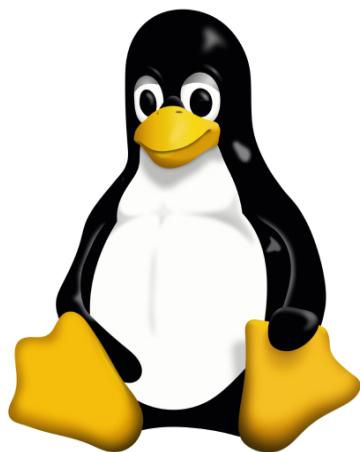


**THE
LINUX**



**COMMANDS
HANDBOOK**

Flavio Copes

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Preface

The Linux Commands Handbook follows the 80/20 rule: learn in 20% of the time the 80% of a topic.

I find this approach gives a well-rounded overview.

This book does not try to cover everything under the sun related to Linux and its commands. It focuses on the small core commands that you will use the 80% or 90% of the time, trying to simplify the usage of the more complex ones.

All those commands work on Linux, macOS, WSL, and anywhere you have a UNIX environment.

I hope the contents of this book will help you achieve what you want: **get comfortable with Linux**.

This book is written by Flavio. I **publish programming tutorials** every day on my website flaviocopes.com.

You can reach me on Twitter [@flaviocopes](https://twitter.com/flaviocopes).

Enjoy!

Introduction to Linux and shells

Linux is an operating system, like macOS or Windows.

It is also the most popular Open Source and free, as in freedom, operating system.

It powers the vast majority of the servers that compose the Internet. It's the base upon which everything is built upon. But not just that. Android is based on (a modified version of) Linux.

The Linux "core" (called *kernel*) was born in 1991 in Finland, and it went a really long way from its humble beginnings. It went on to be the kernel of the GNU Operating System, creating the duo GNU/Linux.

There's one thing about Linux that corporations like Microsoft and Apple, or Google, will never be able to offer: the freedom to do whatever you want with your computer.

They're actually going in the opposite direction, building walled gardens, especially on the mobile side.

Linux is the ultimate freedom.

It is developed by volunteers, some paid by companies that rely on it, some independently, but there's no single commercial company that can dictate what goes into Linux, or the project priorities.

Linux can also be used as your day to day computer. I use macOS because I really enjoy the applications, the design and I also used to be an iOS and Mac apps developer, but before using it I used Linux as my main computer Operating System.

No one can dictate which apps you can run, or "call home" with apps that track you, your position, and more.

Linux is also special because there's not just "one Linux", like it happens on Windows or macOS. Instead, we have **distributions**.

A "distro" is made by a company or organization and packages the Linux core with additional programs and tooling.

For example you have Debian, Red Hat, and Ubuntu, probably the most popular.

Many, many more exist. You can create your own distribution, too. But most likely you'll use a popular one, one that has lots of users and a community of people around it, so you can do what you need to do without losing too much time reinventing the wheel and figuring out answers to common problems.

Some desktop computers and laptops ship with Linux preinstalled. Or you can install it on your Windows-based computer, or on a Mac.

But you don't need to disrupt your existing computer just to get an idea of how Linux works.

I don't have a Linux computer.

If you use a Mac you need to know that under the hood macOS is a UNIX Operating System, and it shares a lot of the same ideas and software that a GNU/Linux system uses, because GNU/Linux is a free alternative to UNIX.

UNIX is an umbrella term that groups many operating systems used in big corporations and institutions, starting from the 70's

The macOS terminal gives you access to the same exact commands I'll describe in the rest of this handbook.

Microsoft has an official [Windows Subsystem for Linux](#) which you can (and should!) install on Windows. This will give you the ability to run Linux in a very easy way on your PC.

But the vast majority of the time you will run a Linux computer in the cloud via a VPS (Virtual Private Server) like DigitalOcean.

A shell is a command interpreter that exposes to the user an interface to work with the underlying operating system.

It allows you to execute operations using text and commands, and it provides users advanced features like being able to create scripts.

This is important: shells let you perform things in a more optimized way than a GUI (Graphical User Interface) could ever possibly let you do. Command line tools can offer many different configuration options without being too complex to use.

There are many different kind of shells. This post focuses on Unix shells, the ones that you will find commonly on Linux and macOS computers.

Many different kind of shells were created for those systems over time, and a few of them dominate the space: Bash, Csh, Zsh, Fish and many more!

All shells originate from the Bourne Shell, called `sh`. "Bourne" because its creator was Steve Bourne.

Bash means *Bourne-again shell*. `sh` was proprietary and not open source, and Bash was created in 1989 to create a free alternative for the GNU project and the Free Software Foundation. Since projects had to pay to use the Bourne shell, Bash became very popular.

If you use a Mac, try opening your Mac terminal. That by default is running ZSH. (or, pre-Catalina, Bash)

You can set up your system to run any kind of shell, for example I use the Fish shell.

Each single shell has its own unique features and advanced usage, but they all share a common functionality: they can let you execute programs, and they can be programmed.

In the rest of this handbook we'll see in detail the most common commands you will use.

man

The first command I want to introduce is a command that will help you understand all the other commands.

Every time I don't know how to use a command, I type `man <command>` to get the manual:

```
LS(1)          BSD General Commands Manual          LS(1)

NAME
  ls — list directory contents

SYNOPSIS
  ls [-ABCDEFGHIOPRSTUW@abcdefghijklmnopqrstuvwxyz1%] [file ...]

DESCRIPTION
  For each operand that names a file of a type other than directory,
  ls displays its name as well as any requested, associated information.
  For each operand that names a file of type directory, ls dis-
  plays the names of files contained within that directory, as well as
  any requested, associated information.

  If no operands are given, the contents of the current directory are
  displayed. If more than one operand is given, non-directory oper-
  ands are displayed first; directory and non-directory operands are
  sorted separately and in lexicographical order.

  The following options are available:

  -@      Display extended attribute keys and sizes in long (-l) out-
            put.

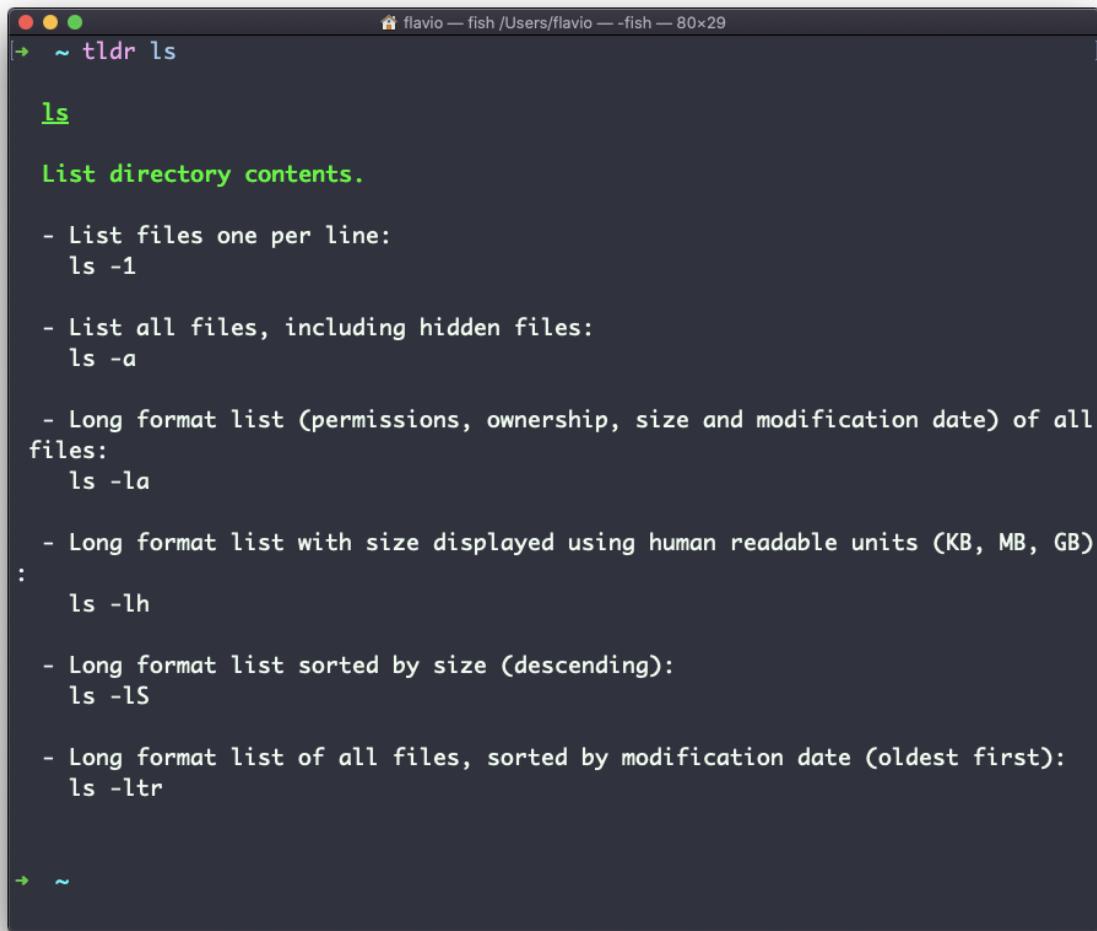
  -1      (The numeric digit ``one'') Force output to be one entry
  :
```

This is a man (from *manual*) page. Man pages are an essential tool to learn, as a developer. They contain so much information that sometimes it's almost too much.

The above screenshot is just 1 of 14 screens of explanation for the `ls` command.

Most of the times when I'm in need to learn a command quickly I use this site called **tldr pages**: <https://tldr.sh/>. It's a command you can install, then you run it like this: `tldr <command>`, which gives you a very quick overview of a

command, with some handy examples of common usage scenarios:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 80x29". The window shows the command "tldr ls" entered at the prompt. The output is a summary of the "ls" command, including its purpose ("List directory contents."), various options, and examples. The options listed are: - List files one per line (ls -1), - List all files, including hidden files (ls -a), - Long format list (permissions, ownership, size and modification date) of all files (ls -la), - Long format list with size displayed using human readable units (KB, MB, GB) (ls -lh), - Long format list sorted by size (descending) (ls -ls), and - Long format list of all files, sorted by modification date (oldest first) (ls -ltr). The terminal window has a dark theme with white text.

```
flavio — fish /Users/flavio — -fish — 80x29
[~] ~ tldr ls

ls

List directory contents.

- List files one per line:
  ls -1

- List all files, including hidden files:
  ls -a

- Long format list (permissions, ownership, size and modification date) of all
files:
  ls -la

- Long format list with size displayed using human readable units (KB, MB, GB)
:
  ls -lh

- Long format list sorted by size (descending):
  ls -ls

- Long format list of all files, sorted by modification date (oldest first):
  ls -ltr

[~]
```

This is not a substitute for `man`, but a handy tool to avoid losing yourself in the huge amount of information present in a man page. Then you can use the man page to explore all the different options and parameters you can use on a command.

