Introduction to Linux

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What is Linux?

Operating System (OS) based on UNIX

- Multiuser → Allows more than one user at the same time
- Multitasking → Allows more than one program executed at the same time
- Networking → Allows network access
- Various user interfaces → Different “desktops” allowed

Other UNIX-based OS?

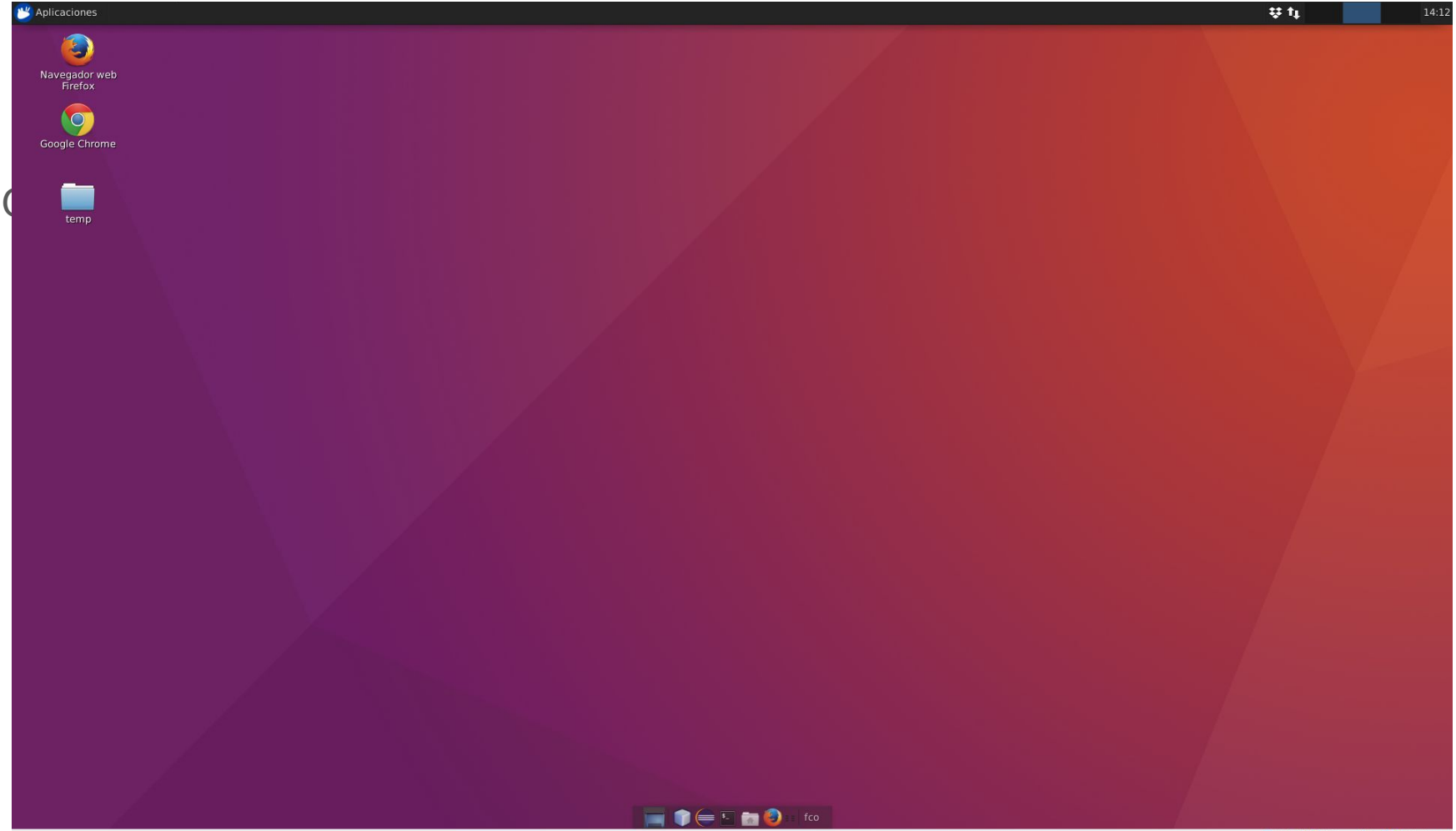
- Mac OS
- Android

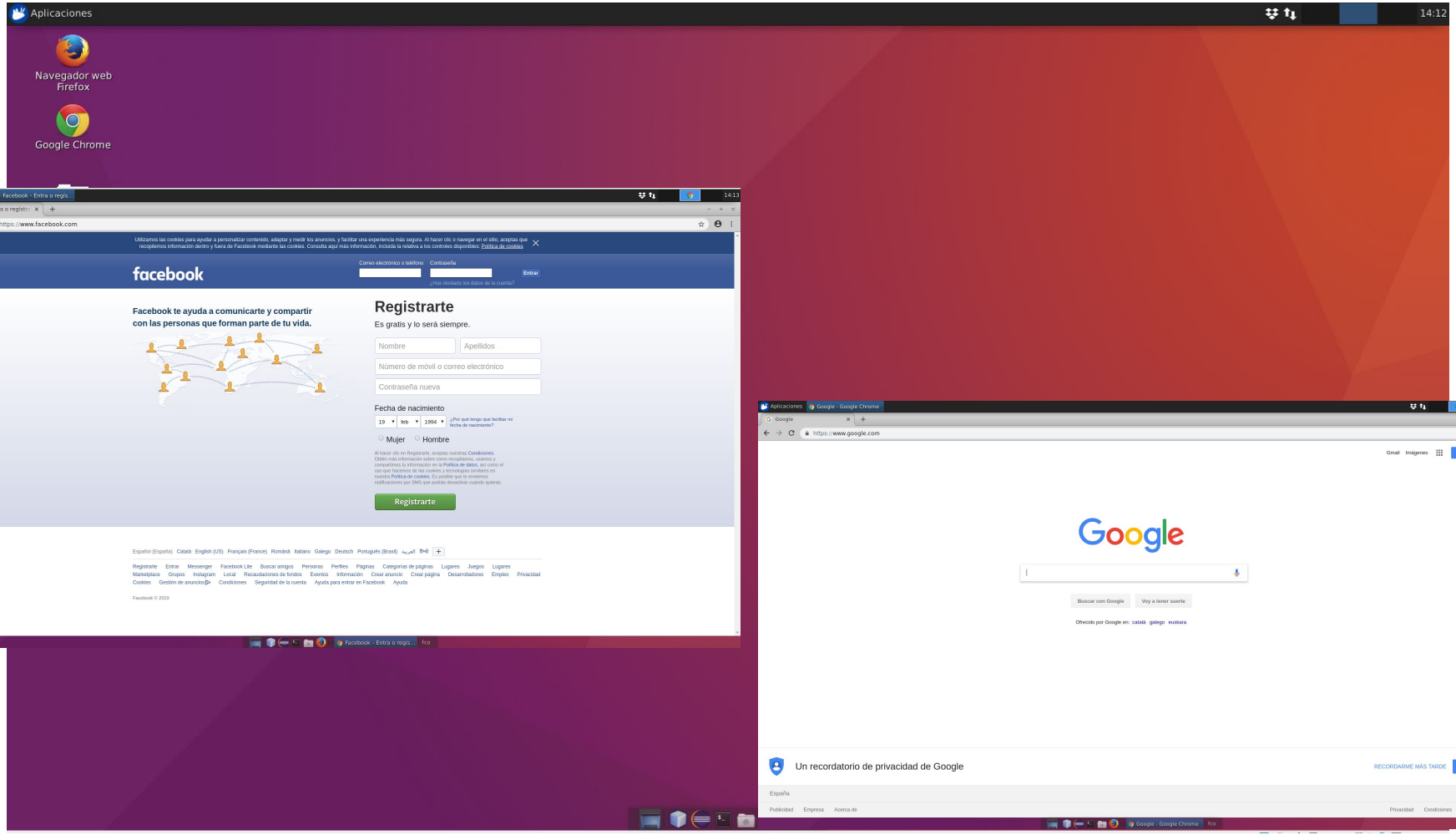
How many Linux are?

