

b) during script changed, example:

```
...
Purpose: Demonstrating effects on environmental variables

Changing it during runtime
export HOME="new_home_dir"
echo "${0}: \${HOME} = \${HOME}"
...
```

```
${WORKSHOP}/exercises/01/09_env_var.sh
```

```
$ echo ${HOME}; ./06_env_var.sh; echo ${HOME}
/home/kit/scc/ab1234
./env_var.sh: ${HOME} = new_home_dir
/home/kit/scc/ab1234
```

Thank you for your attention!