ICTP DP Linux Basic Course - UNIX/Linux

ESP Students - First Semester

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Course Outline [1]

Daily program

- UNIX/Linux
- **Basic CLI in Linux**
  1. The Shell Command Line
  2. Basic command line programs
  3. Basic file editing
- Programming on Linux
- Text file manipulation
- Basic BASH and Python

Slides:

`http://tinyurl.com/2jsvfbd6`

or the LaTeX source on GitHub:

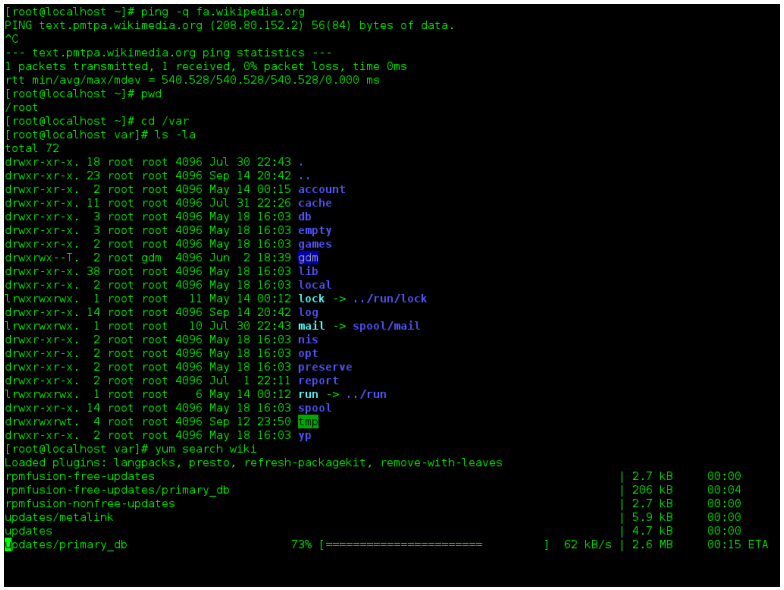
`https://github.com/graziano-giuliani/LinuxBasics`

[1] Course created in 2019 with Adriano Angelone, now LPTMC-FR

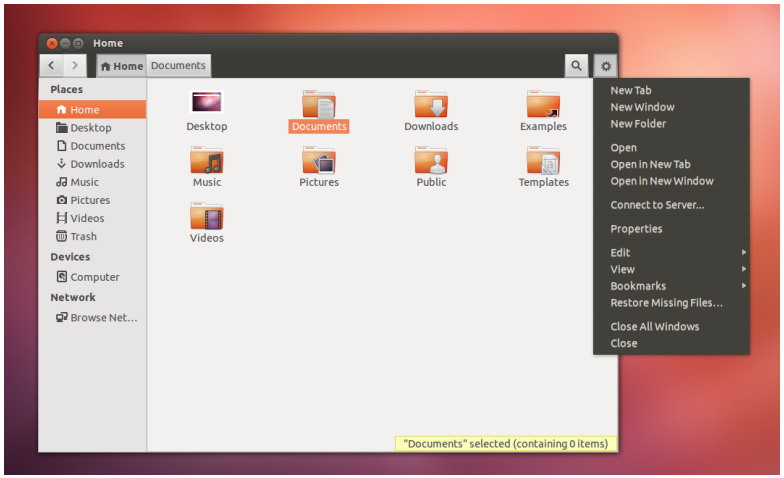
The Command Line

The old terminal

Command Line Interface (CLI): programmable, steep(-ish) learning curve



Graphical User Interfaces (GUI): intuitive, difficult to program



Authentication

Multi-User

To support multiple users, Linux require authentication before authorizing the user programs to allocate system resources.

- **Authentication**: The user is authenticated with username/password challenge by a login program.
- **Authorization**: The system creates an environment by providing the set of system resources the user may access
- **Allocation**: The user access the resources by running programs through a command interpreter.