- Debian
- Ubuntu
- Linux Mint
- Red Had
- Fedora
- OpenSuse
- CentOS
- Gentoo
- ...

Is Linux difficult to use?

Graphic User Interface (Desktop)


Aplicaciones
14:12
Navegador web Firefox
Google Chrome
temp
fco


Aplicaciones
14:12
Navegador web Firefox
Google Chrome
Aplicaciones
Facebook - Entra o regis...
14:13
Facebook - Entra o regist...
https://www.facebook.com
Utilizamos las cookies para ayudar a personalizar contenido, adaptar y medir los anuncios, y facilitar una experiencia más segura. Al hacer clic o navegar en el sitio, aceptas que recopilemos información dentro y fuera de Facebook mediante las cookies. Consulta aquí más información, incluida la relativa a los controles disponibles: Política de cookies
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Apellidos
Número de móvil o correo electrónico
Contraseña nueva
Fecha de nacimiento
19
feb
1994
¿Por qué tengo que facilitar mi fecha de nacimiento?
Mujer
Hombre
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Registrarte Entrar Messenger Facebook Lite Buscar amigos Personas Perfiles Páginas Categorías de páginas Lugares Juegos Lugares Marketplace Grupos Instagram Local Recaudaciones de fondos Eventos Información Crear anuncio Crear página Desarrolladores Empleo Privacidad Cookies Gestión de anuncios Condiciones Seguridad de la cuenta Ayuda para entrar en Facebook Ayuda
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Aplicaciones
Google - Google Chrome
14:13
Google
https://www.google.com
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Iniciar sesión
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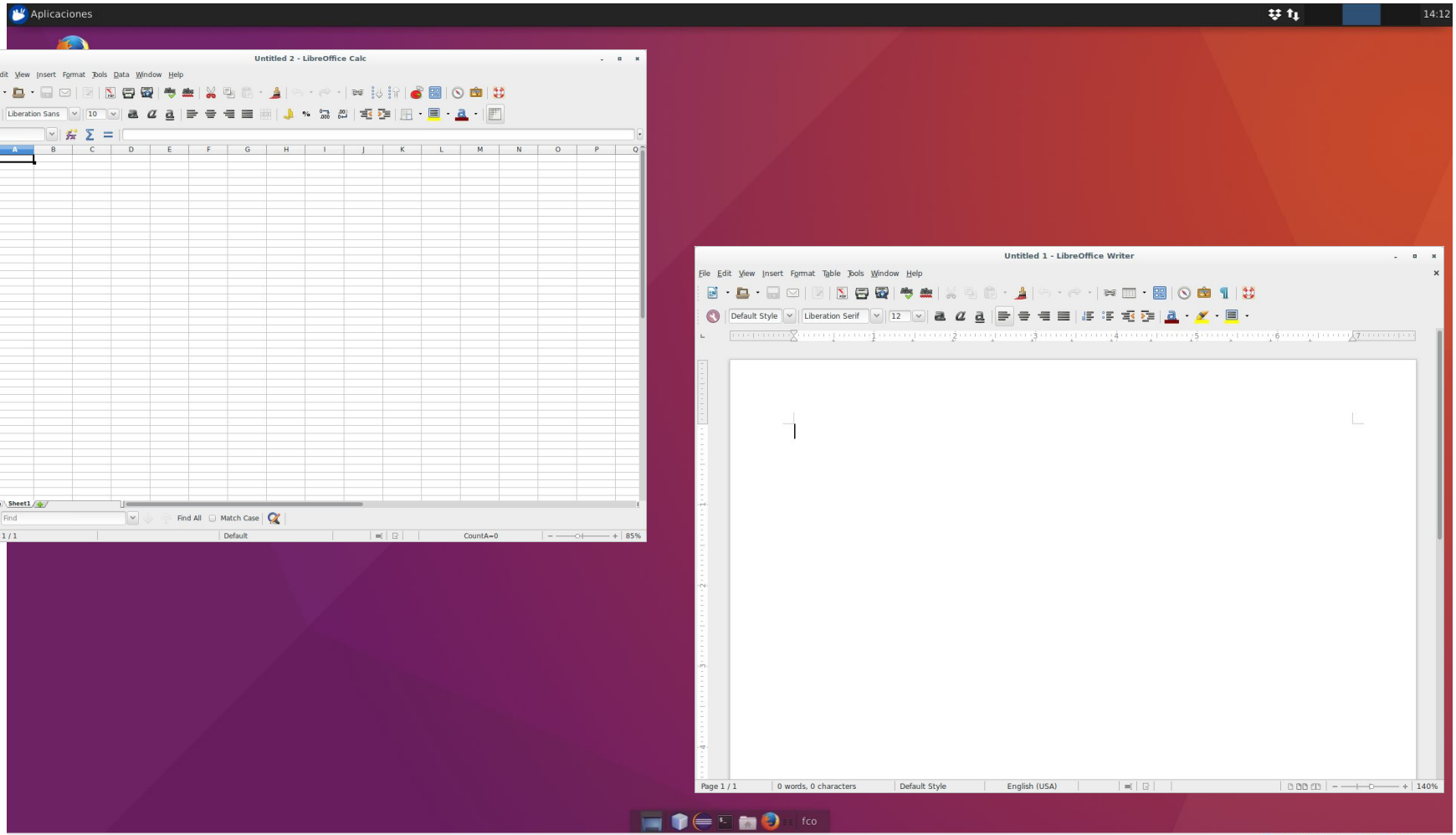
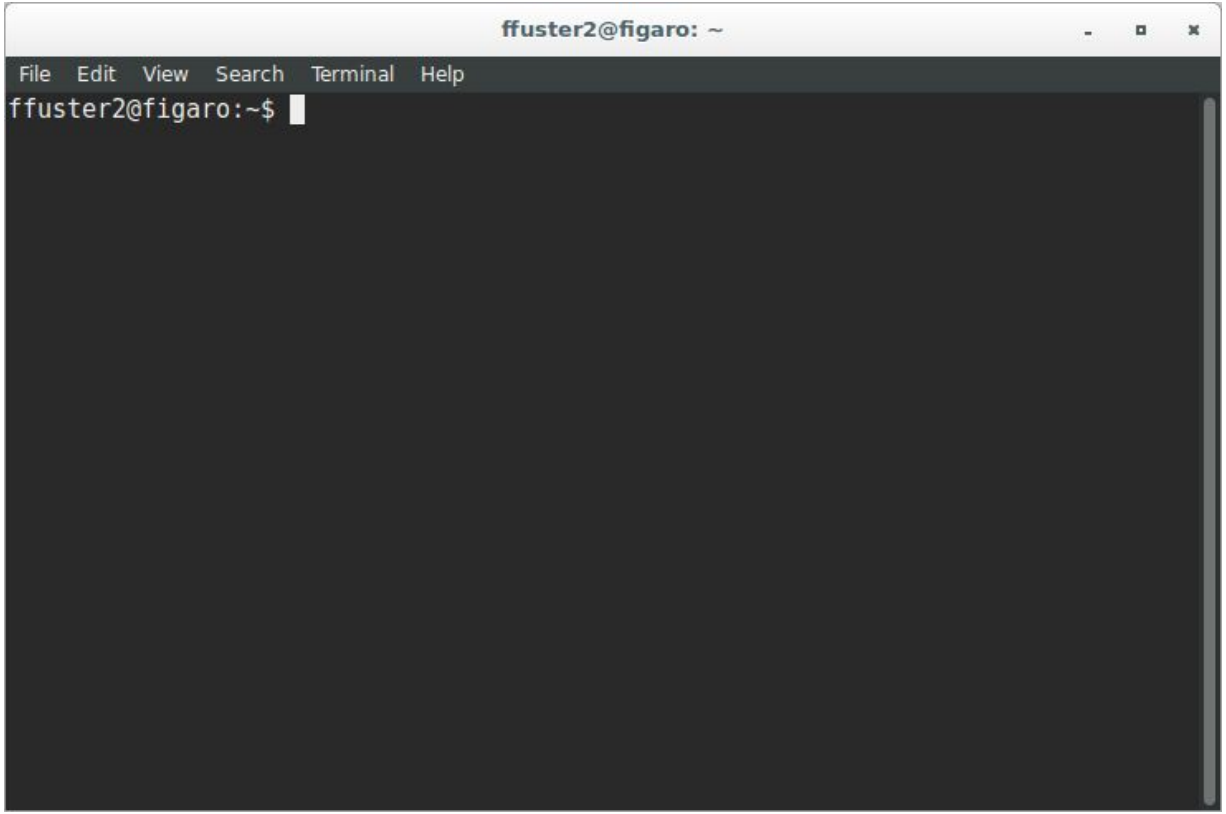
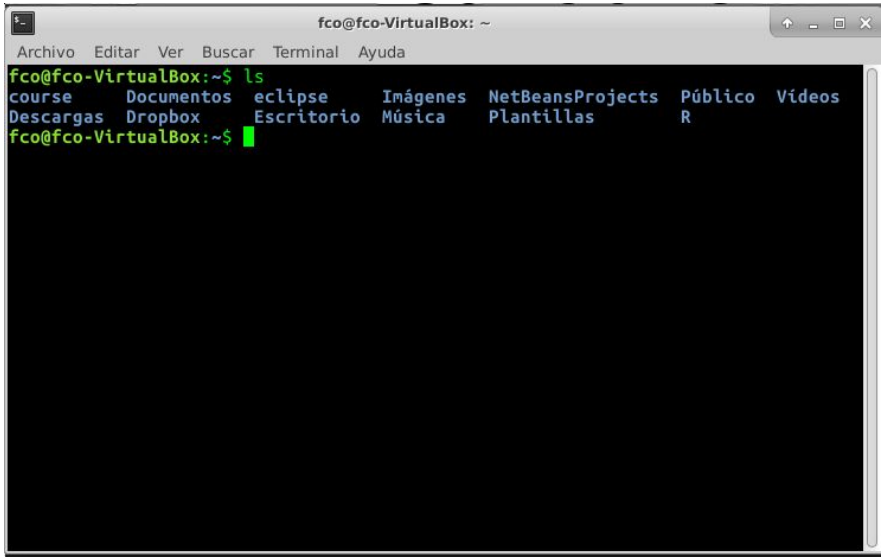
Voy a tener suerte
Ofrecido por Google en: català galego euskara
Un recordatorio de privacidad de Google
RECORDARME MÁS TARDE
LEER AHORA
España
Publicidad Empresa Acerca de
Privacidad Condiciones Configuración
Google - Google Chrome
fco

