



**University of
Zurich^{UZH}**



**URPP Evolution
in Action**

BIO609 - Introduction to UNIX/Linux and Bash Scripting

Basic bash scripting

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What is a bash script?

- Mainly a set of commands that can be executed in the terminal
 - Text file with commands
 - Should begin with the shebang line (`#!/bin/bash`)
 - Executed line by line → new line = new command
 - Run same command with different parameters
 - Create small programs or pipelines
 - Bash script files end with `.sh`
 - Example: `script.sh`
 - ```
#!/bin/bash
```

 → shebang line
    - ```
#this is a comment
```

 → A comment (ignored)
 - ```
echo "Hello World"
```

 → Print something in terminal
- 
- ```
chmod +x script.sh
```

 → Give execution permission
 - ```
./script.sh
```

 → Run script
  - ```
Hello World
```

Write to a file

- “>” will store the output of a command to a file

```
#!/bin/bash
#this is a comment
echo "Hello World" > log.txt
echo "How are you" > log.txt
```

- Print «Hello World» to log.txt file
- Will overwrite the above log.txt file

- “>>” will append the output of a command to the file

```
#!/bin/bash
#this is a comment
echo "Hello World" > log.txt
echo "How are you" >> log.txt
```

- Print «Hello World» to log.txt file
- Append «How are you» to log.txt

Variables

Variables: names for values

- Store data and configuration options
- Make scripts shorter and easier
- Easier to change values
- Create: name followed by “=” and the value
- Call: put “\$” in front of the name,
enclose the name in {} if directly followed by something else
- Example:

```
#!/bin/bash
a=/home/user
echo "My home folder is $a"
echo "My data folder is ${a}/data"
```

→ Create variable with name a

```
My home folder is /home/user
My data folder is /home/user/data
```

Arrays

- Arrays are variables containing multiple values
- Create: name followed by “=()”, values are space separated
- Values can be accessed by their index (number) starting from 0
- Example:

```
#!/bin/bash
col=(red blue yellow)
echo ${col[*]}
col[3]=green
echo ${col[*]}
echo "The sun is ${col[2]}"
echo ${#col[*]}
```

→ Create array with name col

→ Print all elements of the array

→ Set 4. element in the array

→ Return 3. element of the array

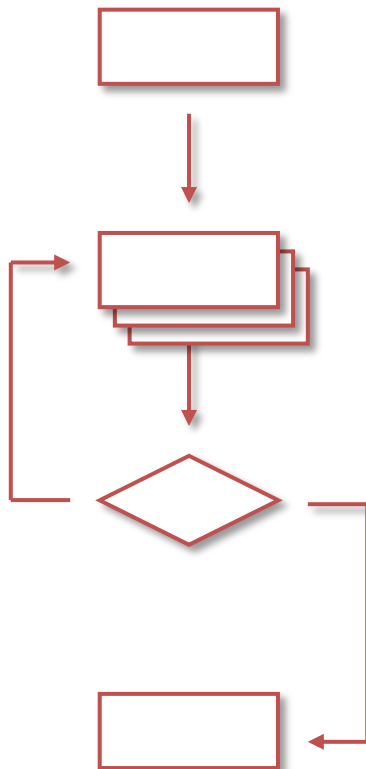
→ Returns the number of elements in the array