The command shell

How it works

The SHELL is a text based command interpreter

- waits for the user command input showing up a prompt
- controls the user environment through variables
- executes user commands managing the input, output and error streams

There is not just a single shell program!

Linux Program

Running a program in the CLI

The User must type in a command line at the CLI prompt

A typical UNIX command line contains:

- The name of the program executable
- The options modifying the execution
  - short format: -f
  - long format: - - a_longer_string
- The argument or list of arguments

Options and arguments may have convenient defaults!

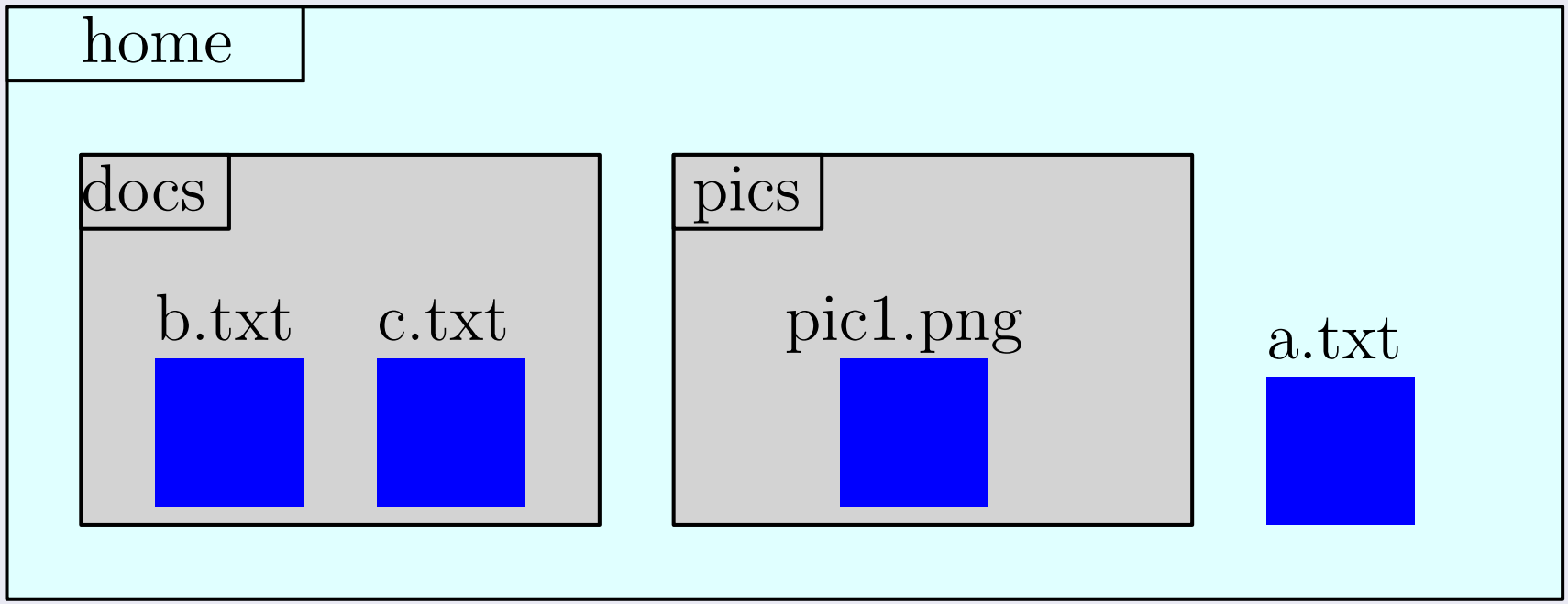
As an example, these are valid syntax for command lines:

```
ls -l Documents
```

```
cp --force theorem.tex Documents
```