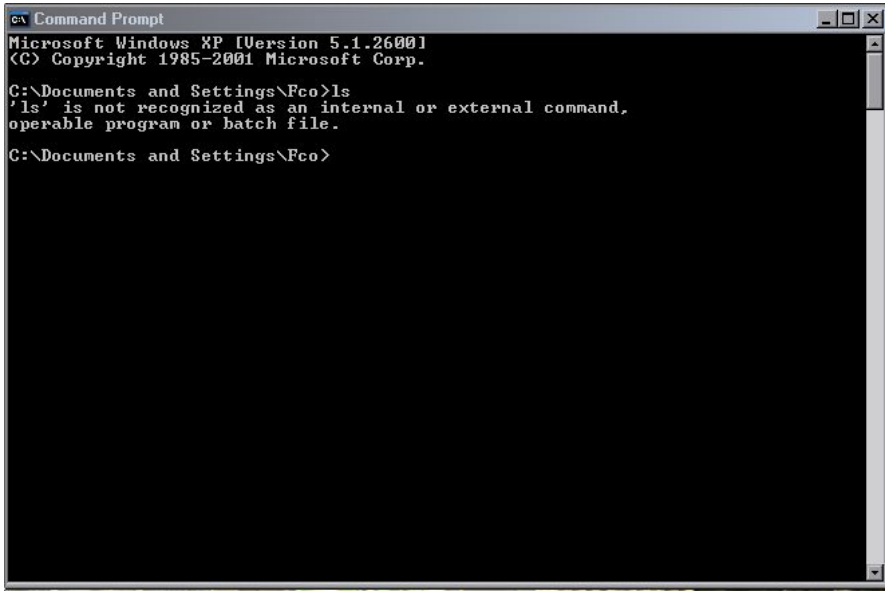

Aplicaciones
14:12
Untitled 2 - LibreOffice Calc
File Edit View Insert Format Tools Data Window Help
Liberation Sans
10
A1
Sheet1
Find
Find All
Match Case
Sheet 1 / 1
Default
CountA=0
85%
Untitled 1 - LibreOffice Writer
File Edit View Insert Format Table Tools Window Help
Default Style
Liberation Serif
12
Page 1 / 1
0 words, 0 characters
Default Style
English (USA)
140%
fco

But...