```
red blue yellow
red blue yellow green
The sun is yellow
4
```

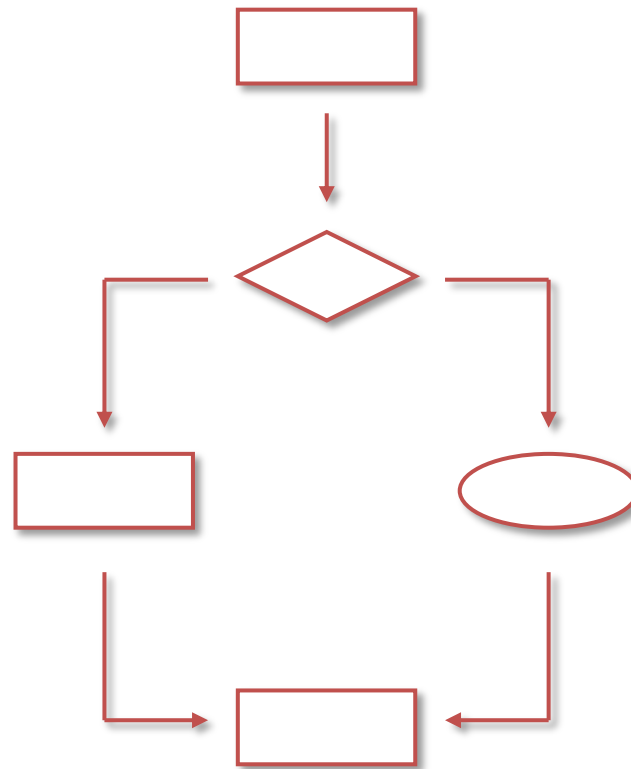
Flow control

- Real power of programs comes from:

repetition



selection



For loop

```
for VARIABLE in 1 2 3
do
    command1
done
```

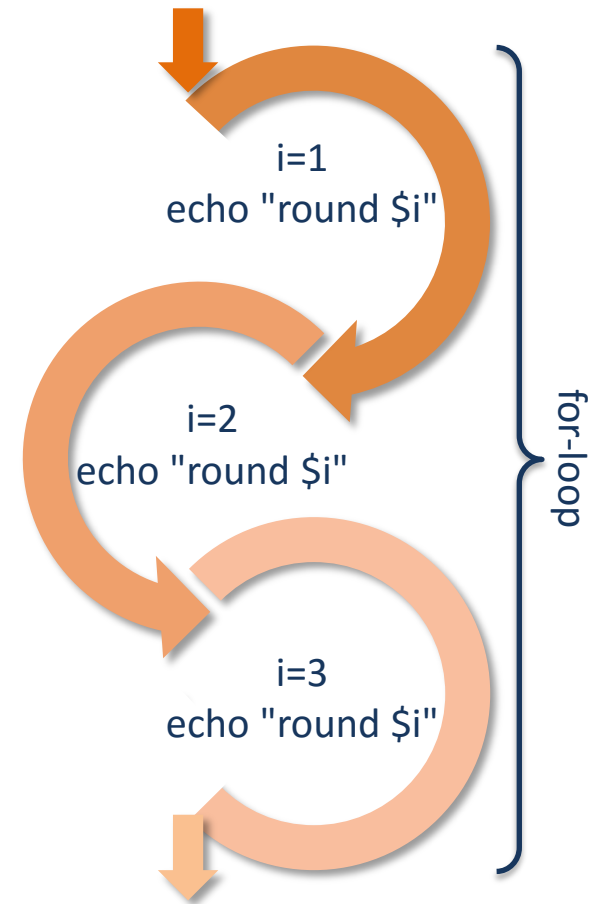
- Can be used to repeat certain tasks

- Examples:

```
#!/bin/bash
for i in 1 2 3
do
    echo "round $i"
done
```

```
#!/bin/bash
for i in {1..3}
do
    echo "round $i"
done
```

```
round 1
round 2
round 3
```



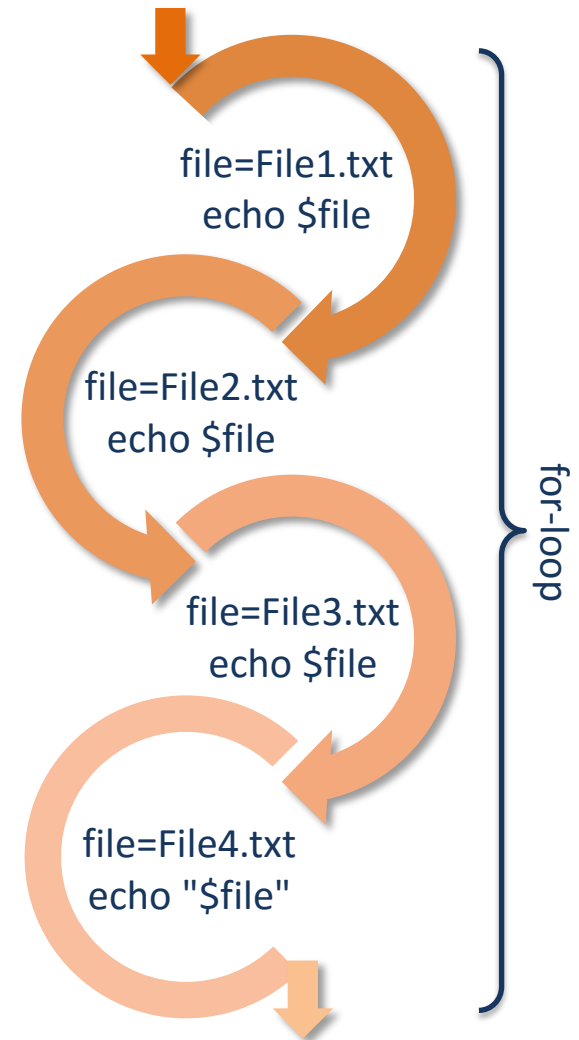
For loop

- Examples:

Go through all files in a folder:

```
#!/bin/bash
for file in /home/user/*
do
    echo $file
done
```

```
File1.txt
File2.txt
File3.txt
File4.txt
```



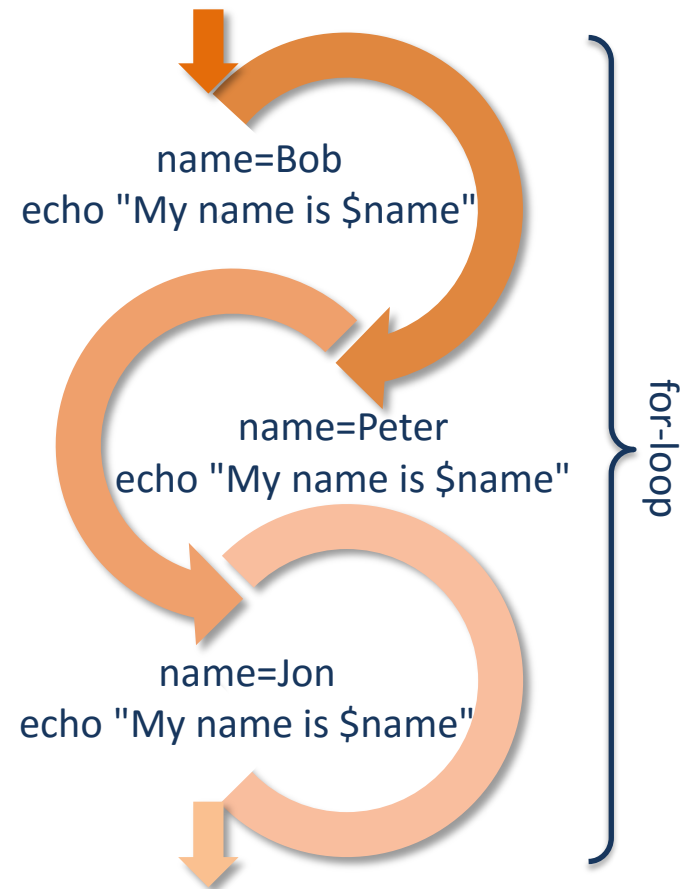
For loop

- Examples:

Go through all items of an array:

```
#!/bin/bash
names=(Bob Peter Jon)
for name in ${names[*]}
do
    echo "My name is $name"
done
```

```
My name is Bob
My name is Peter
My name is Jon
```



While loop

- Can also be used to repeat certain tasks:

```
while [[ something ]]  
do  
    command  
done
```

- Example:

```
#!/bin/bash  
count=0  
while [[ $count -lt 4 ]]  
do  
    echo $count  
    let count+=1  
done  
echo "done"
```

```
0  
1  
2  
3  
done
```

If statement

- If statements can be used to check for something and do something else depending on the outcome of the check → make choices