Directories contain files, files contain information

`/` is the filesystem root directory



Directories in a path are separated by `/`

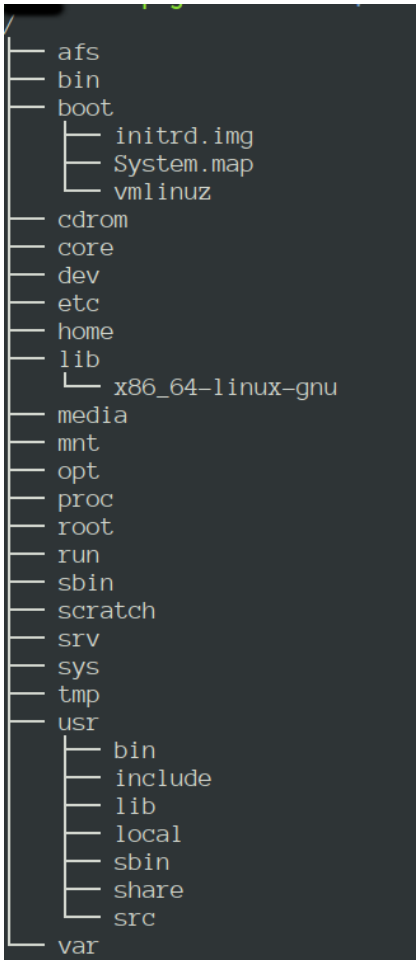
Files and directories have a **full path** in the filesystem:

`/home/docs/c.txt` FQP: Fully Qualified Path

The file system

Filesystem Hierarchy Standard (FHS)

All files and directories appear under the root directory `/`, even if they are stored on different physical or virtual devices.



- `bin` : binaries, contains system executables
- `lib` : libraries, contains shared or static pieces of code which are used by running executables or to create executables
- `tmp` : system or user temporary files
- `etc` : configuration files
- `home` : user files (one directory per user)

Home directory

`.` : the current directory
`..` : the parent of the current directory
`/home/{user}` is the default CWD

Commands

Path finding

Let us try to run the basic programs to navigate the Filesystem:

Print the current directory FQP

`pwd`

`pwd` prints the **fully qualified path** of the current directory

```
[aangelon@login02 ~]$ pwd
/home/aangelon
[aangelon@login02 ~]$
```

In commands, you use by default the **relative path** respect to the **CWD**:
`a.txt` without a path is a file in the current working directory

Have you noticed?

`pwd` does not require options or arguments

`CWD` stands for Current Working Directory

Commands

Moving around

List a file or the files in a directory

```
ls {directory or file}
```

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$
```

Change the working directory

```
cd {directory}
```

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$ cd intel
[aangelon@login02 intel]$ ls
ism
[aangelon@login02 intel]$
```

Have you noticed? Default arguments and options!

`ls` without arguments list the content of the **CWD**

`cd` without arguments change the CWD to the user home directory

Commands

Creating new filesystem objects

Create new directories

`mkdir <directories>`

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$ mkdir new_dir
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  new_dir  scripts
[aangelon@login02 ~]$
```

Create new (empty) text files

`touch <filenames>`

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  new_dir  scripts
[aangelon@login02 ~]$ touch new_example_file
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  new_dir  new_example_file  scripts
[aangelon@login02 ~]$
```

Have you noticed?

A plural is specified above. Guess what it means?

Commands

Removing existing filesystem objects

removes files and directories

`rm <filenames>`

`rm -r <directories>`

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  new_dir  new_example_file  scripts
[aangelon@login02 ~]$ rm new_example_file
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  new_dir  scripts
[aangelon@login02 ~]$ rm -r new_dir
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$
```

ATTENTION!

The remove operation cannot be undone. There is no Trash directory.
Be careful, especially in using the recursive `-r` option!!!

Manual

What are all the possible options?

Reading the manual pages

In CLI mode, you can access the manual page for each command in text format.