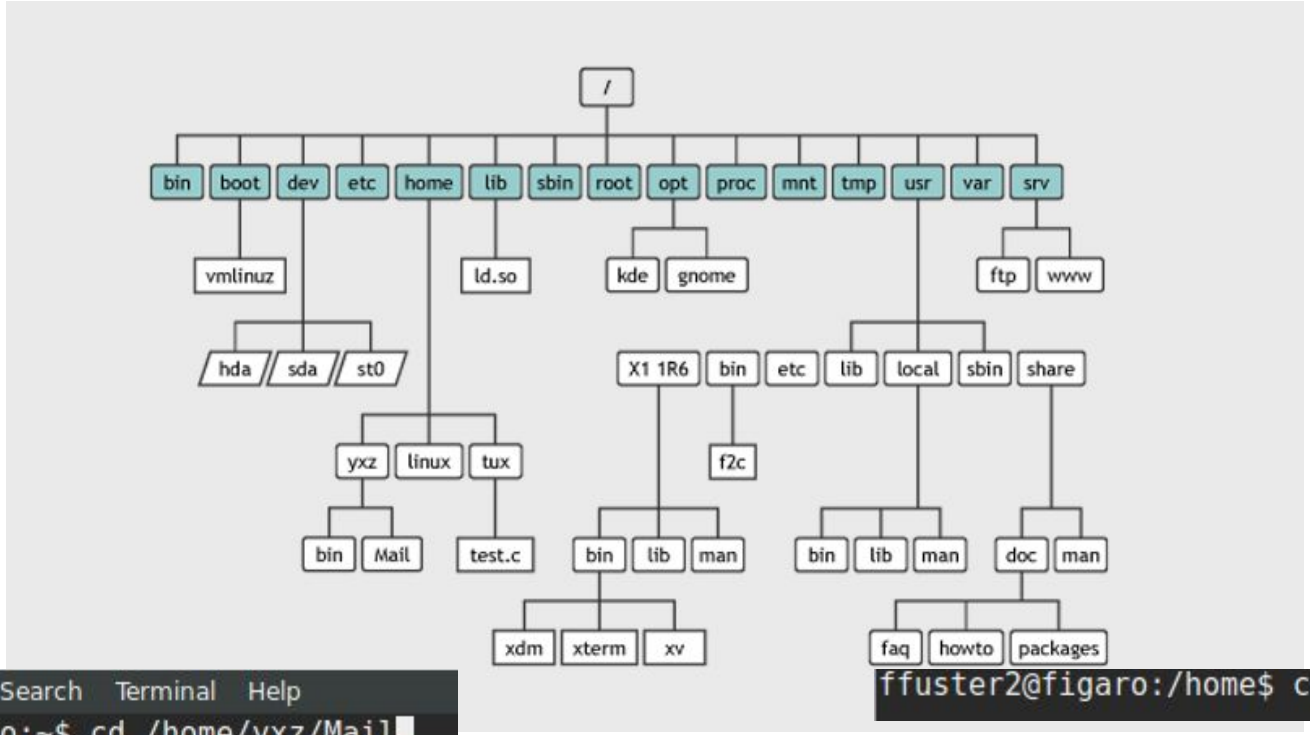

ffuster2@figaro: ~
File Edit View Search Terminal Help
ffuster2@figaro:~$

Differences between Windows & UNIX





The Linux filesystem

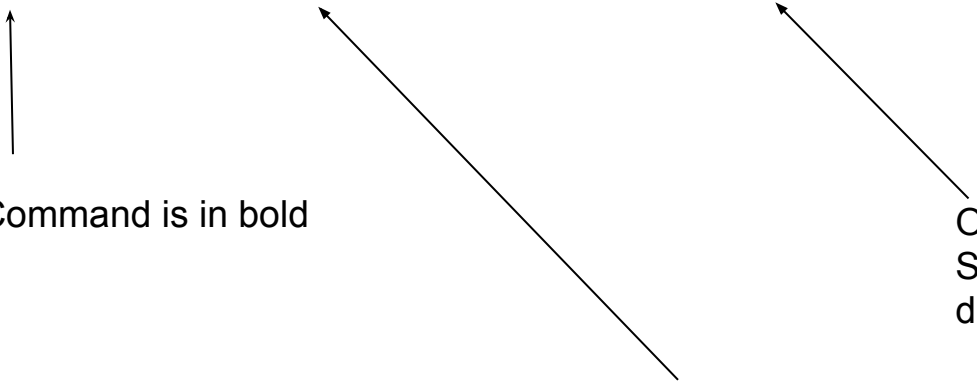



```
File  Edit  View  Search  Terminal  Help
ffuster2@figaro:~$ cd /home/yxz/Mail
```

```
ffuster2@figaro:/home$ cd yxz/Mail
```

Special considerations

command -x -y --option [other_parameters]



Command is in bold

Other parameters are surrounded by ‘[ ]‘. Square brackets are written just to distinguish between parameters

Command options start by ‘-’ or ‘--’

Linux basic commands (1). Folder navigation

- **cd** [folder] → Navigation in directories
- **ls** → List the files/directories in a path
- **pwd** → Get absolute path of current directory
- **mkdir** [folder_name] → creates the folder [folder_name] in the current path
- **find** [path] -name [pattern] → Searches files in the specified position

```
fco@fco-VirtualBox:~$ ls
Descargas   Dropbox  Escritorio  Música           Plantillas  R
Documentos  eclipse  Imágenes    NetBeansProjects  Público     Vídeos
fco@fco-VirtualBox:~$ cd Escritorio/
fco@fco-VirtualBox:~/Escritorio$ ls
firefox.desktop  google-chrome.desktop  temp
```

```
fco@fco-VirtualBox:~/Escritorio$ pwd
/home/fco/Escritorio
```

```
fco@fco-VirtualBox:~/Escritorio$ find . -name new*
./new_dir
```

```
fco@fco-VirtualBox:~/Escritorio$ mkdir new_dir
fco@fco-VirtualBox:~/Escritorio$ ls
firefox.desktop  google-chrome.desktop  new_dir  temp
```

Exercise (1)

Go to your home folder /home/user

Create the directory ‘course’ in you home folder

List all the elements you have in your home folder

Get absolute path of your folder

Exercise (1)

Go to your home folder /home/user

```
fco@fco-VirtualBox:~$ cd /home/fco/
```

Create the directory ‘course’ in you home folder

```
fco@fco-VirtualBox:~$ mkdir course
```

List all the elements you have in your home folder

```
fco@fco-VirtualBox:~$ ls
course     Documentos  eclipse     Imágenes  NetBeansProjects  Público  Vídeos
Descargas  Dropbox     Escritorio  Música    Plantillas        R
```

Get absolute path of your folder

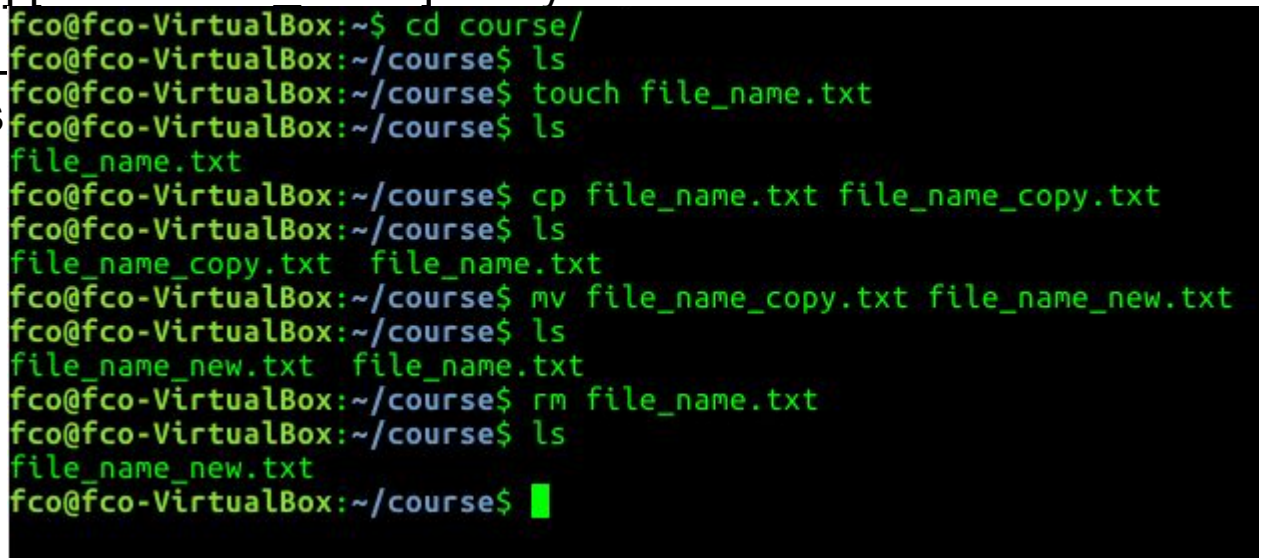
```
fco@fco-VirtualBox:~$ pwd
/home/fco
```