```
if [[ someting ]]
then
    command1
elif [[ something ]]
then
    command2
else
    command3
fi
```

- Can have any number of `elif` clauses (including none)
- `else` clause is optional
- Always tested in order
 - if one test is true, its block of statements is executed and no other branch is tested

If statement

Boolean operators:

- **-e FILE:** True if file exists

```
#!/bin/bash
if [[ -e log.txt ]]
then
    echo "log file exist"
else
    echo "log file doesn't exist"
fi
```

If statement

Boolean operators:

- **-e FILE:** True if file exists
- **STRING = STRING:** True if first string is identical to the second
- **STRING != STRING:** True if first string is not identical to the second
- **STRING < STRING:** True if first string sorts before the second
- **STRING > STRING:** True if first string sorts after the second

```
#!/bin/bash
name=Bob
if [[ $name = "Rod" ]]
then
    echo "Your name is Rod"
else
    echo "Your name is not Rod"
fi
```

If statement

```
#!/bin/bash
a=10
if [ $a -eq 7 ]
then
    echo "Not equal to 7"
else
    echo "You guessed $a"
fi
```

Boolean operators:

- **-e FILE:** True if file exists
- **STRING = STRING:** True if first string is identical to the second
- **STRING != STRING:** True if first string is not identical to the second
- **STRING < STRING:** True if first string sorts before the second
- **STRING > STRING:** True if first string sorts after the second
- **INT -eq INT:** True if both integers are identical
- **INT -ne INT:** True if integers are not identical
- **INT -lt INT:** True if first integer is less than the second
- **INT -gt INT:** True if first integer is greater than the second
- **INT -le INT:** True if first integer is less than or equal to the second
- **INT -ge INT:** True if first integer is greater than or equal to the second

If statement

```
#!/bin/bash
a=Bob
if [[ $a = "Rob" || $a = "Tod" ]]
then
    echo "Your name is Rod or Tod"
else
    echo "Your name is not Rod or Tod"
fi
```

Boolean operators:

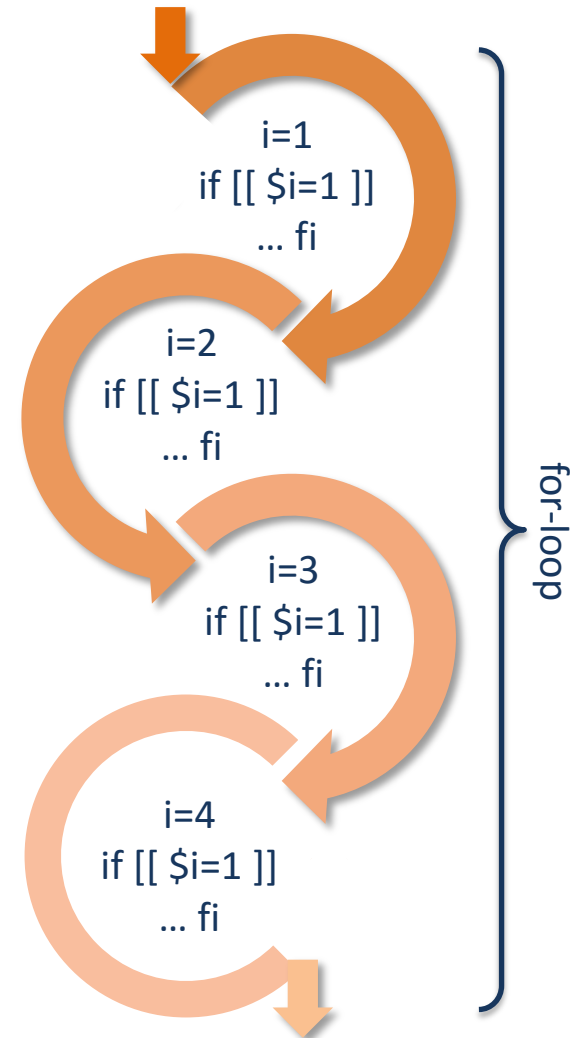
- **-e FILE:** True if file exists
- **STRING = STRING:** True if first string is identical to the second
- **STRING != STRING:** True if first string is not identical to the second
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- **INT -le INT:** True if first integer is less than or equal to the second
- **INT -ge INT:** True if first integer is greater than or equal to the second
- **! EXPR:** Inverts the result of the expression (logical NOT)
- **EXPR && EXPR:** True if both expressions are true (logical AND)
- **EXPR || EXPR:** True if either expression is true (logical OR)

If statement

- Example:

```
#!/bin/bash
for i in {1..4}
do
    if [[ $i = 1 ]]
    then
        echo "first round"
    elif [[ $i = 2 ]]
    then
        echo "second round"
    else
        echo "round $i"
    fi
done
```

```
first round
second round
round 3
round 4
```



Run commands in parallel

- To run a command in the background add & at the end of the line

```
command1 &  
command2 &  
wait
```

→ wait until commands are finished

- This can be used to easily parallelise jobs within a for-loop

```
for i in {1..10}  
do  
  (  
    command1  
    command2  
  ) &  
done  
wait
```

→ Don't forget the wait after the for-loop to make sure that commands are finished before doing the next step

→ **Attention: this will need 10 threads**

Run commands in parallel

- To limit the number of threads one can implement a count variable, which makes sure that only a limited number of threads are started:

```
count=0
for i in {1..10}
do
  (
    command1
    command2
  ) &
  let count+=1
  if [[ $(count%4) -eq 0 ]]
  then wait
  fi
done
wait
```

call wait if count is a multiple of 4, thus only 4 threads are started at once

`$(count%4)`: brackets needed to make sure that expression is interpreted as mathematical operators
(% → modulo, returns the *remainder* of the division)

Functions

- **Functions** are blocks of commands
- Code that you may call multiple times within your script
- Arguments can be passed to functions and be accessed by \$1 (first argument), \$2 (second argument),...
- Example:

```
#!/bin/bash
sum() {
    echo "$1 + $2 = $(( $1 + $2 ))"
}
```

→ Set up function

```
sum 1 4
```

→ Call function

```
sum 8 7
```

→ Call function

```
1 + 4 = 5
8 + 7 = 15
```

Special characters

- **#:** Comment character, anything afterwards on that line is ignored
- **\$:** Expansion character (see variables)
- **"text":** protect the text inside from being split into multiple words or arguments
- **'text':** protect the text inside from being split into multiple words or arguments, but prevents special meaning of all special characters
- **\:** Escape character, prevents the next character from being used in any special sort of way
- **> or <:** Redirection characters, are used to modify (redirect) the input and/or output of a command
- **|:** Pipelines allow you to send the output of one command as the input to another command

```
#!/bin/bash
name=Bob
echo "I am $name"
echo 'I am $name'
echo "I am \ $name"
```

```
I am Bob
I am $name
I am $name
```

Special characters

- **[[expression]]**: evaluates the conditional expression as a logical statement (true/false)
- **{ commands; }**: Command grouping, commands inside the braces are treated as though they were only one command (e.g.: see functions)
- **((expression))**: Inside the parentheses, operators such as +, -, * and / are seen as mathematical operators
- **\$((expression))**: Comparable to the above, but this expression is replaced with the result of its arithmetic evaluation

```
#!/bin/bash
a=4
b=6
echo "The average is (( (a+b)/2 ))"
echo "The average is $(( (a+b)/2 ))"
```

```
The average is (( (a+b)/2 ))
The average is 5
```

Acknowledgment

Tutorials:

- <http://www.allaboutlinux.eu/bash-script-for-beginners/>
 - <http://www.howtogeek.com/67469/the-beginners-guide-to-shell-scripting-the-basics/>
 - http://bash.cyberciti.biz/guide/Main_Page
 - http://www.arachnoid.com/linux/shell_programming.html
 - <http://www.tldp.org/LDP/Bash-Beginners-Guide/html/>
 - <http://ryanstutorials.net/bash-scripting-tutorial/bash-functions.php>
 - <http://mywiki.woledge.org/BashGuide>
- There are a lot of other online tutorials available and forums discussing diverse kinds of topics!