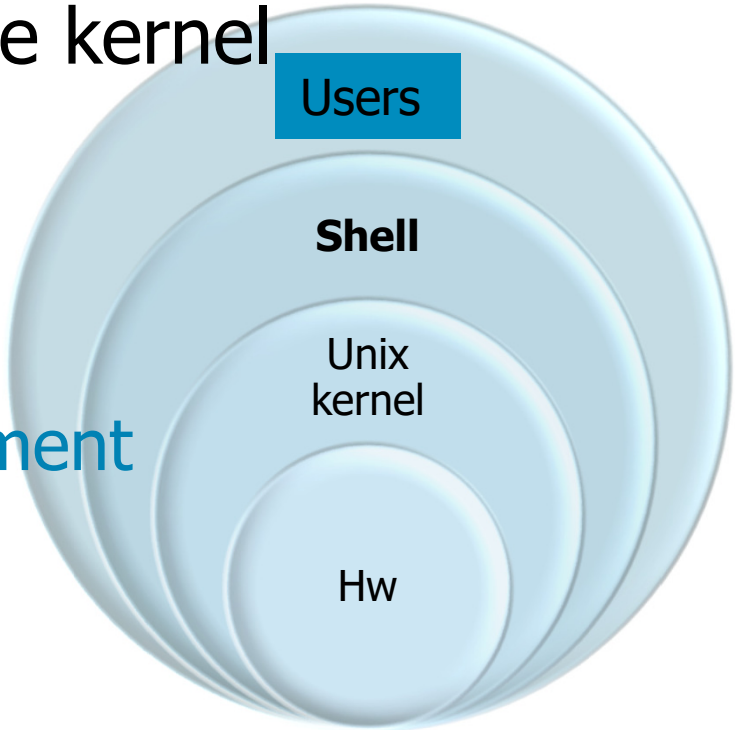
UNIX/Linux Operating System

Shells

Stefano Quer, Pietro Laface, and Stefano Scanzio
Dipartimento di Automatica e Informatica
Politecnico di Torino
skenz.it/os stefano.scanzio@polito.it

Introduction to shells

- The outermost layer of the OS
  - It provides the user interface, which interprets the user commands
  - It was the unique interface before the introduction of graphics servers
- In Unix, a shell is not part of the kernel
  - It is a normal user process
  - Similar to DOS but more powerful
  - Offers a programming environment "native of the OS"



Introduction to shells

- A shell allows
  - Submitting commands on command line
    - The shell automatically understands when the command ends and executes it immediately
  - Writing shell programs (**scripts**)
    - Storing commands in a script file
    - Script execution by submitting the script file
- Writing a script avoids
  - Typing complex command sequences repeatedly
  - Automating tedious, repetitive and error prone tasks