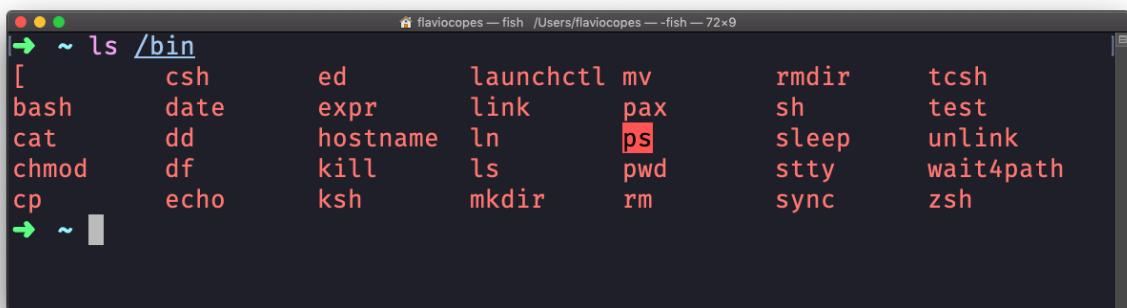
ls

Inside a folder you can list all the files that the folder contains using the `ls` command:

```
ls
```

If you add a folder name or path, it will print that folder contents:

```
ls /bin
```



A screenshot of a macOS terminal window titled "flaviocopes — fish — /Users/flaviocopes — fish — 72x9". The command `ls /bin` is entered in the prompt. The output lists various system binaries:

```
[ ~ ] ls /bin
[      csh      ed    launchctl  mv      rmkdir  tcsh
bash   date    expr     link      pax      sh       test
cat    dd     hostname  ln      ps      sleep    unlink
chmod  df     kill     ls      pwd      stty    wait4path
cp    echo    ksh     mkdir     rm      sync     zsh
[ ~ ]
```

`ls` accepts a lot of options. One of my favorite options combinations is `-al`. Try it:

```
ls -al /bin
```

```
~ ls -al /bin
total 5120
drwxr-xr-x@ 37 root wheel      1184 Feb  4 10:05 .
drwxr-xr-x  30 root wheel      960 Feb  8 15:32 ..
-rw xr-xr-x  1 root wheel    22704 Jan 16 02:21 [
-rw xr-xr-x  1 root wheel   618416 Jan 16 02:21 bash
-rw xr-xr-x  1 root wheel   23648 Jan 16 02:21 cat
-rw xr-xr-x  1 root wheel   34144 Jan 16 02:21 chmod
-rw xr-xr-x  1 root wheel   29024 Jan 16 02:21 cp
-rw xr-xr-x  1 root wheel  379952 Jan 16 02:21 csh
-rw xr-xr-x  1 root wheel   28608 Jan 16 02:21 date
-rw xr-xr-x  1 root wheel   32000 Jan 16 02:21 dd
-rw xr-xr-x  1 root wheel   23392 Jan 16 02:21 df
-rw xr-xr-x  1 root wheel   18128 Jan 16 02:21 echo
-rw xr-xr-x  1 root wheel   54080 Jan 16 02:21 ed
-rw xr-xr-x  1 root wheel   23104 Jan 16 02:21 expr
-rw xr-xr-x  1 root wheel   18288 Jan 16 02:21 hostname
-rw xr-xr-x  1 root wheel   18688 Jan 16 02:21 kill
-rw xr-xr-x  1 root wheel 1282864 Jan 16 02:21 ksh
-rw xr-xr-x  1 root wheel  121296 Jan 16 02:21 launchctl
```

compared to the plain `ls`, this returns much more information.

You have, from left to right:

- the file permissions (and if your system supports ACLs, you get an ACL flag as well)
- the number of links to that file
- the owner of the file
- the group of the file
- the file size in bytes
- the file modified datetime
- the file name

This set of data is generated by the `l` option. The `a` option instead also shows the hidden files.

Hidden files are files that start with a dot (`.`).

cd

Once you have a folder, you can move into it using the `cd` command. `cd` means **c**hange **d**irectory. You invoke it specifying a folder to move into. You can specify a folder name, or an entire path.

Example:

```
mkdir fruits  
cd fruits
```

Now you are into the `fruits` folder.

You can use the `..` special path to indicate the parent folder:

```
cd .. #back to the home folder
```

The `#` character indicates the start of the comment, which lasts for the entire line after it's found.

You can use it to form a path:

```
mkdir fruits  
mkdir cars  
cd fruits  
cd ../cars
```

There is another special path indicator which is `.`, and indicates the **c**urrent folder.

You can also use absolute paths, which start from the root folder `/`:

```
cd /etc
```

This command works on Linux, macOS, WSL, and anywhere you have a UNIX environment

pwd

Whenever you feel lost in the filesystem, call the `pwd` command to know where you are:

```
pwd
```

It will print the current folder path.

mkdir

You create folders using the `mkdir` command:

```
mkdir fruits
```

You can create multiple folders with one command:

```
mkdir dogs cars
```

You can also create multiple nested folders by adding the `-p` option:

```
mkdir -p fruits/apples
```

Options in UNIX commands commonly take this form. You add them right after the command name, and they change how the command behaves. You can often combine multiple options, too.

You can find which options a command supports by typing `man <commandname>`. Try now with `man mkdir` for example (press the `q` key to esc the man page). Man pages are the amazing built-in help for UNIX.

rmdir

Just as you can create a folder using `mkdir`, you can delete a folder using `rmdir`:

```
mkdir fruits  
rmdir fruits
```

You can also delete multiple folders at once:

```
mkdir fruits cars  
rmdir fruits cars
```

The folder you delete must be empty.

To delete folders with files in them, we'll use the more generic `rm` command which deletes files and folders, using the `-rf` options:

```
rm -rf fruits cars
```

Be careful as this command does not ask for confirmation and it will immediately remove anything you ask it to remove.

There is no **bin** when removing files from the command line, and recovering lost files can be hard.

mv

Once you have a file, you can move it around using the `mv` command. You specify the file current path, and its new path:

```
touch pear  
mv pear new_pear
```

The `pear` file is now moved to `new_pear`. This is how you **rename** files and folders.

If the last parameter is a folder, the file located at the first parameter path is going to be moved into that folder. In this case, you can specify a list of files and they will all be moved in the folder path identified by the last parameter:

```
touch pear  
touch apple  
mkdir fruits  
mv pear apple fruits #pear and apple moved to the fruits folder
```

cp

You can copy a file using the `cp` command:

```
touch test
cp apple another_apple
```

To copy folders you need to add the `-r` option to recursively copy the whole folder contents:

```
mkdir fruits
cp -r fruits cars
```

touch

You can create an empty file using the `touch` command:

```
touch apple
```

If the file already exists, it opens the file in write mode, and the timestamp of the file is updated.

find

The `find` command can be used to find files or folders matching a particular search pattern. It searches recursively.

Let's learn it by example.

Find all the files under the current tree that have the `.js` extension and print the relative path of each file matching:

```
find . -name '*.js'
```

It's important to use quotes around special characters like `*` to avoid the shell interpreting them.

Find directories under the current tree matching the name "src":

```
find . -type d -name src
```

Use `-type f` to search only files, or `-type l` to only search symbolic links.

`-name` is case sensitive. use `-iname` to perform a case-insensitive search.

You can search under multiple root trees:

```
find folder1 folder2 -name filename.txt
```

Find directories under the current tree matching the name "node_modules" or 'public':

```
find . -type d -name node_modules -or -name public
```

You can also exclude a path, using `-not -path`:

```
find . -type d -name '*.md' -not -path 'node_modules/*'
```

You can search files that have more than 100 characters (bytes) in them:

```
find . -type f -size +100c
```

Search files bigger than 100KB but smaller than 1MB:

```
find . -type f -size +100k -size -1M
```

Search files edited more than 3 days ago

```
find . -type f -mtime +3
```

Search files edited in the last 24 hours

```
find . -type f -mtime -1
```

You can delete all the files matching a search by adding the `-delete` option. This deletes all the files edited in the last 24 hours:

```
find . -type f -mtime -1 -delete
```

You can execute a command on each result of the search. In this example we run `cat` to print the file content:

```
find . -type f -exec cat {} \;
```

notice the terminating `\;`. `{}` is filled with the file name at execution time.

In

The `ln` command is part of the Linux file system commands.

It's used to create links. What is a link? It's like a pointer to another file. A file that points to another file. You might be familiar with Windows shortcuts. They're similar.

We have 2 types of links: **hard links** and **soft links**.

Hard links

Hard links are rarely used. They have a few limitations: you can't link to directories, and you can't link to external filesystems (disks).

A hard link is created using

```
ln <original> <link>
```

For example, say you have a file called `recipes.txt`. You can create a hard link to it using:

```
ln recipes.txt newrecipes.txt
```

The new hard link you created is indistinguishable from a regular file:

```
flavio — fish /Users/flavio — -fish — 63x10
|~ ls -al newrecipes.txt
|-rw-r--r-- 1 flavio staff 8 Sep 2 11:25 newrecipes.txt
|~
```

Now any time you edit any of those files, the content will be updated for both.

If you delete the original file, the link will still contain the original file content, as that's not removed until there is one hard link pointing to it.

```
flavio — fish /Users/flavio — -fish — 49x9
|~ ln recipes.txt newrecipes.txt
|~ cat newrecipes.txt
recipes
|~ rm recipes.txt
|~ cat newrecipes.txt
recipes
|~ ~
```

Soft links

Soft links are different. They are more powerful as you can link to other filesystems and to directories, but when the original is removed, the link will be broken.

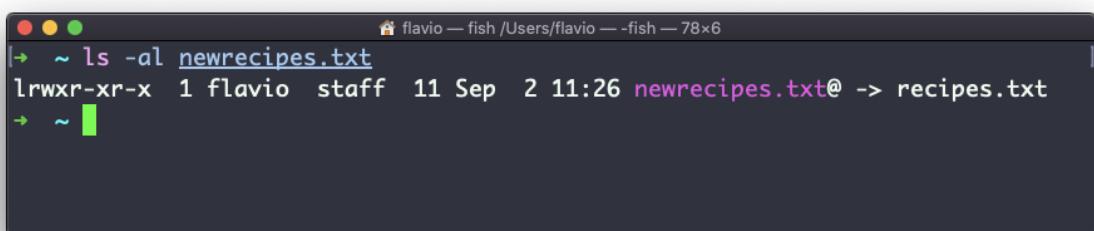
You create soft links using the `-s` option of `ln`:

```
ln -s <original> <link>
```

For example, say you have a file called `recipes.txt`. You can create a soft link to it using:

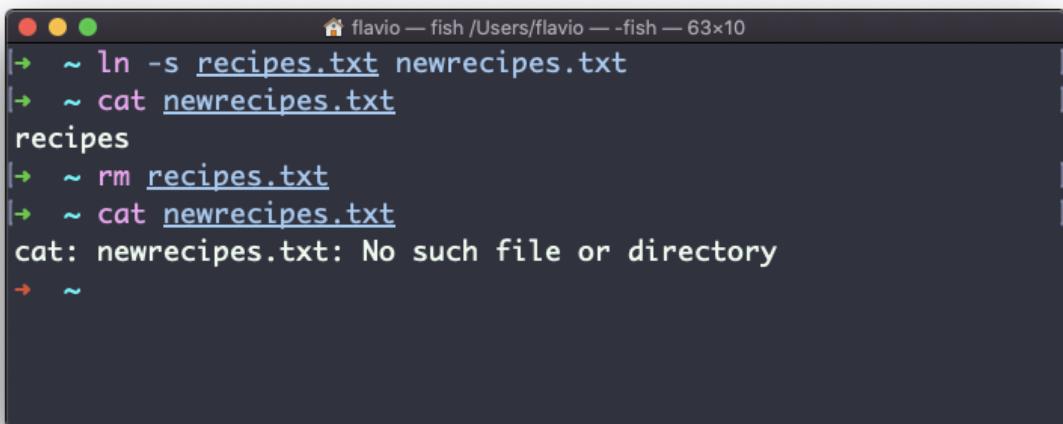
```
ln -s recipes.txt newrecipes.txt
```

In this case you can see there's a special `l` flag when you list the file using `ls -al`, and the file name has a `@` at the end, and it's colored differently if you have colors enabled:



```
flavio — fish /Users/flavio — -fish — 78x6
[~] ~ ls -al newrecipes.txt
lrwxr-xr-x 1 flavio staff 11 Sep 2 11:26 newrecipes.txt@ -> recipes.txt
[~]
```

Now if you delete the original file, the links will be broken, and the shell will tell you "No such file or directory" if you try to access it:



```
flavio — fish /Users/flavio — -fish — 63x10
[~] ~ ln -s recipes.txt newrecipes.txt
[~] ~ cat newrecipes.txt
recipes
[~] ~ rm recipes.txt
[~] ~ cat newrecipes.txt
cat: newrecipes.txt: No such file or directory
[~]
```

gzip

You can compress a file using the gzip compression protocol named [LZ77](#) using the `gzip` command.

