Computer Science Basics
Unix

Fall Term 2024/2025

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Unix

- Last Week
- GNU/Linux
- Shell
  - Main Functionalities
  - Rights Management
  - Install software
- Binary vs text files
- Conclusion

Last Week

Operating System

Name some Operating Systems

What are the main tasks of Operating Systems?

What means “virtualization” for memory? Why is it important?

What is the difference between a Process and a Program?

GNU/Linux

Linux

Unix Family

- Multi-task and multi-user Operating Systems
- First version in 1969
- Very popular for servers in the 1980s
- Many different versions:
  FreeBSD, NetBSD, OpenBSD, Solaris, OSX, iOS, GNU/Linux et Dalvik/Linux (Android).

GNU/Linux

- Free and open source operating system
- Multitask and multiuser
- Kernel was developed by Linus Torvald in 1991
- Free software, source code is available
- Available in different distributions: Red Hat, Slackware, Debian, Ubuntu ...
- Available for PCs, but more used on servers, smartphones and tablets.

Install GNU/Linux

Install the operating system

- Downloader the system from a server
- Boot from that disk
- Follow the instructions (choice of the language, keyboard, users)

root

- One user is specific: `root`
- Super-user
- Can do everything on the system
- Normal users can not change config files or install / configure applications

Shell

Command Shell

GNU/Linux can be manipulated using a graphical interface

- Each distribution has its own interface
- Quite useful for administration tasks

Shell: Much more useful

- Direct access to information
- Clear commands (no ambiguities)
- Standard for all Unix systems (including Mac OSX, Linux, ...)
- There is no alternative to manage a server
- Problem: you need to know some commands by heart.

Visit directories

See the content of the current directory:

```
$ ls
Desktop    Downloads         examples-php  Pictures  Templates
Documents  examples.desktop  Music         Public    Videos
```

The color allows you to distinguish files from folders.

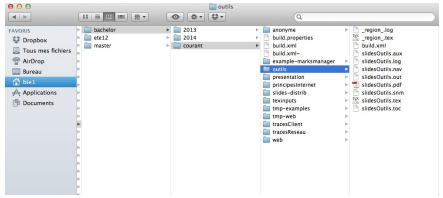
Print the working directory `pwd`

```
$ pwd
/home/emmanuel
$
```

Change the working directory `cd`

```
$ cd Videos
$ pwd
/home/emmanuel/Videos
```


Directory tree



Files and directories form a tree

To visit a directory
`cd myDirectory`

To visit parent directory
`cd ..`

One can move many levels in one command
`cd ../../myDirectory`

The file hierarchy (Cont.)

```
$ pwd
/home/emmanuel
$ ls
Desktop    Downloads         examples-php  Pictures  Templates  Videos
Documents  examples.desktop  Music         Public    tmp
$ cd examples-php/
$ ls
base  basic.zip
$ cd base
$ pwd
/home/emmanuel/examples-php/base
$ cd ../../Downloads/
$ pwd
/home/emmanuel/Downloads
$
```

Manipulate directories

Create a directory: `mkdir myDirectory`

Copy one or many files : `cp originalFile copyFile`

- You can use jokers
- `*` anything (many characters)
- `?` one single character

Remove a file: `rm myFile`

- The same jokers can be used

Remove a directory: `rm -r myDirectory`

Directories (Cont.)

Example:

- Create a directory `tmp`
- Visit this directory
- Copy the file `basic.zip` from the directory `../examples-php/` into `tmp`.

```
$ mkdir tmp
$ cd tmp
$ cp ../examples-php/basic.zip .
$
```


Rights on a file

Each file belongs to one user and one group

- To see the details: `ls -l` ou `ll`

```
$ ls -l
total 52
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Desktop
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Documents
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Downloads
-rw-r--r-- 1 emmanuel emmanuel 8445 Feb 17 21:51 examples.desktop
drwxrwxr-x 3 emmanuel emmanuel 4096 Feb 18 10:21 examples-php
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Music
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Pictures
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Public
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Templates
drwxrwxr-x 2 emmanuel emmanuel 4096 Feb 18 15:01 tmp
drwxr-xr-x 2 emmanuel emmanuel 4096 Feb 17 21:57 Videos
```


Rights (Cont.)

Different rights

- Read - `r`
- Write - `w`
- Execute - `x`

Different users

- user owner of the file (user - `u`)
- users belonging to the group (group - `g`)
- any other user (other - `o`)

Representation of the rights

```
rwxr-xr--
 \ /\ /\ /
  v  v  v
  |  |  rights for other users (o)
  |  rights for the group (g)
 rights for the user (u)
```

Change Rights

`sudo` **to execute a command as the** `root`

Change Owner - `chown`

```
$ ll
total 8
-rw-r--r-- 1 root root 178 Feb 17 22:04 index.html
$ chown emmanuel index.html
chown: changing ownership of ‘index.html’: Operation not permitted
$ sudo chown emmanuel index.html
[sudo] password for emmanuel:
$ ll
total 8
-rw-r--r-- 1 emmanuel root 178 Feb 17 22:04 index.html
$
```


Change Rights (Cont.)