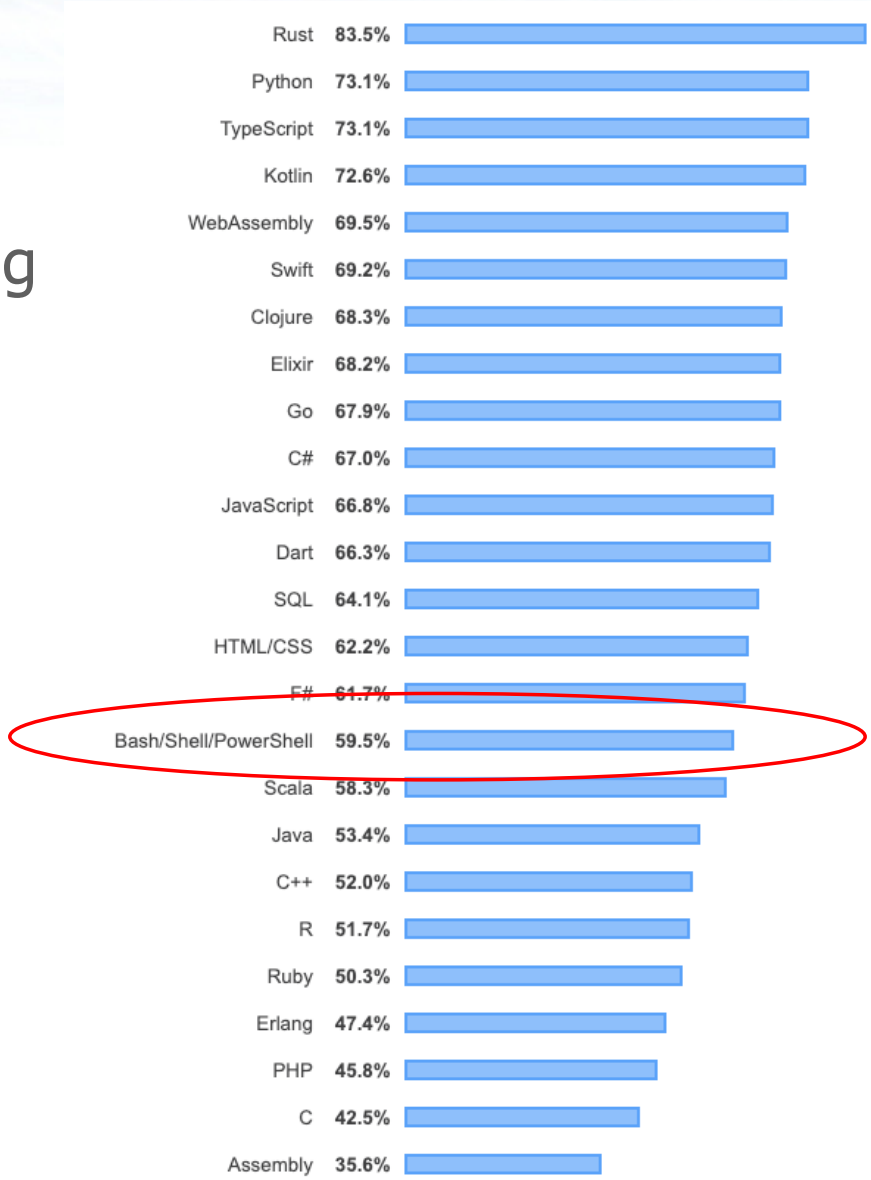
Main shells

List available shells:
cat /etc/shells

Shell	Characteristics
Bourne shell (sh)	Original shell, often used in Unix system programming
C-shell (csh)	Berkeley shell, very good for interactive usage, and for user scripts. Uses a syntax similar to C language
Korn shell (ksh)	Bourne shell rewritten by AT&T to be similar to C-shell
Tahoe C-shell (tcsh)	Tahoe project, an improved C-shell (superset)
Bourne again shell (bash)	Is compatible but extends csh and ksh Standard GNU Shell; POSIX conformant; powerful but not complex. Most sh scripts are interpreted by bash without changes

Main shells

- Shell scripts?
  - From "Stack Overflow"
    - Most Loved Programming Languages in 2019



Bash & co. (59.9%)

Introduction to shells

- Different shells may accept slightly different commands
- Often **/bin/sh** is a link to the current shell
  - The default shell can be modified
    - **chsh** (change login shell)
  - Version in use
    - /bin/bash -version
    - echo $BASH_VERSION

tcsh	bash
set myVar = ”ciao”	myVar=”ciao”
setenv MY_DIR /home/usr/	**export** MY_VAR=/home/usr/
if ($str1==$str2) then … else … endif	if test $str1=$str2 then … else … fi if [$str1=$str2]; then … else … fi

shell execution

- A shell can be activated
  - Automatically at login
  - Nested within another shell
    - As a user program
      - `/bin/tcsh`, `/bin/bash`, …
- A shell exit by typing
  - Command **`exit`**
  - The EOF character (usually Ctrl-d)
    - Exiting an inner shell will return to the outer shell

Introduction to bash

- At login (and exit) a shell looks for, and executes, some configuration files that contain initialization (or termination) commands
- **Startup files** differ in
  - Login files
    - Shell is executed after authentication in the system (password)
  - Non-login files
    - The shell is executed through an icon or system menu