Linux basic commands (2). Copy, move, remove files

- **touch** [file_name] → creates an empty file called [file_name]
- **cp** [file_origin] [file_destination] → copy [file_origin] in [file_destination]
- **rsync** [origin_folder] [destination_folder] → Synchronize both folders
- **mv** [file_origin] [file_destination] → move [file_origin] to [file_destination]
- **rm** [file] → removes [file]

Linux basic commands (2). Copy, move, remove files

- **touch** [file_name] → creates an empty file called [file_name]
- **cp** [file_origin] [file_destination] → copy [file_origin] in [file_destination]
- **rsync** [origin_folder] [destination_folder] → Synchronize both folders
- **mv** [file_origin] [file_
- **rm** [file] → removes



Exercise (2)

Create a new file called ex2.sh in your home folder

Copy this file to your recently created folder

Remove the file from your home folder

Exercise (2)

Create a new file called ex2.sh in your home folder

```
fco@fco-VirtualBox:~$ touch ex2.sh
```

Copy this file to your recently created folder

```
fco@fco-VirtualBox:~$ cp ex2.sh course/
```

Remove the file from your home folder

```
fco@fco-VirtualBox:~$ rm ex2.sh
```

Exercise (2)

Create a new file called ex2.sh in your home folder

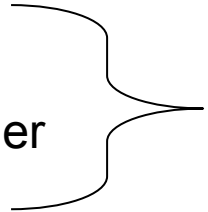
```
fco@fco-VirtualBox:~$ touch ex2.sh
```

Copy this file to your recently created folder

```
fco@fco-VirtualBox:~$ cp ex2.sh course/
```

Remove the file from your home folder

```
fco@fco-VirtualBox:~$ rm ex2.sh
```



```
fco@fco-VirtualBox:~$ mv ex2.sh course/
```

Linux commands (3). Working with files

- **head** -n [number_of_lines] [file]→ Show first [number_of_lines] of the [file]
- **tail** -n [number_of_lines] [file] → Show last [number_of_lines] of the [file]
- **cat** [file] → Print all the file
- **less** [fille] → Print all the file
- **grep** [word] [file] → Find [word] in [file]
- **cut** -f [columns] [file] → Show only [columns] of [file]
- **sort** -k [column] [file]→ Sort the lines of a file by [column]
- **diff** [file1] [file2] → Compare [file1] and [file2] line by line
- **uniq** [file] → Report or omit repeated lines in file
- **tr** → Translate or delete characters

Examples (2)

cat & less

```
fco@fco-VirtualBox:~$ less example.txt
fco@fco-VirtualBox:~$ cat example.txt
Hi humans!
This is just a text example
With a lot of different lines
I'm planning to have, at least 20
But I think I'm not going to have enough ideas
I will try
No, sure I haven't
How many lines do we have? 8
Bullshit, not enough. We need at least 10 more
So...
What I'm going to write?
Idea! just count last lines and that's it
Line 13
Line 14
Line 15
Line 16
Line 17
Almost done. This is 18
Second last: 19
And line 20!! Got it!
Congratulations!
fco@fco-VirtualBox:~$
```

```
Hi humans!
This is just a text example
With a lot of different lines
I'm planning to have, at least 20
But I think I'm not going to have enough ideas
I will try
No, sure I haven't
How many lines do we have? 8
Bullshit, not enough. We need at least 10 more
So...
What I'm going to write?
Idea! just count last lines and that's it
Line 13
Line 14
Line 15
Line 16
Line 17
Almost done. This is 18
Second last: 19
And line 20!! Got it!
Congratulations!
~
~
(END)
```

Examples

head & tail

```
fco@fco-VirtualBox:~$ head -n 5 example.txt
Hi humans!
This is just a text example
With a lot of different lines
I'm planning to have, at least 20
But I think I'm not going to have enough ideas
fco@fco-VirtualBox:~$
```

```
fco@fco-VirtualBox:~$ tail -n 8 example.txt
Line 14
Line 15
Line 16
Line 17
Almost done. This is 18
Second last: 19
And line 20!! Got it!
Congratulations!
fco@fco-VirtualBox:~$
```

Examples (3)

diff

```
fco@fco-VirtualBox:~$ cp example.txt example2.txt
fco@fco-VirtualBox:~$ echo "new line attached" >> example2.txt
fco@fco-VirtualBox:~$ tail example2.txt
Line 13
Line 14
Line 15
Line 16
Line 17
Almost done. This is 18
Second last: 19
And line 20!! Got it!
Congratulations!
new line attached
fco@fco-VirtualBox:~$ diff example.txt example2.txt
21a22
> new line attached
fco@fco-VirtualBox:~$ diff example2.txt example.txt
22d21
< new line attached
fco@fco-VirtualBox:~$
```

Examples (4)

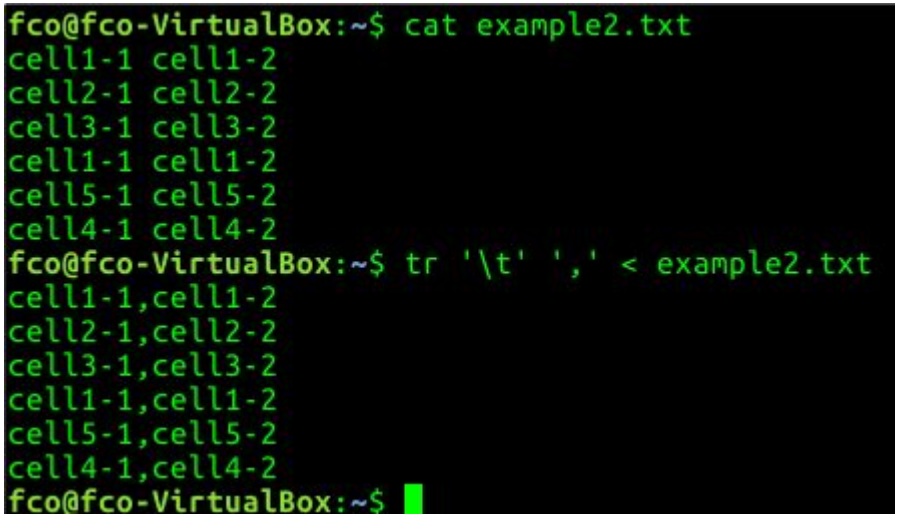
sort, uniq & cut

```
fco@fco-VirtualBox:~$ cat example2.txt
cell1-1 cell1-2
cell2-1 cell2-2
cell3-1 cell3-2
cell3-1 cell3-2
cell3-1 cell3-2
cell4-1 cell4-2
fco@fco-VirtualBox:~$ cut -f 1 example2.txt
cell1-1
cell2-1
cell3-1
cell3-1
cell3-1
cell4-1
fco@fco-VirtualBox:~$ uniq example2.txt
cell1-1 cell1-2
cell2-1 cell2-2
cell3-1 cell3-2
cell4-1 cell4-2
fco@fco-VirtualBox:~$
```

```
fco@fco-VirtualBox:~$ sort example.txt
Almost done. This is 18
And line 20!! Got it!
Bullshit, not enough. We need at least 10 more
But I think I'm not going to have enough ideas
Congratulations!
Hi humans!
How many lines do we have? 8
Idea! just count last lines and that's it
I'm planning to have, at least 20
I will try
Line 13
Line 14
Line 15
Line 16
Line 17
No, sure I haven't
Second last: 19
So...
This is just a text example
What I'm going to write?
With a lot of different lines
fco@fco-VirtualBox:~$
```