```
man <command>
```

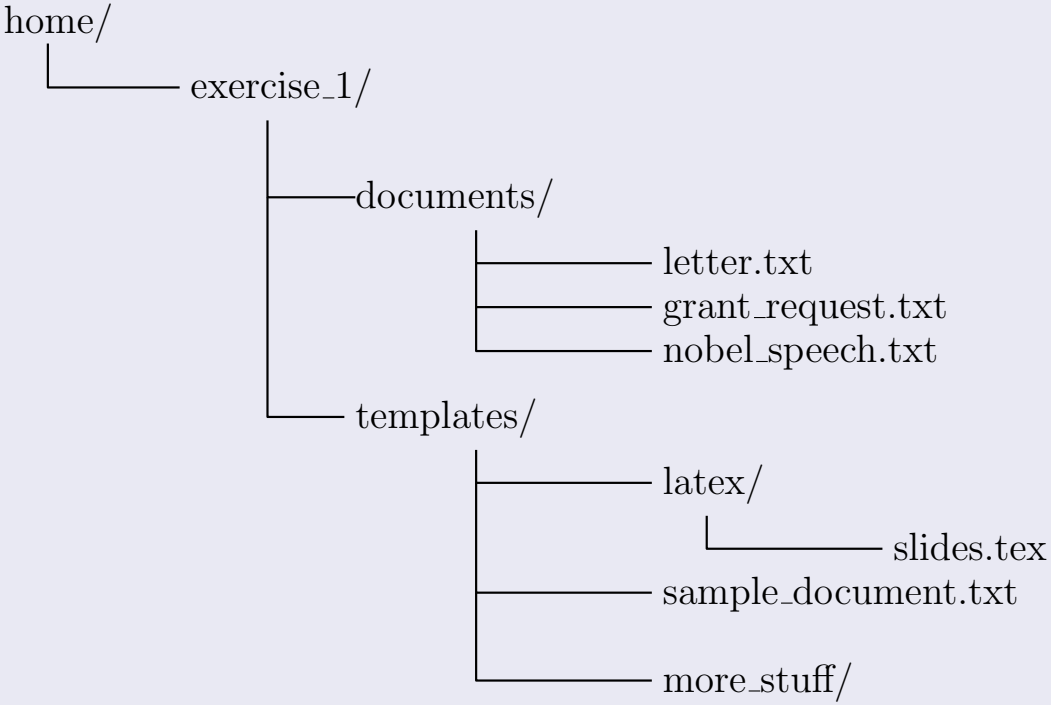
ATTENTION!

The formatting of the manual page on the text window is a complex operation and depends on the available lines/rows of the terminal. To be compatible with old terminals, the best window size for the man program is at **80rows x 24 lines**.

Exercise I

cd, mkdir, touch, rm

Using the commands we have seen, create the below directories and files, and then remove them all (**after carefully checking**):



How to check?

```
ictp-install tree
tree home
```

Solution to Exercise I

Creation part

```
cd
mkdir -p home/exercise_1/documents
mkdir -p home/exercise_1/templates/{latex,more_stuff}
cd home/exercise_1/documents
touch letter.txt grant_request.txt nobel_speech.txt
cd ../templates
touch latex/slides.tex sample_document.txt
cd
```

Removal part

```
cd
rm -r home
```

Commands

Moving and copying files

Copy an object to another location

`cp <old_path> <new_path>`

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$ ls intel
ism
[aangelon@login02 ~]$ cp example_file intel/
[aangelon@login02 ~]$ ls intel
example_file  ism
[aangelon@login02 ~]$
```

```
[aangelon@login02 ~]$ ls
arch  devil  entham  example_file  intel  lpmc  scripts
[aangelon@login02 ~]$ cd intel/
[aangelon@login02 intel]$ ls
ism
[aangelon@login02 intel]$ cp ../example_file ./example_file_2
[aangelon@login02 intel]$ ls
example_file_2  ism
[aangelon@login02 intel]$
```

Attention! `<new_path>` is overwritten and lost!

Suggestion: use `cp -i`

`cp -r`: copy entire directories

Move an object to another location

`mv <old_path> <new_path>`

Same syntax as `cp`, `old_path` is removed after copy.