Here's the simplest usage:

```
gzip filename
```

This will compress the file, and append a `.gz` extension to it. The original file is deleted. To prevent this, you can use the `-c` option and use output redirection to write the output to the `filename.gz` file:

```
gzip -c filename > filename.gz
```

The `-c` option specifies that output will go to the standard output stream, leaving the original file intact

Or you can use the `-k` option:

```
gzip -k filename
```

There are various levels of compression. The more the compression, the longer it will take to compress (and decompress). Levels range from 1 (fastest, worst compression) to 9 (slowest, better compression), and the default is 6.

You can choose a specific level with the `-<NUMBER>` option:

```
gzip -1 filename
```

You can compress multiple files by listing them:

```
gzip filename1 filename2
```

You can compress all the files in a directory, recursively, using the `-r` option:

```
gzip -r a_folder
```

The `-v` option prints the compression percentage information. Here's an example of it being used along with the `-k` (keep) option:

A screenshot of a macOS terminal window. The title bar shows "flavio — fish /Users/flavio — -fish — 58x5". The command entered is "gzip -kv wget-log". The output shows "wget-log: 49.7% -- replaced with wget-log.gz".

```
flavio — fish /Users/flavio — -fish — 58x5
gzip -kv wget-log
wget-log: 49.7% -- replaced with wget-log.gz
```

`gzip` can also be used to decompress a file, using the `-d` option:

```
gzip -d filename.gz
```

gunzip

The `gunzip` command is basically equivalent to the `gzip` command, except the `-d` option is always enabled by default.

The command can be invoked in this way:

```
gunzip filename.gz
```

This will gunzip and will remove the `.gz` extension, putting the result in the `filename` file. If that file exists, it will overwrite that.

You can extract to a different filename using output redirection using the `-c` option:

```
gunzip -c filename.gz > anotherfilename
```

tar

The `tar` command is used to create an archive, grouping multiple files in a single file.

Its name comes from the past and means *tape archive*. Back when archives were stored on tapes.

This command creates an archive named `archive.tar` with the content of `file1` and `file2`:

```
tar -cf archive.tar file1 file2
```

The `c` option stands for *create*. The `f` option is used to write to file the archive.

To extract files from an archive in the current folder, use:

```
tar -xf archive.tar
```

the `x` option stands for *extract*

and to extract them to a specific directory, use:

```
tar -xf archive.tar -C directory
```

You can also just list the files contained in an archive:



```
flavio — fish /Users/flavio — -fish — 55x5
~ tar -tf archive.tar
file1
file2
~
```

`tar` is often used to create a **compressed archive**, gzipping the archive.

This is done using the `z` option:

```
tar -czf archive.tar.gz file1 file2
```

This is just like creating a tar archive, and then running `gzip` on it.

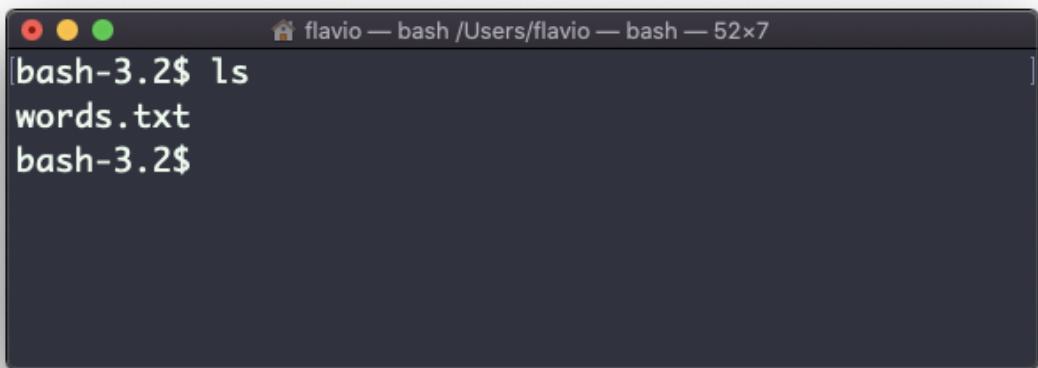
To unarchive a gzipped archive, you can use `gunzip`, or `gzip -d`, and then unarchive it, but `tar -xf` will recognize it's a gzipped archive, and do it for you:

```
tar -xf archive.tar.gz
```

alias

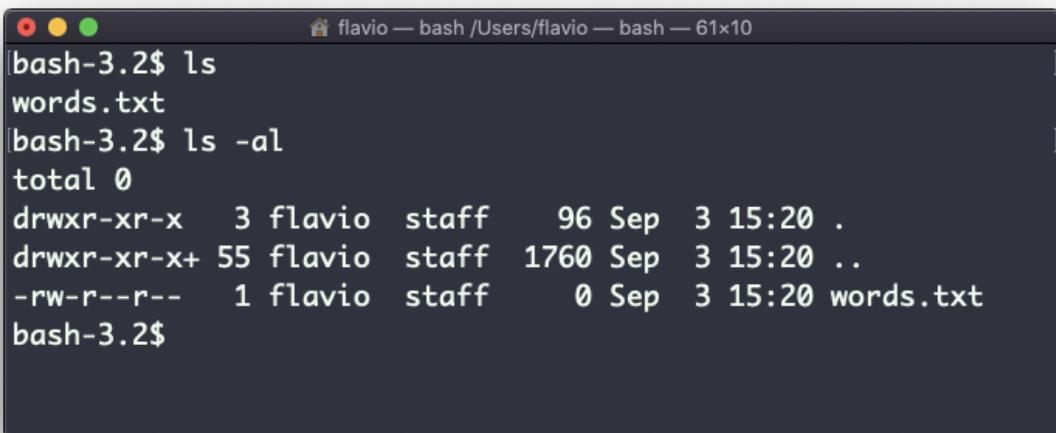
It's common to always run a program with a set of options you like using.

For example, take the `ls` command. By default it prints very little information:



```
flavio — bash /Users/flavio — bash — 52x7
|bash-3.2$ ls
words.txt
bash-3.2$
```

while using the `-al` option it will print something more useful, including the file modification date, the size, the owner, and the permissions, also listing hidden files (files starting with a `.`):



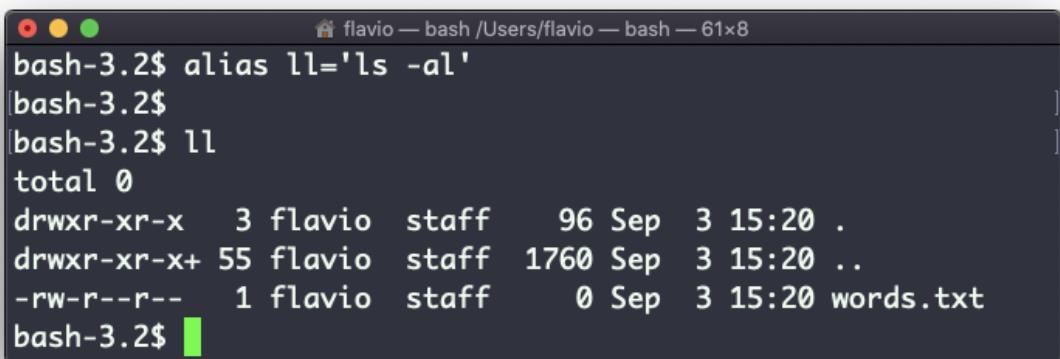
```
flavio — bash /Users/flavio — bash — 61x10
|bash-3.2$ ls
words.txt
|bash-3.2$ ls -al
total 0
drwxr-xr-x  3 flavio  staff   96 Sep  3 15:20 .
drwxr-xr-x+ 55 flavio  staff  1760 Sep  3 15:20 ..
-rw-r--r--  1 flavio  staff     0 Sep  3 15:20 words.txt
bash-3.2$
```

You can create a new command, for example I like to call it `ll`, that is an alias to `ls -al`.

You do it in this way:

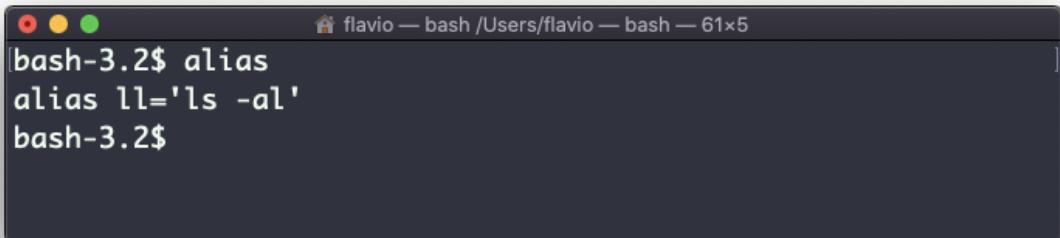
```
alias ll='ls -al'
```

Once you do, you can call `ll` just like it was a regular UNIX command:



```
flavio — bash /Users/flavio — bash — 61x8
bash-3.2$ alias ll='ls -al'
bash-3.2$ ll
total 0
drwxr-xr-x  3 flavio  staff    96 Sep  3 15:20 .
drwxr-xr-x+ 55 flavio  staff  1760 Sep  3 15:20 ..
-rw-r--r--  1 flavio  staff     0 Sep  3 15:20 words.txt
bash-3.2$
```

Now calling `alias` without any option will list the aliases defined:



```
flavio — bash /Users/flavio — bash — 61x5
bash-3.2$ alias
alias ll='ls -al'
bash-3.2$
```

The alias will work until the terminal session is closed.

To make it permanent, you need to add it to the shell configuration, which could be `~/.bashrc` or `~/.profile` or `~/.bash_profile` if you use the Bash shell, depending on the use case.

Be careful with quotes if you have variables in the command: using double quotes the variable is resolved at definition time, using single quotes it's resolved at invocation time. Those 2 are different:

```
alias lsthis="ls $PWD"
alias lscurrent='ls $PWD'
```

\$PWD refers to the current folder the shell is into. If you now navigate away to a new folder, `lscurrent` lists the files in the new folder, `lsthis` still lists the files in the folder you were when you defined the alias.

cat

Similar to `tail` in some way, we have `cat`. Except `cat` can also add content to a file, and this makes it super powerful.

In its simplest usage, `cat` prints a file's content to the standard output:

```
cat file
```

You can print the content of multiple files:

```
cat file1 file2
```

and using the output redirection operator `>` you can concatenate the content of multiple files into a new file:

```
cat file1 file2 > file3
```

Using `>>` you can append the content of multiple files into a new file, creating it if it does not exist:

```
cat file1 file2 >> file3
```

When watching source code files it's great to see the line numbers, and you can have `cat` print them using the `-n` option:

```
cat -n file1
```

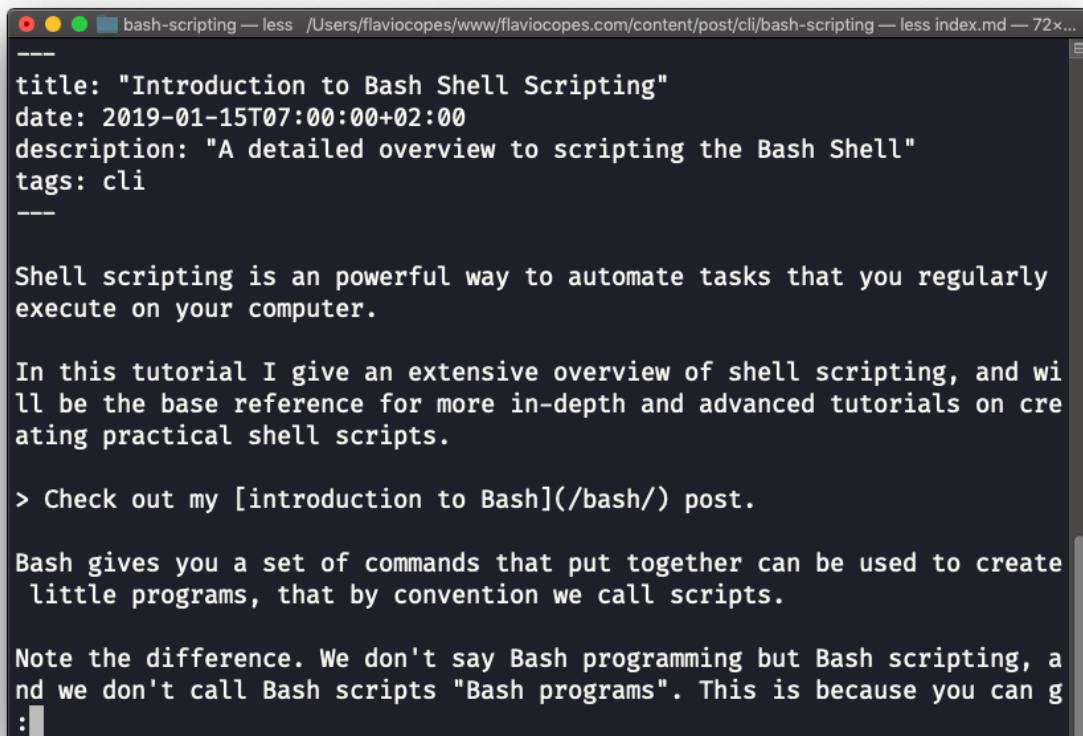
You can only add a number to non-blank lines using `-b`, or you can also remove all the multiple empty lines using `-s`.