Examples (5)

tr



Exercise (3)

Copy exercise.tsv in course folder

Print last 10 lines of the file

Print 6th column of the file

Convert all the ‘:’ to ‘-’ in the file

Exercise (3)

Copy exercise.tsv in course folder

```
ffuster2@figaro:~/course$ cp /media/ffuster2/USB\ DISK/exercise.tsv .
```

Print last 10 lines of the file

```
ffuster2@figaro:~/course$ tail -n 10 exercise.tsv
chr3    128199429       T       649     568     T:555:2
chr3    128199662       G       797     786     G:422:2
chr3    128204951       C       562     540     C:261:2
chr3    128205860       G       302     297     G:0:0:0
chr3    128206618       C       251     240     C:123:2
chr3    128206710       T       173     167     T:0:0:0
chr3    136056728       G       723     719     G:697:2
chr3    136056861       T       775     771     T:1:1:6
chr3    136191272       C       447     434     C:430:2
chr3    168801495       C       743     734     C:1:1:5
```

Print 6th column of the file

```
ffuster2@figaro:~/course$ cut -f 6 exercise.tsv
base:reads:strands:avg_qual:map_qual:plus_reads:minus_reads
T:451:2:42:1:308:143:183
T:635:2:44:1:409:226:0
G:650:2:45:1:472:178:13
A:307:2:37:1:154:153:0
A:0:0:0:0:0:0:0
T:567:2:36:1:518:49:0
A:545:2:32:1:509:36:2
```

Convert all the ‘:’ to ‘-’ in the file

```
ffuster2@figaro:~/course$ tr ':' '-' < exercise.tsv
chrom   position        ref_base        depth   q20_depth       base-reads-
chr1    35649754        T       647     634     T-451-2-42-1-308-143-183
-3-AAA-1-1-13-1-1-0     INS-1-A-54-2-41-1-32-22 INS-2-AA-7-2-32-1-5-2
chr1    35649768        T       669     645     T-635-2-44-1-409-226-0  T
chr1    35649862        G       692     663     G-650-2-45-1-472-178-13 GA
chr1    35658369        A       347     308     A-307-2-37-1-154-153-0  A
```

Special characters

‘>’ [file] → Store the output in [file]

‘>>’ [file] → Append output to [file]

2> [file] → Store error output to [file]

2>> [file] → Append output error to [file]

‘<’ [file] → Use [file] as input

‘;’ → Separator between commands

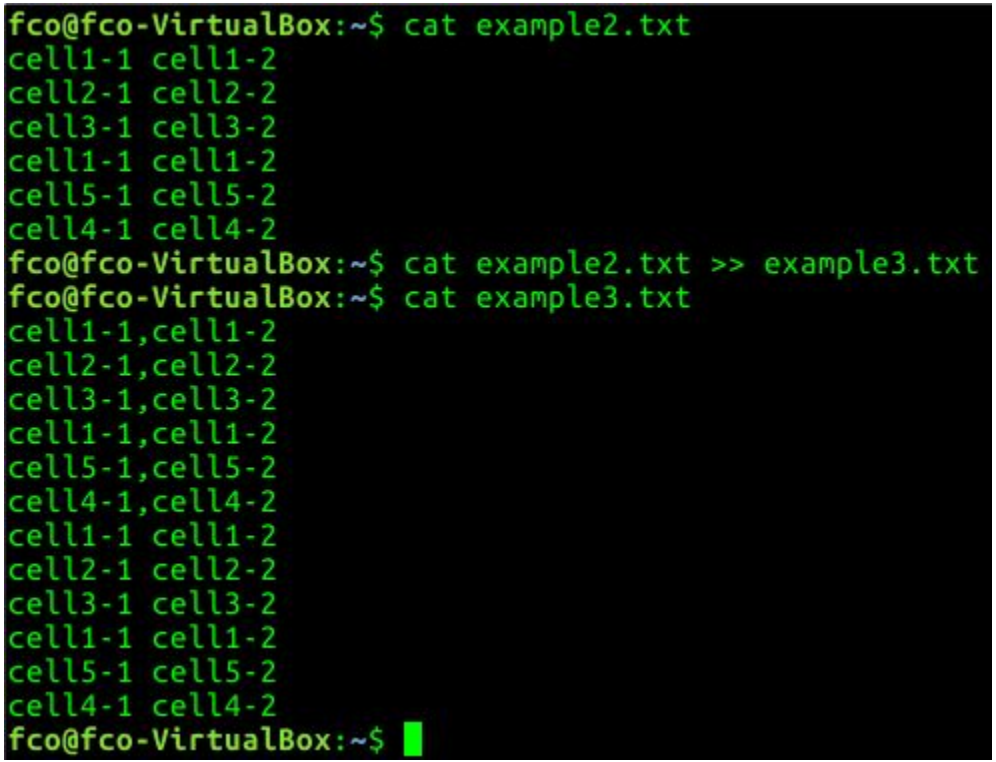
‘|’ → Send the output to other program (pipe)

‘*’ → All characters

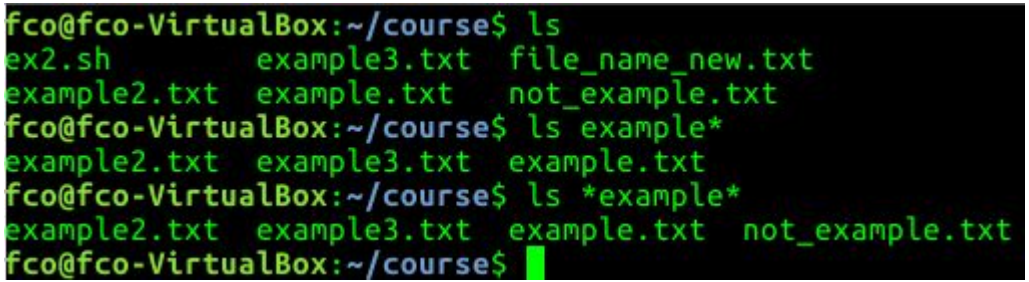
Examples

```
fco@fco-VirtualBox:~$ cat example2.txt
cell1-1 cell1-2
cell2-1 cell2-2
cell3-1 cell3-2
cell1-1 cell1-2
cell5-1 cell5-2
cell4-1 cell4-2
fco@fco-VirtualBox:~$ tr '\t' ',' < example2.txt
cell1-1,cell1-2
cell2-1,cell2-2
cell3-1,cell3-2
cell1-1,cell1-2
cell5-1,cell5-2
cell4-1,cell4-2
fco@fco-VirtualBox:~$ tr '\t' ',' < example2.txt > example3.txt
fco@fco-VirtualBox:~$ cat example3.txt
cell1-1,cell1-2
cell2-1,cell2-2
cell3-1,cell3-2
cell1-1,cell1-2
cell5-1,cell5-2
cell4-1,cell4-2
fco@fco-VirtualBox:~$
```