Commands

Finding and listing files

Recursively searches files in a directory

```
find <directory> <options>
```

- `-name`:
  specify file name (no paths here)
- `-path`:
  specify (part of) the file path
- `-printf %{format}`:
  print details of the items found
- `-delete`:
  deletes the files found

```
~/example_folder » ls
file_1  file_2  file_3  subfolder
-------------------------------------------------------
~/example_folder » ls subfolder
file_1  file_2
-------------------------------------------------------
~/example_folder » find . -name 'file_1'
./subfolder/file_1
./file_1
-------------------------------------------------------
~/example_folder » find . -path '*/file_1'
./subfolder/file_1
./file_1
-------------------------------------------------------
~/example_folder » find . -path '*/*/file_1'
./subfolder/file_1
```

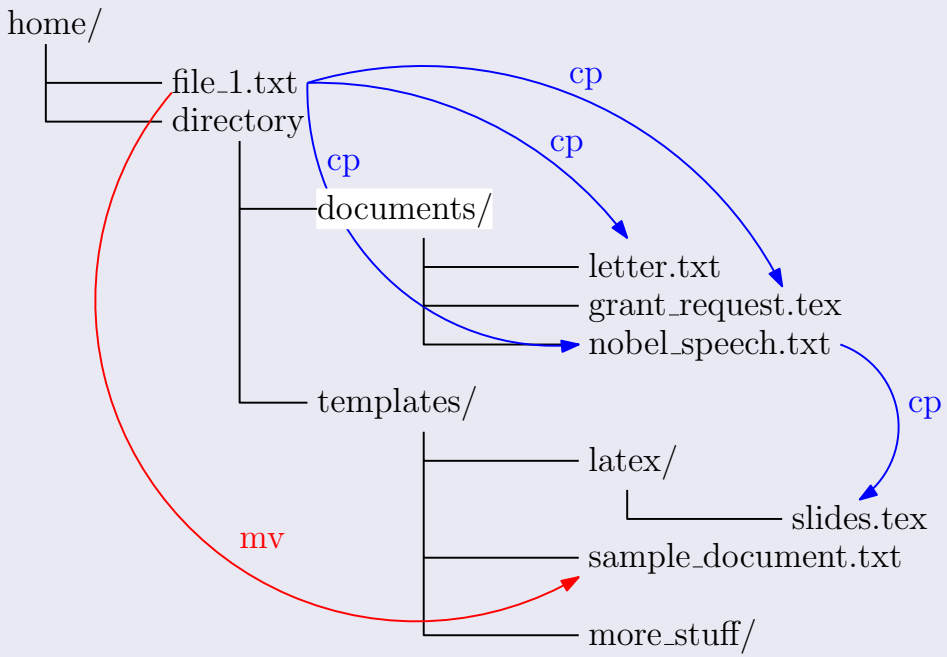
You can use wildcards

`*` can replace any character (more in the future)

Exercise II

cp, mv, find

Using the commands you know, create these directories and files, copying and moving files as shown:



Then, using `find`, show the location of all `.tex` files

Be careful with the order of the operations!

Text file editors

Edit text files from the command line

Install some programs to edit text file

```
ictp-install emacs nano ne tilde vim
```

There is NO default editor program

I have selected the editors in alphabetic order.
You need to try all of them and select the one you like more!

- vim is powerful but arcane
- emacs is even more powerful and arcane
- nano is simple and CTRL based
- ne is simple and ESC based
- tilde is simple and ALT based

Exercise III

Text editing

Using the above command line text editors, create and save a text file `first.csv` with the following content:

```
# Year Month Day Precipitation
2000,06,01,23.0
2000,06,02,3.0
2000,06,03,7.0
2000,06,04,0.0
2000,06,05,2.0
2000,06,06,0.0
2000,06,07,0.0
2000,06,08,0.0
2000,06,09,1.0
2000,06,10,0.0
```

ATTENTION!

Keep the file! We will use it tomorrow!