`cat` is often used in combination with the pipe operator `|` to feed a file content as input to another command: `cat file1 | anothercommand`.

less

The `less` command is one I use a lot. It shows you the content stored inside a file, in a nice and interactive UI.

Usage: `less <filename>`.



A screenshot of a terminal window titled "bash-scripting — less /Users/flaviocopes/www/flaviocopes.com/content/post/cli/bash-scripting — less index.md — 72x...". The window displays the contents of a file named "index.md" using the "less" command. The text includes YAML metadata at the top:

```
---  
title: "Introduction to Bash Shell Scripting"  
date: 2019-01-15T07:00:00+02:00  
description: "A detailed overview to scripting the Bash Shell"  
tags: cli  
---
```

Below the metadata, there is a section of text:

```
Shell scripting is an powerful way to automate tasks that you regularly execute on your computer.
```

Following that is another section:

```
In this tutorial I give an extensive overview of shell scripting, and will be the base reference for more in-depth and advanced tutorials on creating practical shell scripts.
```

Then there is a bullet point:

```
> Check out my [introduction to Bash](/bash/) post.
```

Another section follows:

```
Bash gives you a set of commands that put together can be used to create little programs, that by convention we call scripts.
```

Finally, there is a note:

```
Note the difference. We don't say Bash programming but Bash scripting, and we don't call Bash scripts "Bash programs". This is because you can g :|
```

Once you are inside a `less` session, you can quit by pressing `q`.

You can navigate the file contents using the `up` and `down` keys, or using the `space bar` and `b` to navigate page by page. You can also jump to the end of the file pressing `G` and jump back to the start pressing `g`.

You can search contents inside the file by pressing `/` and typing a word to search. This searches *forward*. You can search backwards using the `?` symbol and typing a word.

This command just visualises the file's content. You can directly open an editor by pressing `v`. It will use the system editor, which in most cases is `vim`.

Pressing the `F` key enters *follow mode*, or *watch mode*. When the file is changed by someone else, like from another program, you get to see the changes *live*. By default this is not happening, and you only see the file version at the time you opened it. You need to press `ctrl-C` to quit this mode. In this case the behaviour is similar to running the `tail -f <filename>` command.

You can open multiple files, and navigate through them using `:n` (to go to the next file) and `:p` (to go to the previous).

tail

The best use case of tail in my opinion is when called with the `-f` option. It opens the file at the end, and watches for file changes. Any time there is new content in the file, it is printed in the window. This is great for watching log files, for example:

```
tail -f /var/log/system.log
```

To exit, press `ctrl-C`.

You can print the last 10 lines in a file:

```
tail -n 10 <filename>
```

You can print the whole file content starting from a specific line using `+` before the line number:

```
tail -n +10 <filename>
```

`tail` can do much more and as always my advice is to check `man tail`.

WC

The `wc` command gives us useful information about a file or input it receives via pipes.

```
echo test >> test.txt
wc test.txt
1      1      5 test.txt
```

Example via pipes, we can count the output of running the `ls -al` command:

```
ls -al | wc
6      47      284
```

The first column returned is the number of lines. The second is the number of words. The third is the number of bytes.

We can tell it to just count the lines:

```
wc -l test.txt
```

or just the words:

```
wc -w test.txt
```

or just the bytes:

```
wc -c test.txt
```

Bytes in ASCII charsets equate to characters, but with non-ASCII charsets, the number of characters might differ because some characters might take multiple bytes, for example this happens in Unicode.

In this case the `-m` flag will help getting the correct value:

```
wc -m test.txt
```

grep

The `grep` command is a very useful tool, that when you master will help you tremendously in your day to day.

If you're wondering, `grep` stands for *global regular expression print*

You can use `grep` to search in files, or combine it with pipes to filter the output of another command.

For example here's how we can find the occurrences of the `document.getElementById` line in the `index.md` file:

```
grep document.getElementById index.md
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 77x7". The command `grep document.getElementById index.md` is run, and the output shows two lines of code from the `index.md` file. The first line is `document.getElementById('button').addEventListener('click', () => {` and the second line is `document.getElementById('button').addEventListener('click', () => {`. The prompt `bash-3.2$` is visible at the bottom.

Using the `-n` option it will show the line numbers:

```
grep -n document.getElementById index.md
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 77x7". The command `grep -n document.getElementById index.md` is run, and the output shows the line numbers 60 and 128, followed by the same two lines of code from the `index.md` file. The prompt `bash-3.2$` is visible at the bottom.

One very useful thing is to tell grep to print 2 lines before, and 2 lines after the matched line, to give us more context. That's done using the `-C` option, which accepts a number of lines:

```
grep -nC 2 document.getElementById index.md
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 76x16". The command entered is "grep -nC 2 document.getElementById index.md". The output shows line numbers 58 through 126, with line 60 being the matched line. Lines 58 and 59 precede the match, and lines 61 and 62 follow it. Lines 126 and 127 also precede the match. Lines 128 and 129 follow it. Line 130 follows line 129. The prompt "bash-3.2\$" is at the bottom.

```
bash-3.2$ grep -nC 2 document.getElementById index.md
58-
59-```js
60:document.getElementById('button').addEventListener('click', () => {
61-   //item clicked
62-)
-- 
-- 
126-```js
127>window.addEventListener('load', () => {
128:   document.getElementById('button').addEventListener('click', () => {
129-     setTimeout(() => {
130-       items.forEach(item => {
bash-3.2$
```

Search is case sensitive by default. Use the `-i` flag to make it insensitive.

As mentioned, you can use grep to filter the output of another command. We can replicate the same functionality as above using:

```
less index.md | grep -n document.getElementById
```

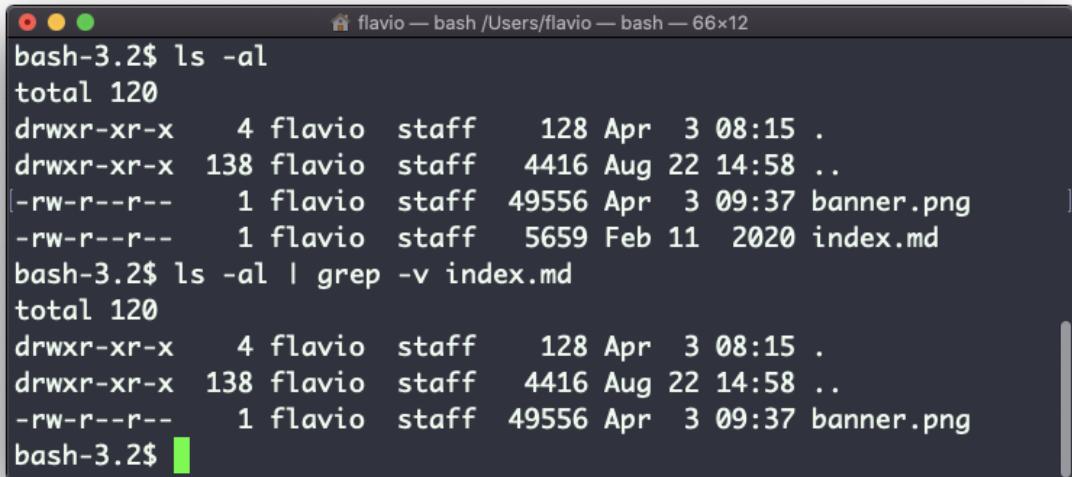


A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 77x7". The command entered is "less index.md | grep -n document.getElementById". The output shows line numbers 60 and 128, with line 60 being the matched line. The prompt "bash-3.2\$" is at the bottom.

```
bash-3.2$ less index.md | grep -n document.getElementById
60:document.getElementById('button').addEventListener('click', () => {
128:   document.getElementById('button').addEventListener('click', () => {
bash-3.2$
```

The search string can be a regular expression, and this makes `grep` very powerful.

Another thing you might find very useful is to invert the result, excluding the lines that match a particular string, using the `-v` option:

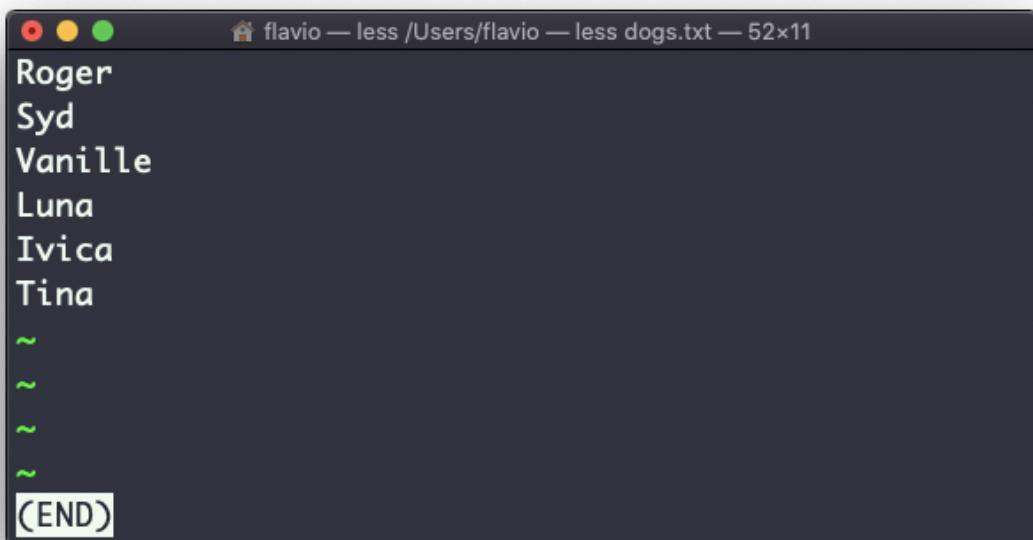


A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 66x12". The window shows two commands being run. The first command is `ls -al`, which lists all files in the current directory. The second command is `ls -al | grep -v index.md`, which filters out the line containing "index.md" from the output of the first command. The terminal window has a dark background and light-colored text. A vertical scroll bar is visible on the right side of the window.