Examples


fco@fco-VirtualBox:~$ cat example2.txt
cell1-1 cell1-2
cell2-1 cell2-2
cell3-1 cell3-2
cell1-1 cell1-2
cell5-1 cell5-2
cell4-1 cell4-2
fco@fco-VirtualBox:~$ cat example2.txt >> example3.txt
fco@fco-VirtualBox:~$ cat example3.txt
cell1-1,cell1-2
cell2-1,cell2-2
cell3-1,cell3-2
cell1-1,cell1-2
cell5-1,cell5-2
cell4-1,cell4-2
cell1-1 cell1-2
cell2-1 cell2-2
cell3-1 cell3-2
cell1-1 cell1-2
cell5-1 cell5-2
cell4-1 cell4-2
fco@fco-VirtualBox:~$

Examples


fco@fco-VirtualBox:~/course$ ls
ex2.sh example3.txt file_name_new.txt
example2.txt example.txt not_example.txt
fco@fco-VirtualBox:~/course$ ls example*
example2.txt example3.txt example.txt
fco@fco-VirtualBox:~/course$ ls *example*
example2.txt example3.txt example.txt not_example.txt
fco@fco-VirtualBox:~/course$

Examples

```
fco@fco-VirtualBox:~/course$ grep "!" example.txt
Hi humans!
Idea! just count last lines and that's it
And line 20!! Got it!
Congratulations!
fco@fco-VirtualBox:~/course$ grep "!" example.txt | tr "!" "?"
Hi humans?
Idea? just count last lines and that's it
And line 20?? Got it?
Congratulations?
fco@fco-VirtualBox:~/course$ grep "!" example.txt | tr "!" "?" | sort
And line 20?? Got it?
Congratulations?
Hi humans?
Idea? just count last lines and that's it
fco@fco-VirtualBox:~/course$ grep "!" example.txt | tr "!" "?" | sort | tr "?" "."
And line 20.. Got it.
Congratulations.
Hi humans.
Idea. just count last lines and that's it
fco@fco-VirtualBox:~/course$
```

Exercise (4)

Print 1st column of exercise.tsv and store the output in a new file called exercise2.tsv

Add to exercise2.tsv, the first 5 lines of exercise.tsv

Find ‘:’ in exercise2.tsv. Convert ‘.’ to ‘,’. Store the output in new file called exercise3.tsv

Exercise (4)

Print 1st column of exercise.tsv and store the output in a new file called exercise2.tsv

```
fco@fco-VirtualBox:~/course$ cut -f 1 exercise.tsv > exercise2.tsv
```

Add to exercise2.tsv, the first 5 lines of exercise.tsv

```
fco@fco-VirtualBox:~/course$ head -n 5 exercise.tsv >> exercise2.tsv
fco@fco-VirtualBox:~/course$ tail -n 10 exercise2.tsv
chr3
chr3
chr3
chr3
chr3
chrom   position        ref_base        depth   q20_depth       base:reads:strands:avg_qual:map_qual:plus_reac
chr1    35649754        T       647     634     T:451:2:42:1:308:143:183        TA      0       0       0
-3-AAA:1:1:13:1:1:0     INS-1-A:54:2:41:1:32:22 INS-2-AA:7:2:32:1:5:2
chr1    35649768        T       669     645     T:635:2:44:1:409:226:0  T       635     2       44      1
chr1    35649862        G       692     663     G:650:2:45:1:472:178:13 GA      0       0       0       0
chr1    35658369        A       347     308     A:307:2:37:1:154:153:0  A       307     2       37      1
fco@fco-VirtualBox:~/course$
```

Find ‘:’ in exercise2.tsv. Convert ‘:’ to ‘,’. Store the output in new file called exercise3.tsv

```
fco@fco-VirtualBox:~/course$ grep ':' exercise2.tsv | tr ':' ',' > exercise3.tsv
fco@fco-VirtualBox:~/course$ cat exercise3.tsv
chrom   position        ref_base        depth   q20_depth       base,reads,strands,avg_qual,map_qual,plus_reads,minus_reads
chr1    35649754        T       647     634     T,451,2,42,1,308,143,183        TA      0       0       0       0       0       0       A,1,1,34,1,0,1  DEL-1-A,105,2,44,1,80,25        DEL-2-AA,19,2,43,1,11,8 DEL
-3-AAA,1,1,13,1,1,0     INS-1-A,54,2,41,1,32,22 INS-2-AA,7,2,32,1,5,2
chr1    35649768        T       669     645     T,635,2,44,1,409,226,0  T       635     2       44      1       409     226     0       A,8,2,46,1,6,2
chr1    35649862        G       692     663     G,650,2,45,1,472,178,13 GA      0       0       0       0       0       0       DEL-1-A,7,2,38,1,3,4    INS-1-A,7,2,46,1,3,4
chr1    35658369        A       347     308     A,307,2,37,1,154,153,0  A       307     2       37      1       154     153     0
fco@fco-VirtualBox:~/course$
```

Linux commands (4). Other useful commands

- **man** [command] → Get the manual of [command]
- **wc** [file] → Print newline, word, and byte counts of [file]
- **history** → Print all the commands used
- **clear** → “Cleans” the terminal
- **echo** [“Some words”] → Prints [“some words”] in the terminal

Exercise (5)

What is the parameter in ‘wc’ command to print only the number of lines that file has?

Print all the ‘cd’ command you have used during the course

Exercise (5)

What is the parameter in ‘wc’ command to print only the number of lines that file has?

```
ffuster2@figaro:~/course$ man wc
ffuster2@figaro:~/course$
ffuster2@figaro:~/course$ wc -l exercise.tsv
40 exercise.tsv
```

Print all the ‘cd’ command you have used during the course

```
ffuster2@figaro:~/course$ history | grep cd
```

Merging all

We can combine different instructions if needed

```
#!/bin/bash

#Do all exercises at once
cd /home/fco #Go to home folder
mkdir course #Create new folder
cd course #Go to folder
touch ex2.sh #Create new blank file
cp /media/ffuster/USB/exercise.tsv . #Copy example exercise from the USB.
tr ':' '-' < exercise.tsv > exercise2.tsv #Change ‘:’ to ‘-’ in the file and store the ouput in a new file
sort exercise2.tsv > exercise3.tsv #Sort the file and store it in a new file
```

Merging all

We can combine different instructions if needed

```
#!/bin/bash

#Do all exercises at once
cd /home/fco #Go to home folder
mkdir course #Create new folder
cd course #Go to folder
touch ex2.sh #Create new blank file
cp /media/ffuster/USB/exercise.tsv . #Copy example exercise from the USB.
tr ':' '-' < exercise.tsv > exercise2.tsv #Change ‘:’ to ‘-’ in the file and store the ouput in a new file
sort exercise2.tsv > exercise3.tsv #Sort the file and store it in a new file
```

My first bash script!!