Change Group - `chgrp`

```
$ ls -l
total 8
-rw-r--r-- 1 emmanuel root 178 Feb 17 22:04 index.html
-rw-r--r-- 1 root     root 177 Feb 17 22:01 index.html~
lrwxrwxrwx 1 root     root  22 Feb 17 22:16 phpmyadmin -> /usr/share/phpmyadmin/
$ chgrp emmanuel index.html
$ ls -l
total 8
-rw-r--r-- 1 emmanuel emmanuel 178 Feb 17 22:04 index.html
-rw-r--r-- 1 root     root     177 Feb 17 22:01 index.html~
lrwxrwxrwx 1 root     root      22 Feb 17 22:16 phpmyadmin -> /usr/share/phpmyadmin/
```


Change Rights (Cont.)

Change the rights on a file or a directory - `chmod`

```
$ cp index.html test.html
cp: cannot create regular file ‘test.html’: Permission denied
$ cd ..
$ ls -l
total 48
...
drwxr-xr-x  2 root root     4096 Feb 17 22:16 www
$ chmod og+w www
chmod: changing permissions of ‘www’: Operation not permitted
$ sudo chmod og+w www
$
```


Install software

At the beginning of Unix

- Download source files
- Read the documentation
- Configure system
- Install new libraries
- Compile
- Install

Package managers

- You can download an install any application in one sentence
- Manages dependances automatically
- Very easy to manage software
- Automatic update of the programs (for patching management)

Install software (Cont.)

Install a package [1]
```
sudo apt install apache2
```

Remove a package
```
sudo apt remove apache2
```

Upate Package Index for the list of available packages
```
sudo apt update
```

Update packages for patching all the software you have (all the programs at once)
```
sudo apt upgrade
```

[1] `apache2` is an example for a package

Binary vs text files

Binary vs. text files

Different file formats
- Proprietary file formats: doc, ppt, xls
- Images: jpeg, gif, png
- Documents: pdf
- Executable: exe, dll, so, class
- Texts: txt, xml, html, tex
- Program source files: java, asm, cpp, c

Two big families
- Binary files (office, images, executables, …)
- Text files (txt, tex, html, source files, …)

Text files

Text files
- ASCII files
- Each letter is encoded on 1 byte
- Standardized on 7 bits (for English)
- 94 visible characters
- Plus other invisibles like: cariage return, tab, space, bell, …

Text files encoding
- Different encoding formats for accents
- Depends on the language: western Europeans, eastern Europeans, …
- ISO latin1, UTF-8, …

Letters encoded on more than one byte
- Unicode permits to encode any language
- Characters can be coded on more than one byte
- Arabic, chinese, herbrew, …

How to see text data?
- Using any text editor or IDE: notepad (windows), gEdit, Emacs, Kate, Eclipse, Net Beans …

Binary files

Proprietary file formats

- Office files (Word, Excel, Powerpoint, …)
- Many other applications

Executable files

- Windows: exe,
- Linux: elf (32 bits), elf64 (64-bit)
- Contain machine instructions encoded in binary
- Can be analyzed using a **decompiler**

Images

- tiff: bitmap of an image (high-quality photos)
- jpeg: format family, lossy compression (for online photos)
- gif: 8-bit color, animations possible (legacy)
- png: 32-bit color, no animations, modern lossless compression (screenshots)
- File formats are known, libraries manipulate those binary files

Hexadecimal Editor can read any binary format (in hex)

Example of Binary File

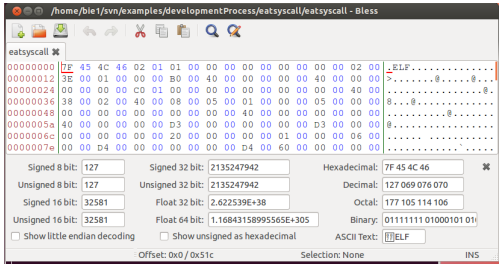
Using the editor `Bless`

- Can open a file

Two versions

- See the text version on the left (bytes are interpreted as chars)
- See the binary version on the right
- Can read and edit any binary
- You can edit executable files: BUT DO NOT DO IT!

The binary editor Bless



Interpreting Raw Data

Data is ultimately always encoded in binary

- Common format for text is ASCII
- Capital letter “S” in encoded with ox53
- Corresponds also to the decimal number 83
- In the computer it is a set of 8 bits ob01010011
- This pattern can be anything else in a binary computer program
- Can be part of an instruction
- Can be part of a 16-bit number
- Can be part of a 32-bit integer
- Can be any data (floating point numbers, objects, address, …)

Example

- `0x 53` may be interpreted as value 83
- `0x 53 61` may be interpreted as the decimal 21’345
- `0x 53 61 6D 0A` may be interpreted as the decimal 1’398’893’834
- `0x 53 61 6D 0A 77 61 73 0A` may be interpreted as the floating point $4.543650386409 77.10^{93}$

Conclusion

Conclusion

Unix is representing 95% of all servers

- GNU/Linux, Solaris, FreeBSD, OpenBSD, MacOS-X, …

But also 100% of all Smartphones

- Android and iOS are both Unix systems.

Different types of files : Text files

- stored in ASCII or other encodings (topic of next week)
- Source of programs, texts, XML, HTML, CSS,

Different types of files : Binary files

- Write data with a specific encoding
- Programs (runnable), Databases, …
- Some standards are proprietary some are open.
- We will see standards for images.