Introduction to bash

- For each login with password, the shell executes
  - Global scripts
    - `/etc/profile`
    - User scripts (executes the first existing file among)
      - `~/.bash_profile`
      - `~/.bash_login`
      - `~/.profile`
  - There is an error in case of incorrect or unreadable file

Introduction to bash

- For each login without a password, the shell executes
  - **`~/.bashrc`**
  - This file often refers to **`~/.bashrc_profile`**
  - It is also the file typically executed in remote login
- For each logout, the shell executes
  - **`~/.bash_logout`**

shell command expansion

- Some characters have special meaning within the shell
- bash provide complex substitution mechanisms
  - After dividing the command line into tokens, the shell expands or solves these tokens, i.e., it applies different types of replacement
    - Braces, tilde, variables and parameters, commands, arithmetic expressions, etc.
  - The substitution is complex and takes place with a specific order

Parentheses

- Parentheses (), [], {}
  - Enclose variables, arithmetic operations, etc.
  - In some cases, they are subject to automatic expansion (brace expansion)

- `name=Jean`
- `echo $namePaul`
- `echo {$name}Paul`

`{Jean}Paul`

- `echo ${name}Paul`

`JeanPaul`

echo: print command

This variable does not exist

Quoting

- "Quoting" means the use of for quotation marks
  - Quotes ' '
    - Variables within quotes are **not expanded**
    - They cannot be nested
  - Double quotes " "
    - Variables within double quotes are **expanded**
    - They can be nested
  - Backslash \
    - Identifies the escape character, which remove the special meaning of the character that follows it

Examples

```
➢ myVar="A string"
➢ echo $myVar
A string

➢ echo 'v = $myVar'
v = $myVar

➢ echo "v = $myVar"
v = A string

➢ echo \$myVar
$myVar
➢ echo "double quote\""
double quote”
```

Variable usage:
- set without **$**
- used with **$**

' ... ' → no expansion

" ... " → expansion

\ cancels the meaning of the next character, which becomes a "meta-character"

Using the output of command

- The standard output of a command can be **captured** by
  - Enclosing the command in $(...)
  - Enclosing the command in **backquotes** ``

Alt-96 → `
Alt-239 → `
Alt-123 → {
Alt-125 → }

- In particular, the output of a command can be stored in a variable

```
d=$(date)
echo $d
Fri Nov 22 10:00:0 \
    CET 2013
d=`date`
...
```

```
out=`cat file.txt`
echo $out
... file content ...

out=`< file.txt`
echo $out
... file content ...
```

Command execution

- In a shell, a command can be executed
  - Directly
    - `cd /home ; ls`

The current shell executes the command; change directory to **`/home`**; executes **`ls`**; at the end the working directory is **`/home`**

  - Indirectly
    - `(cd /home; ls)`

The current shell executes the command **in a subprocess**; change directory to **`/home`**; executes **`ls`**; at the end the working directory is **`the original directory`**

history

- A shell
  - Keeps the list of the last submitted commands
    - In bash, the list is stored in file `.bash_history`
      - Stored in the user home directory
  - Shell commands allow to reference this list

Command	Meaning
`history`	Displays the list of the last submitted commands
`!n`	Executes command number `n` in the history list
`!str`	Executes last command beginning by `str`
`^str1^str2`	Executes last command replacing `str1` by `str2`

Aliasing

- In shell you can define new names to existing commands
  - The **`alias`** command allows defining these names
    - **`alias name="string"`**
      - defines a new alias for "string"

No blanks near symbol =

  - The shell maintains a list of aliases
    - **`alias`**
      - provides the list of active aliases used in the shell
  - Old aliases can be deleted
    - **`unalias name`**
      - Deletes the alias name from the shell

Examples

- `alias`

```
alias egrep='egrep --color=auto'
alias emacs='emacs -r -geometry 100x36 -fn 9x15 &'
alias fgrep='fgrep --color=auto'
alias grep='grep --color=auto'
alias ls='ls --color=auto'
alias mx='xdvi -mfmode ljfour:1200'
```

Existent aliases

- `alias ll= "ls -la"`

Definition of a new alias

- `unalias emacs`
- `unalias ll`

Deletion of a pre-existing alias (the eventual command returns to be what it was)