Bash scripts. Variables

Pieces of code that can get whatever value

```
fco@fco-VirtualBox:~/course$ cat script1.sh
#! /bin/bash

variable="My first variable"

echo $variable
fco@fco-VirtualBox:~/course$ ./script1.sh
My first variable
fco@fco-VirtualBox:~/course$
```

Special variables:

- $1 - $9 → Get the value of first - ninth option
- …

Bash Scripting. If statement

Piece of code that will be executed if a condition is true

```
#!/bin/bash

#My first if statement
if [ condition ]
then
        [Commands that will be executed if condition is true]
else
        [Commands that will be executed if the condition is false]
fi
```

Bash Scripting. If statement

Piece of code that will be executed if a condition is true

```
#!/bin/bash

#My first if statement
if [ condition ]
then
        [Commands that will be executed if condition is true]
else
        [Commands that will be executed if the condition is false]
fi
```

Bash scripting. For loop

Piece of code that will be executed several times

```
#!/bin/bash

#My first for loop
for ( )
do
        [Commands that will be executed several times]
done
```

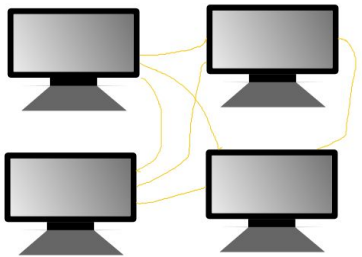
Bash scripting. For loop

Piece of code that will be executed several times

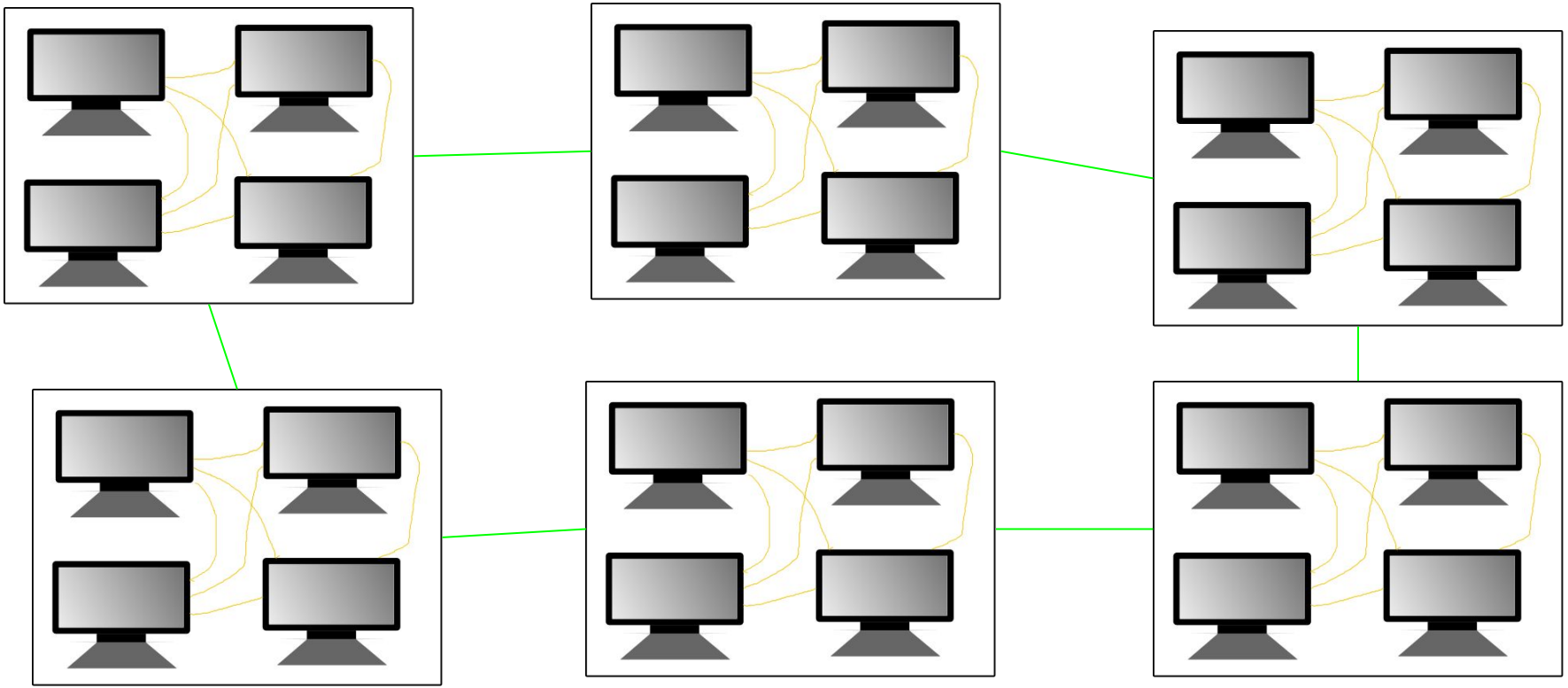
```
#!/bin/bash

#My first for loop
for ( )
do
        [Commands that will be executed several times]
done
```

Cluster

Cluster



Cluster



Queuing system

Orders the jobs sent to cluster according to priorities

- SGE
- SLURM
- ...

SGE useful commands

qsub [bash_script] → Sends [bash_script] to cluster

qstat →Check cluster status

qdel → Delete a job from cluster

Exercise (6)

Copy cluster_template.sh to your course folder

Modify cluster_template.sh, with your name

Send the job to cluster

Check the cluster status

Exercise (6)

Copy cluster_template.sh to your course folder

Modify cluster_template.sh, with your name

Send the job to cluster

Check the cluster status

Additional exercises (1)

Print last 10 lines of exercise.tsv, but excluding last one

Print 2nd column of exercise.tsv, sort the output and store it in a new file called exercise2.tsv

Find the files in course folder that starts with ‘ex’ and has ‘2’ in the name

Print 6th column of exercise.tsv, change ‘:’ to ‘,’ and sort the output. Append the output to exercise2.tsv

Additional exercises (1)

Print last 10 lines of exercise.tsv, but excluding last one

```
ffuster2@figaro:~/course$ tail -n 10 exercise.tsv | head -n 9
chr3    128199429       T       649     568     T:555:2:36:1:515:40:0
chr3    128199662       G       797     786     G:422:2:46:1:301:121:0
chr3    128204951       C       562     540     C:261:2:47:1:159:102:0
chr3    128205860       G       302     297     G:0:0:0:0:0:0:0 G
chr3    128206618       C       251     240     C:123:2:42:1:78:45:0
chr3    128206710       T       173     167     T:0:0:0:0:0:0:0 T
chr3    136056728       G       723     719     G:697:2:47:1:457:240:22
chr3    136056861       T       775     771     T:1:1:67:1:1:0:0
chr3    136191272       C       447     434     C:430:2:48:1:305:125:0
```

Print 2nd column of exercise.tsv, sort the output and store it in a new file called exercise2.tsv

```
ffuster2@figaro:~/course$ cut -f 2 exercise.tsv | sort > exercise2.tsv
```

Additional exercises (1)

Find the files in course folder that starts with ‘ex’ and has ‘2’ in the name

```
ffuster2@figaro:~/course$ find . -name ex*2*
```

Print 6th column of exercise.tsv, change ‘:’ to ‘,’ and sort the output. Append the output to exercise2.tsv

```
ffuster2@figaro:~/course$ cut -f 6 exercise.tsv | tr ':' ',' >> exercise2.tsv
```