```
bash-3.2$ ls -al
total 120
drwxr-xr-x  4 flavio  staff   128 Apr  3 08:15 .
drwxr-xr-x  138 flavio  staff  4416 Aug 22 14:58 ..
-rw-r--r--  1 flavio  staff  49556 Apr  3 09:37 banner.png
-rw-r--r--  1 flavio  staff   5659 Feb 11  2020 index.md
bash-3.2$ ls -al | grep -v index.md
total 120
drwxr-xr-x  4 flavio  staff   128 Apr  3 08:15 .
drwxr-xr-x  138 flavio  staff  4416 Aug 22 14:58 ..
-rw-r--r--  1 flavio  staff  49556 Apr  3 09:37 banner.png
bash-3.2$
```

sort

Suppose you have a text file which contains the names of dogs:

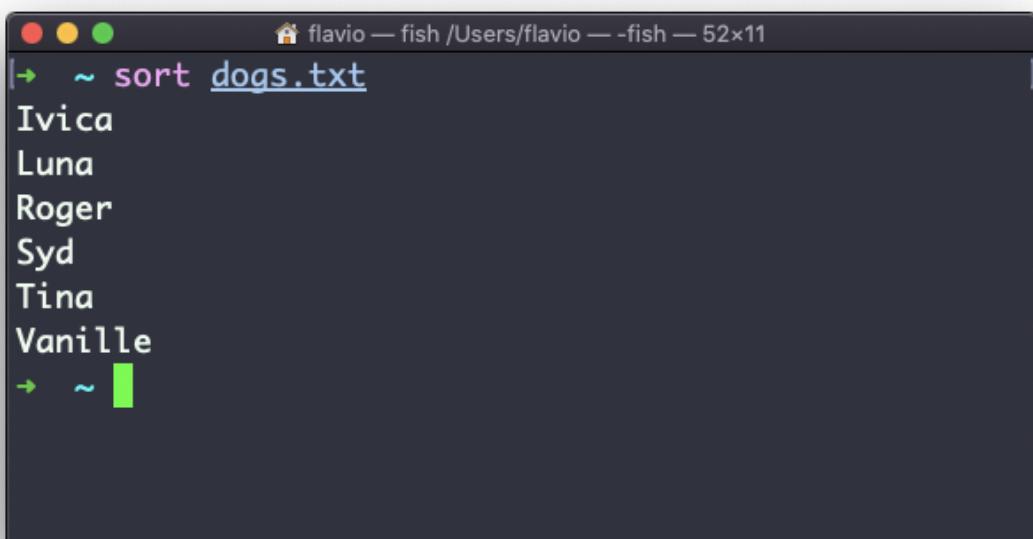


A screenshot of a terminal window titled "flavio — less /Users/flavio — less dogs.txt — 52x11". The window displays a list of dog names: Roger, Syd, Vanille, Luna, Ivica, Tina, followed by four question marks (~), and then "(END)".

```
Roger
Syd
Vanille
Luna
Ivica
Tina
~
~
~
~
(END)
```

This list is unordered.

The `sort` command helps us sorting them by name:



A screenshot of a terminal window titled "flavio — fish /Users/flavio — -fish — 52x11". The window displays the same list of dog names, but they are now sorted alphabetically: Ivica, Luna, Roger, Syd, Tina, Vanille. The command "sort dogs.txt" is visible at the top of the list.

```
~ sort dogs.txt
Ivica
Luna
Roger
Syd
Tina
Vanille
~
```

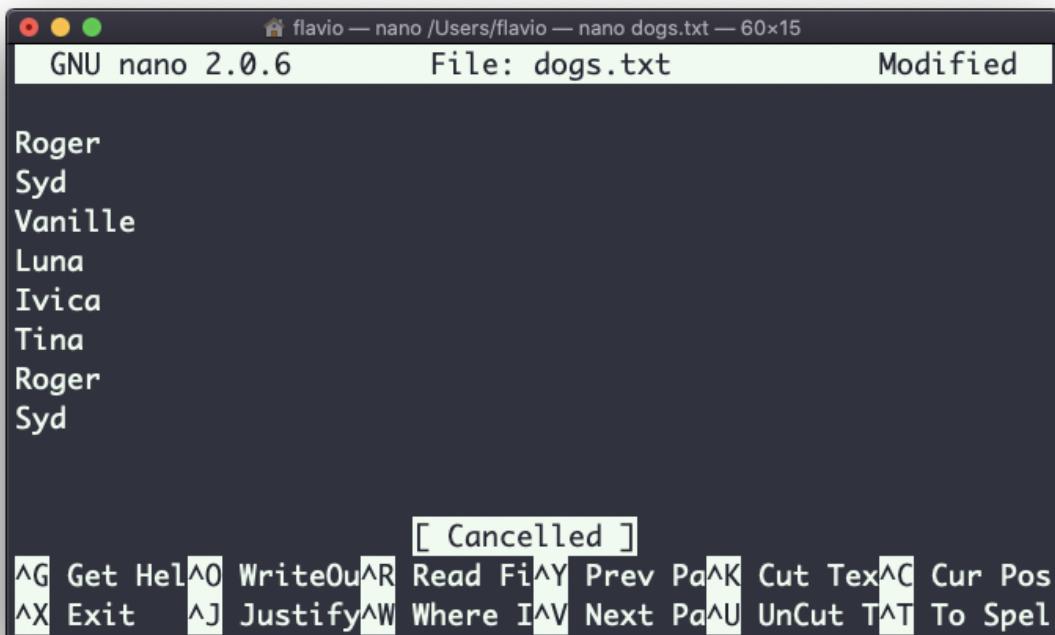
Use the `-r` option to reverse the order:



```
flavio — fish /Users/flavio — -fish — 51×9
|→ ~ sort -r dogs.txt
Vanille
Tina
Syd
Roger
Luna
Ivica
→ ~ |
```

Sorting by default is case sensitive, and alphabetic. Use the `--ignore-case` option to sort case insensitive, and the `-n` option to sort using a numeric order.

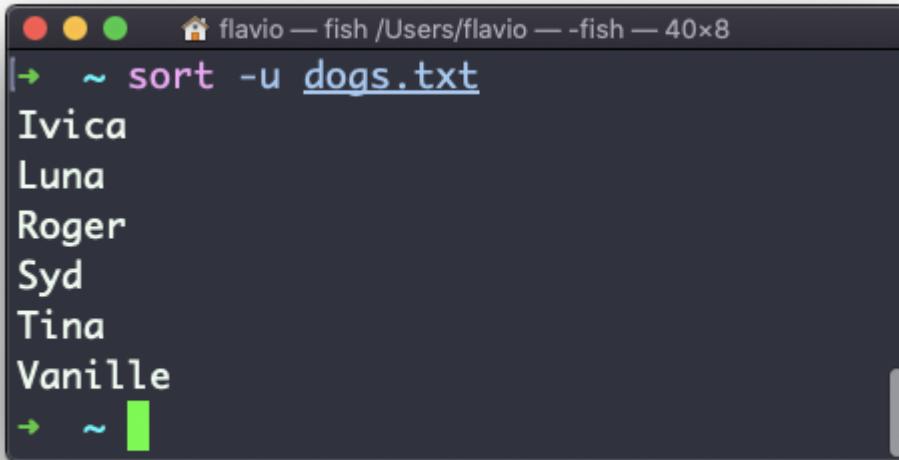
If the file contains duplicate lines:



```
flavio — nano /Users/flavio — nano dogs.txt — 60×15
GNU nano 2.0.6          File: dogs.txt          Modified
Roger
Syd
Vanille
Luna
Ivica
Tina
Roger
Syd

[ Cancelled ]
^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit      ^J Justify ^W Where I ^V Next Page ^U Uncut T ^T To Spell
```

You can use the `-u` option to remove them:



```
flavio — fish /Users/flavio — -fish — 40x8
|→ ~ sort -u dogs.txt
Ivica
Luna
Roger
Syd
Tina
Vanille
→ ~
```

`sort` does not just work on files, as many UNIX commands it also works with pipes, so you can use on the output of another command, for example you can order the files returned by `ls` with:

```
ls | sort
```

`sort` is very powerful and has lots more options, which you can explore calling `man sort`.

```
flavio — man /Users/flavio — less + man sort — 115x55
                                BSD General Commands Manual          SORT(1)

NAME
    sort -- sort or merge records (lines) of text and binary files

SYNOPSIS
    sort [-bcCdfghiRMmnrsuVz] [-k field1[,field2]] [-S memsize] [-T dir] [-t char] [-o output]
          [file ...]
    sort --help
    sort --version

DESCRIPTION
The sort utility sorts text and binary files by lines. A line is a record separated from the subsequent record by a newline (default) or NUL '\0' character (-z option). A record can contain any printable or unprintable characters. Comparisons are based on one or more sort keys extracted from each line of input, and are performed lexicographically, according to the current locale's collating rules and the specified command-line options that can tune the actual sorting behavior. By default, if keys are not given, sort uses entire lines for comparison.

The command line options are as follows:

-c, --check, -C, --check=silent|quiet
    Check that the single input file is sorted. If the file is not sorted, sort produces the appropriate error messages and exits with code 1, otherwise returns 0. If -C or --check=silent is specified, sort produces no output. This is a "silent" version of -c.

-m, --merge
    Merge only. The input files are assumed to be pre-sorted. If they are not sorted the output order is undefined.

-o output, --output=output
    Print the output to the output file instead of the standard output.

-S size, --buffer-size=size
    Use size for the maximum size of the memory buffer. Size modifiers %,b,K,M,G,T,P,E,Z,Y can be used. If a memory limit is not explicitly specified, sort takes up to about 90% of available memory. If the file size is too big to fit into the memory buffer, the temporary disk files are used to perform the sorting.

-T dir, --temporary-directory=dir
    Store temporary files in the directory dir. The default path is the value of the environment variable TMPDIR or /var/tmp if TMPDIR is not defined.

-u, --unique
    Unique keys. Suppress all lines that have a key that is equal to an already processed one. This option, similarly to -s, implies a stable sort. If used with -c or -C, sort also checks that there are no lines with duplicate keys.

-s
    Stable sort. This option maintains the original record order of records that have an equal key. This is a non-standard feature, but it is widely accepted and used.

--version
    Print the version and silently exits.
:
```

uniq

`uniq` is a command useful to sort lines of text.

You can get those lines from a file, or using pipes from the output of another command:

```
uniq dogs.txt  
ls | uniq
```

You need to consider this key thing: `uniq` will only detect adjacent duplicate lines.

This implies that you will most likely use it along with `sort`:

```
sort dogs.txt | uniq
```

The `sort` command has its own way to remove duplicates with the `-u` (*unique*) option. But `uniq` has more power.

By default it removes duplicate lines:

The screenshot shows a terminal window with the following session:

```
flavio — fish /Users/flavio — -fish — 40x17
|→ ~ cat dogs.txt
Roger
Syd
Vanille
Luna
Ivica
Tina
Roger
Syd
|→ ~ sort dogs.txt | uniq
Ivica
Luna
Roger
Syd
Tina
Vanille
|→ ~
```

You can tell it to only display duplicate lines, for example, with the `-d` option:

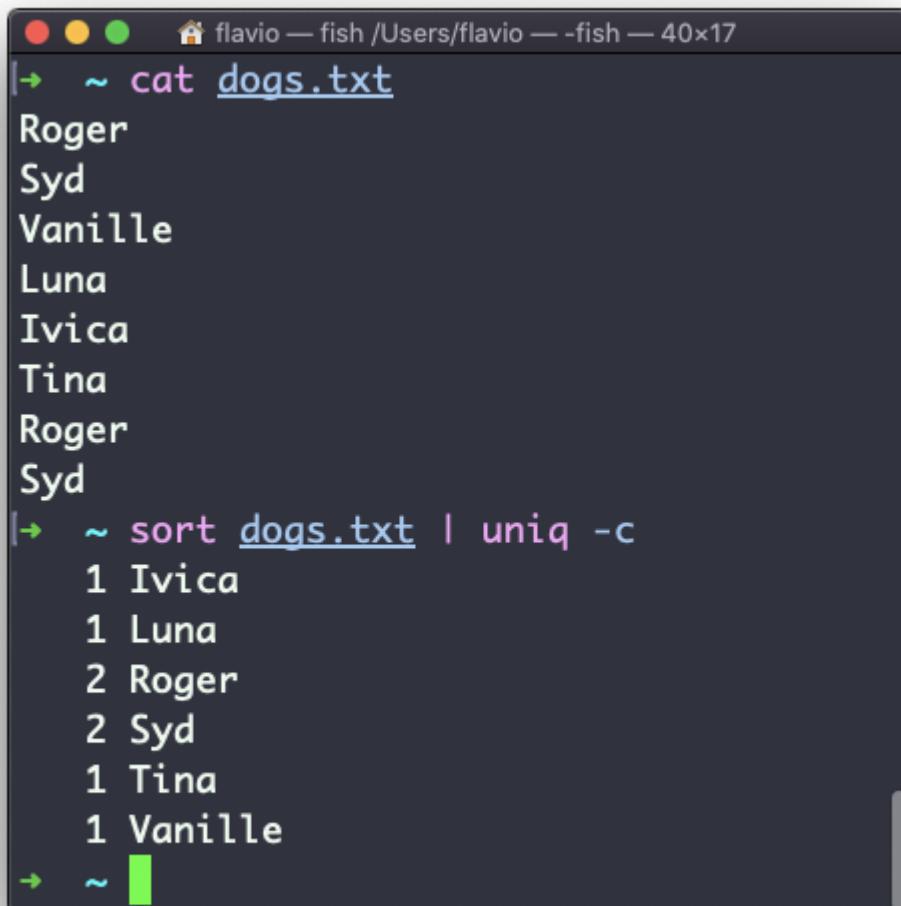
```
sort dogs.txt | uniq -d
```

```
flavio — fish /Users/flavio — -fish — 40x13
|→ ~ cat dogs.txt
Roger
Syd
Vanille
Luna
Ivica
Tina
Roger
Syd
|→ ~ sort dogs.txt | uniq -d
Roger
Syd
|→ ~
```

You can use the `-u` option to only display non-duplicate lines:

```
flavio — fish /Users/flavio — -fish — 40x15
|→ ~ cat dogs.txt
Roger
Syd
Vanille
Luna
Ivica
Tina
Roger
Syd
|→ ~ sort dogs.txt | uniq -u
Ivica
Luna
Tina
Vanille
→ ~ █
```

You can count the occurrences of each line with the `-c` option:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 40x17". The window shows the following command and its output:

```
|→ ~ cat dogs.txt
Roger
Syd
Vanille
Luna
Ivica
Tina
Roger
Syd
|→ ~ sort dogs.txt | uniq -c
1 Ivica
1 Luna
2 Roger
2 Syd
1 Tina
1 Vanille
|→ ~
```

Use the special combination:

```
sort dogs.txt | uniq -c | sort -nr
```

to then sort those lines by most frequent:

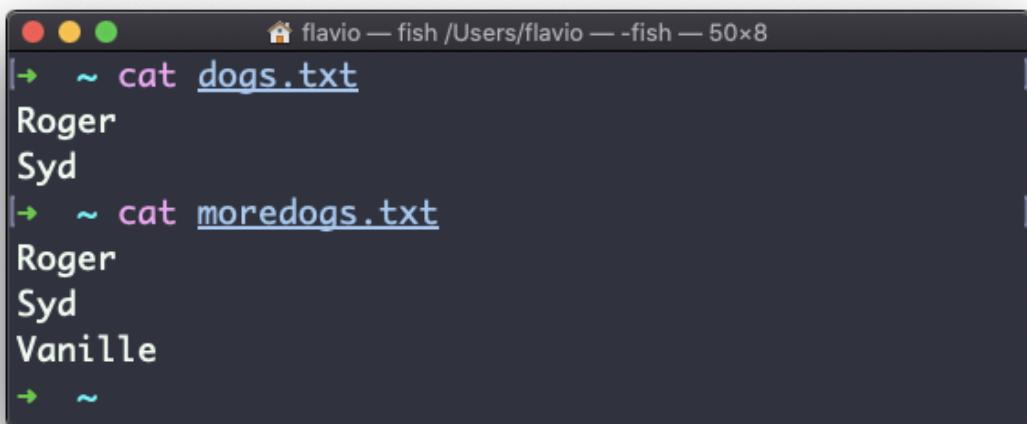
```
flavio — fish /Users/flavio — -fish — 44x8
[→ ~ sort dogs.txt | uniq -c | sort -nr ]
 2 Syd
 2 Roger
 1 Vanille
 1 Tina
 1 Luna
 1 Ivica
[→ ~
```

diff

`diff` is a handy command. Suppose you have 2 files, which contain almost the same information, but you can't find the difference between the two.

`diff` will process the files and will tell you what's the difference.

Suppose you have 2 files: `dogs.txt` and `moredogs.txt`. The difference is that `moredogs.txt` contains one more dog name:



```
flavio — fish /Users/flavio — -fish — 50x8
|~ cat dogs.txt
Roger
Syd
|~ cat moredogs.txt
Roger
Syd
Vanille
→ ~
```

`diff dogs.txt moredogs.txt` will tell you the second file has one more line, line 3 with the line `Vanille`:



```
flavio — fish /Users/flavio — -fish — 50x5
|~ diff dogs.txt moredogs.txt
2a3
> Vanille
→ ~
```

If you invert the order of the files, it will tell you that the second file is missing line 3, whose content is `Vanille`:



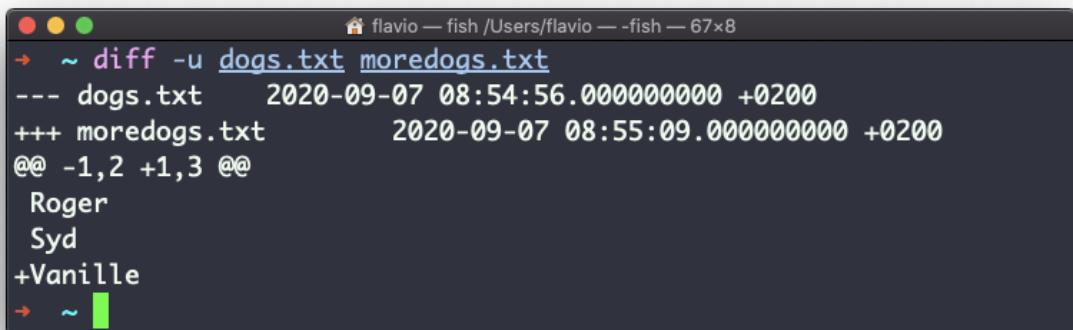
```
flavio — fish /Users/flavio — -fish — 50x5
|→ ~ diff moredogs.txt dogs.txt
3d2
< Vanille
→ ~
```

Using the `-y` option will compare the 2 files line by line:



```
flavio — fish /Users/flavio — -fish — 86x9
|→ ~ diff -y dogs.txt moredogs.txt
Roger                               Roger
Syd                                Syd
> Vanille
→ ~
```

The `-u` option however will be more familiar to you, because that's the same used by the Git version control system to display differences between versions:



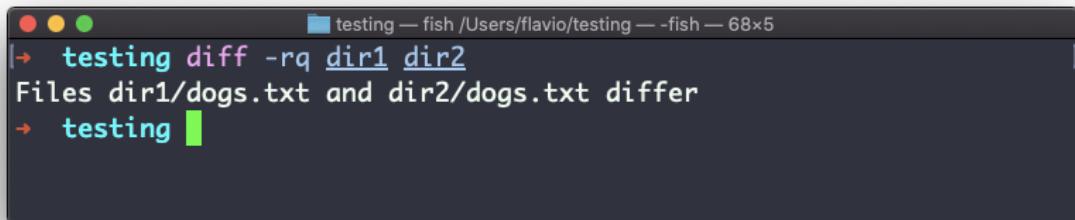
```
flavio — fish /Users/flavio — -fish — 67x8
|→ ~ diff -u dogs.txt moredogs.txt
--- dogs.txt      2020-09-07 08:54:56.000000000 +0200
+++ moredogs.txt      2020-09-07 08:55:09.000000000 +0200
@@ -1,2 +1,3 @@
 Roger
 Syd
+Vanille
→ ~
```

Comparing directories works in the same way. You must use the `-r` option to compare recursively (going into subdirectories):



```
testing ls dir1
dogs.txt
testing ls dir2
dogs.txt
testing diff -u dir1 dir2
diff -u dir1/dogs.txt dir2/dogs.txt
--- dir1/dogs.txt      2020-09-07 08:54:56.000000000 +0200
+++ dir2/dogs.txt      2020-09-07 08:55:09.000000000 +0200
@@ -1,2 +1,3 @@
    Roger
    Syd
+Vanille
→ testing
```

In case you're interested in which files differ, rather than the content, use the `r` and `q` options:



```
testing diff -rq dir1 dir2
Files dir1/dogs.txt and dir2/dogs.txt differ
→ testing
```

There are many more options you can explore in the man page running `man diff`:

```
flavio — man /Users/flavio — less + man diff — 115x55
DIFF(1)                               User Commands                               DIFF(1)

NAME
    diff — compare files line by line

SYNOPSIS
    diff [OPTION]... FILES

DESCRIPTION
    Compare files line by line.

    -i --ignore-case
        Ignore case differences in file contents.

    --ignore-file-name-case
        Ignore case when comparing file names.

    --no-ignore-file-name-case
        Consider case when comparing file names.

    -E --ignore-tab-expansion
        Ignore changes due to tab expansion.

    -b --ignore-space-change
        Ignore changes in the amount of white space.

    -w --ignore-all-space
        Ignore all white space.

    -B --ignore-blank-lines
        Ignore changes whose lines are all blank.

    -I RE --ignore-matching-lines=RE
        Ignore changes whose lines all match RE.

    --strip-trailing-cr
        Strip trailing carriage return on input.

    -a --text
        Treat all files as text.

    -c -C NUM --context[=NUM]
        Output NUM (default 3) lines of copied context.

    -u -U NUM --unified[=NUM]
        Output NUM (default 3) lines of unified context.

    --label LABEL
        Use LABEL instead of file name.

    -p --show-c-function
        Show which C function each change is in.

    -F RE --show-function-line=RE
```

echo

The `echo` command does one simple job: it prints to the output the argument passed to it.

This example:

```
echo "hello"
```

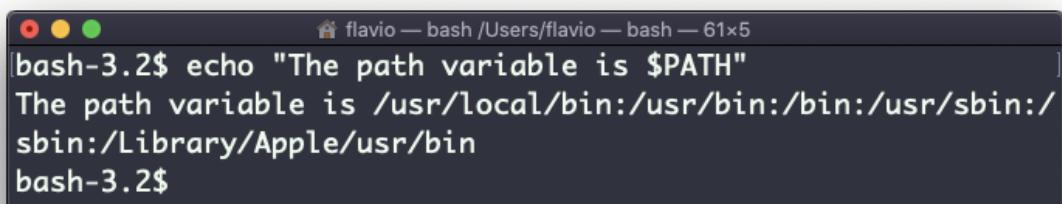
will print `hello` to the terminal.

We can append the output to a file:

```
echo "hello" >> output.txt
```

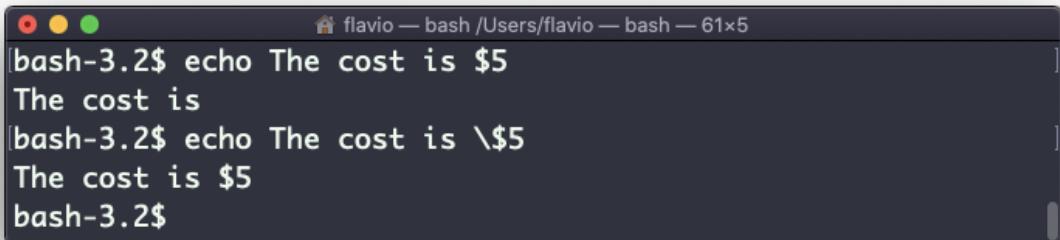
We can interpolate environment variables:

```
echo "The path variable is $PATH"
```



A screenshot of a macOS terminal window titled 'flavio — bash /Users/flavio — bash — 61x5'. The window shows the command `echo "The path variable is $PATH"` being run, followed by its output: `The path variable is /usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin`. The window has the standard OS X title bar with red, yellow, and green buttons.

Beware that special characters need to be escaped with a backslash `\` . `$` for example:



```
flavio — bash /Users/flavio — bash — 61x5
bash-3.2$ echo The cost is $5
The cost is
bash-3.2$ echo The cost is \$5
The cost is $5
bash-3.2$
```

This is just the start. We can do some nice things when it comes to interacting with the shell features.

We can echo the files in the current folder:

```
echo *
```

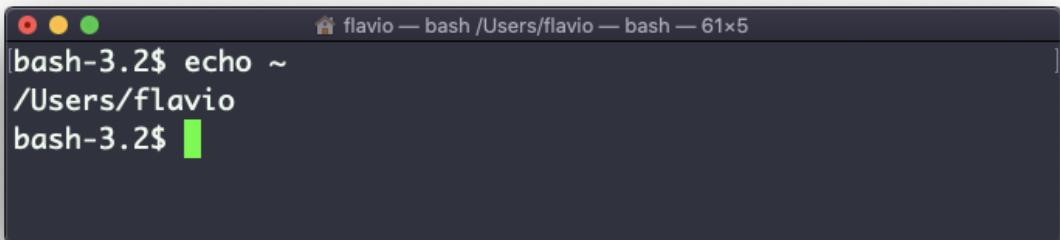
We can echo the files in the current folder that start with the letter o :

```
echo o*
```

Any valid Bash (or any shell you are using) command and feature can be used here.

You can print your home folder path:

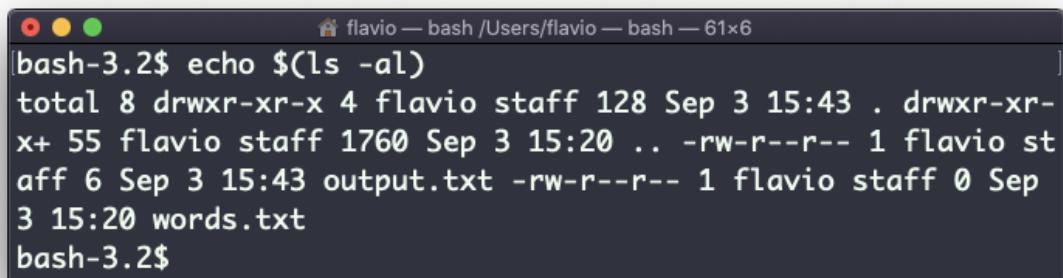
```
echo ~
```



```
flavio — bash /Users/flavio — bash — 61x5
bash-3.2$ echo ~
/Users/flavio
bash-3.2$
```

You can also execute commands, and print the result to the standard output (or to file, as you saw):

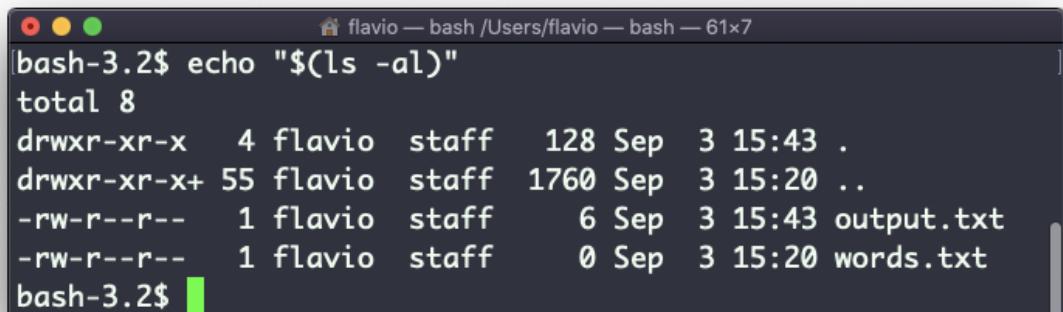
```
echo $(ls -al)
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x6". The window shows the command "bash-3.2\$ echo \$(ls -al)" followed by the output of the "ls -al" command. The output lists several files and directories with their permissions, names, and timestamps. The output is displayed in white text on a dark background.

```
bash-3.2$ echo $(ls -al)
total 8 drwxr-xr-x 4 flavio staff 128 Sep 3 15:43 .
drwxr-xr-x+ 55 flavio staff 1760 Sep 3 15:20 ..
-rw-r--r-- 1 flavio staff 6 Sep 3 15:43 output.txt
-rw-r--r-- 1 flavio staff 0 Sep 3 15:20 words.txt
bash-3.2$
```

Note that whitespace is not preserved by default. You need to wrap the command in double quotes to do so:

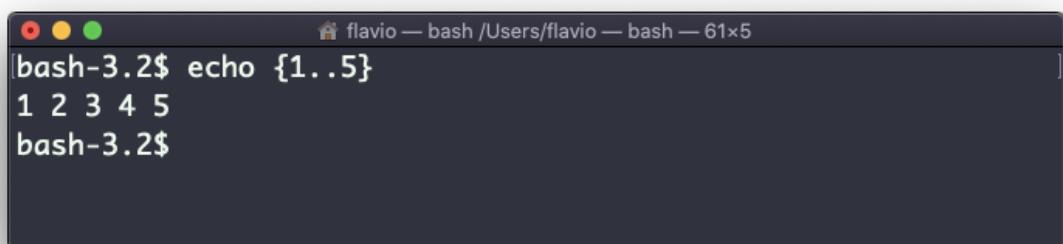


A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x7". The window shows the command "bash-3.2\$ echo "\$(ls -al)" followed by the output of the "ls -al" command. The output is identical to the previous screenshot, but the command itself is wrapped in double quotes. The output is displayed in white text on a dark background.

```
bash-3.2$ echo "$(ls -al)"
total 8
drwxr-xr-x 4 flavio staff 128 Sep 3 15:43 .
drwxr-xr-x+ 55 flavio staff 1760 Sep 3 15:20 ..
-rw-r--r-- 1 flavio staff 6 Sep 3 15:43 output.txt
-rw-r--r-- 1 flavio staff 0 Sep 3 15:20 words.txt
bash-3.2$
```

You can generate a list of strings, for example ranges:

```
echo {1..5}
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x5". The window contains the following text:

```
bash-3.2$ echo {1..5}
1 2 3 4 5
bash-3.2$
```

chown

Every file/directory in an Operating System like Linux or macOS (and every UNIX systems in general) has an **owner**.

The owner of a file can do everything with it. It can decide the fate of that file.

The owner (and the `root` user) can change the owner to another user, too, using the `chown` command:

```
chown <owner> <file>
```

Like this:

```
chown flavio test.txt
```

For example if you have a file that's owned by `root`, you can't write to it as another user:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 65x7". The window shows the following command history:

```
[~] ~ sudo touch test.txt
[~] ~ echo test >> test.txt
<W> fish: An error occurred while redirecting file 'test.txt'
open: Permission denied
[~]
```

You can use `chown` to transfer the ownership to you:



A screenshot of a macOS terminal window titled "fish /Users/flavio". The terminal shows the following session:

```
~ sudo touch test.txt
~ echo test >> test.txt
<W> fish: An error occurred while redirecting file 'test.txt'
open: Permission denied
~ sudo chown flavio test.txt
~ echo test >> test.txt
~
```

It's rather common to have the need to change the ownership of a directory, and recursively all the files contained, plus all the subdirectories and the files contained in them, too.

You can do so using the `-R` flag:

```
chown -R <owner> <file>
```

Files/directories don't just have an owner, they also have a **group**. Through this command you can change that simultaneously while you change the owner:

```
chown <owner>:<group> <file>
```

Example:

```
chown flavio:users test.txt
```

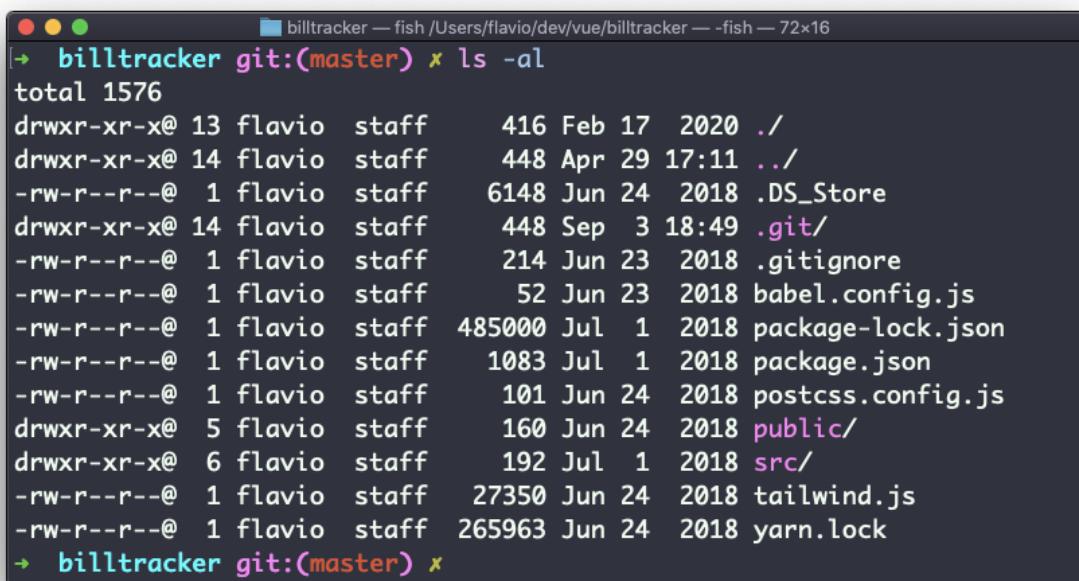
You can also just change the group of a file using the `chgrp` command:

```
chgrp <group> <filename>
```

chmod

Every file in the Linux / macOS Operating Systems (and UNIX systems in general) has 3 permissions: Read, write, execute.

Go into a folder, and run the `ls -al` command.



```
billtracker — fish /Users/flavio/dev/vue/billtracker — -fish — 72x16
|→ billtracker git:(master) ✘ ls -al
total 1576
drwxr-xr-x@ 13 flavio  staff      416 Feb 17  2020 .
drwxr-xr-x@ 14 flavio  staff      448 Apr 29 17:11 ..
-rw-r--r--@  1 flavio  staff     6148 Jun 24  2018 .DS_Store
drwxr-xr-x@ 14 flavio  staff      448 Sep  3 18:49 .git/
-rw-r--r--@  1 flavio  staff     214 Jun 23  2018 .gitignore
-rw-r--r--@  1 flavio  staff      52 Jun 23  2018 babel.config.js
-rw-r--r--@  1 flavio  staff   485000 Jul  1  2018 package-lock.json
-rw-r--r--@  1 flavio  staff    1083 Jul  1  2018 package.json
-rw-r--r--@  1 flavio  staff     101 Jun 24  2018 postcss.config.js
drwxr-xr-x@  5 flavio  staff     160 Jun 24  2018 public/
drwxr-xr-x@  6 flavio  staff     192 Jul  1  2018 src/
-rw-r--r--@  1 flavio  staff   27350 Jun 24  2018 tailwind.js
-rw-r--r--@  1 flavio  staff  265963 Jun 24  2018 yarn.lock
→ billtracker git:(master) ✘
```

The weird strings you see on each file line, like `drwxr-xr-x`, define the permissions of the file or folder.

Let's dissect it.

The first letter indicates the type of file:

- `-` means it's a normal file
- `d` means it's a directory
- `l` means it's a link

Then you have 3 sets of values:

- The first set represents the permissions of the **owner** of the file
- The second set represents the permissions of the members of the **group** the file is associated to

- The third set represents the permissions of the **everyone else**

Those sets are composed by 3 values. `rwx` means that specific *persona* has read, write and execution access. Anything that is removed is swapped with a `-`, which lets you form various combinations of values and relative permissions: `rw-`, `r--`, `r-x`, and so on.

You can change the permissions given to a file using the `chmod` command.

`chmod` can be used in 2 ways. The first is using symbolic arguments, the second is using numeric arguments. Let's start with symbols first, which is more intuitive.

You type `chmod` followed by a space, and a letter:

- `a` stands for *all*
- `u` stands for *user*
- `g` stands for *group*
- `o` stands for *others*

Then you type either `+` or `-` to add a permission, or to remove it. Then you enter one or more permissions symbols (`r`, `w`, `x`).

All followed by the file or folder name.

Here are some examples:

```
chmod a+r filename #everyone can now read
chmod a+rw filename #everyone can now read and write
chmod o-rwx filename #others (not the owner, not in the same group of the
```

You can apply the same permissions to multiple personas by adding multiple letters before the `+ / -`:

```
chmod og-r filename #other and group can't read any more
```

In case you are editing a folder, you can apply the permissions to every file contained in that folder using the `-r` (recursive) flag.

Numeric arguments are faster but I find them hard to remember when you are not using them day to day. You use a digit that represents the permissions of the persona. This number value can be a maximum of 7, and it's calculated in this way:

- 1 if has execution permission
- 2 if has write permission
- 4 if has read permission

This gives us 4 combinations:

- 0 no permissions
- 1 can execute
- 2 can write
- 3 can write, execute
- 4 can read
- 5 can read, execute
- 6 can read, write
- 7 can read, write and execute

We use them in pairs of 3, to set the permissions of all the 3 groups altogether:

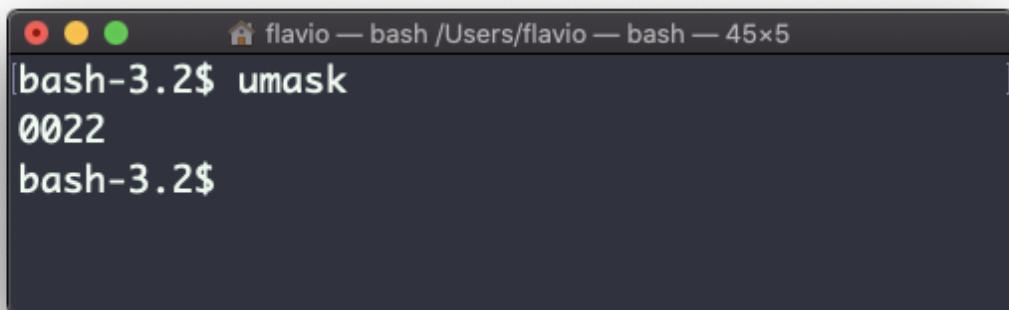
```
chmod 777 filename  
chmod 755 filename  
chmod 644 filename
```

umask

When you create a file, you don't have to decide permissions up front. Permissions have defaults.

Those defaults can be controlled and modified using the `umask` command.

Typing `umask` with no arguments will show you the current umask, in this case `0022`:

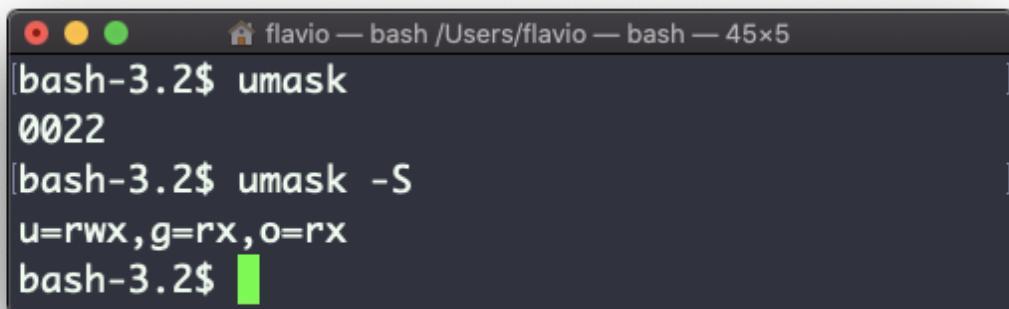


```
flavio — bash /Users/flavio — bash — 45x5
[bash-3.2$ umask
0022
bash-3.2$
```

What does `0022` mean? That's an octal value that represent the permissions.

Another common value is `0002`.

Use `umask -S` to see a human-readable notation:



```
flavio — bash /Users/flavio — bash — 45x5
[bash-3.2$ umask
0022
[bash-3.2$ umask -S
u=rwx,g=rx,o=rx
bash-3.2$
```

In this case, the user (`u`), owner of the file, has read, write and execution permissions on files.

Other users belonging to the same group (`g`) have read and execution permission, same as all the other users (`o`).

In the numeric notation, we typically change the last 3 digits.

Here's a list that gives a meaning to the number:

- `0` read, write, execute
- `1` read and write
- `2` read and execute
- `3` read only
- `4` write and execute
- `5` write only
- `6` execute only
- `7` no permissions

Note that this numeric notation differs from the one we use in `chmod`.

We can set a new value for the mask setting the value in numeric format:

```
umask 002
```

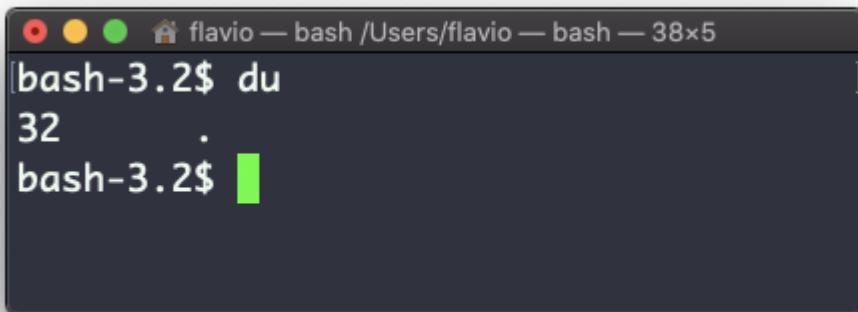
or you can change a specific role's permission:

```
umask g+r
```

du

The `du` command will calculate the size of a directory as a whole:

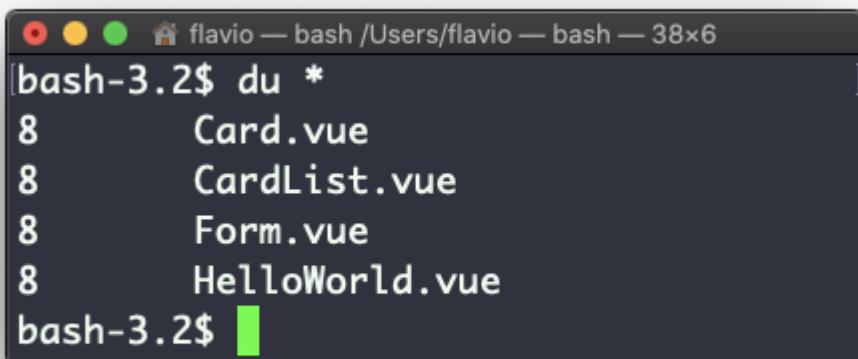
```
du
```



A screenshot of a macOS terminal window. The title bar shows "flavio — bash /Users/flavio — bash — 38x5". The command entered is "bash-3.2\$ du". The output is "32 .". The prompt "bash-3.2\$" is visible at the bottom.

The `32` number here is a value expressed in bytes.

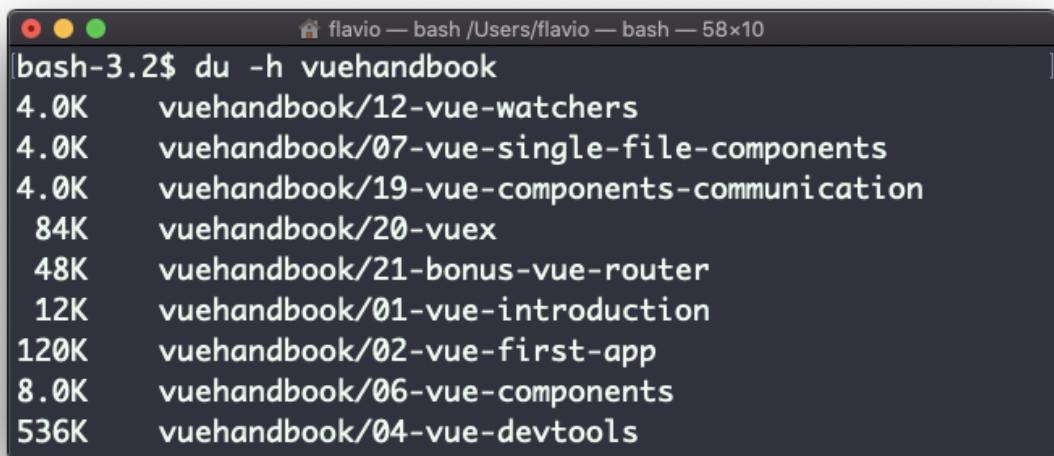
Running `du *` will calculate the size of each file individually:



A screenshot of a macOS terminal window. The title bar shows "flavio — bash /Users/flavio — bash — 38x6". The command entered is "bash-3.2\$ du *". The output shows the size (8) and name for four files: "Card.vue", "CardList.vue", "Form.vue", and "HelloWorld.vue". The prompt "bash-3.2\$" is visible at the bottom.

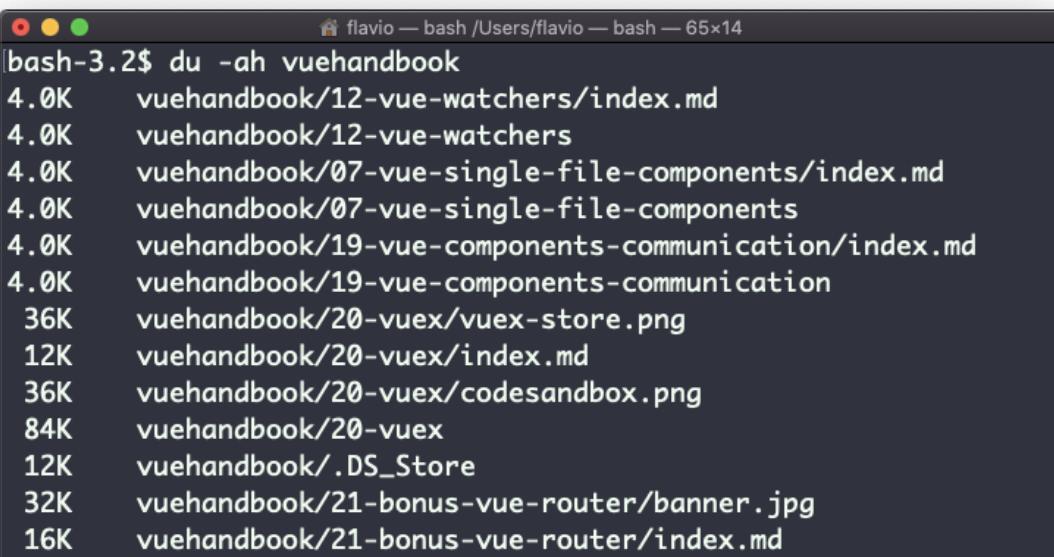
You can set `du` to display values in MegaBytes using `du -m`, and GigaBytes using `du -g`.

The `-h` option will show a human-readable notation for sizes, adapting to the size:



```
flavio — bash /Users/flavio — bash — 58x10
[bash-3.2$ du -h vuehandbook
4.0K    vuehandbook/12-vue-watchers
4.0K    vuehandbook/07-vue-single-file-components
4.0K    vuehandbook/19-vue-components-communication
84K     vuehandbook/20-vuex
48K     vuehandbook/21-bonus-vue-router
12K     vuehandbook/01-vue-introduction
120K    vuehandbook/02-vue-first-app
8.0K    vuehandbook/06-vue-components
536K   vuehandbook/04-vue-devtools
```

Adding the `-a` option will print the size of each file in the directories, too:



```
flavio — bash /Users/flavio — bash — 65x14
[bash-3.2$ du -ah vuehandbook
4.0K    vuehandbook/12-vue-watchers/index.md
4.0K    vuehandbook/12-vue-watchers
4.0K    vuehandbook/07-vue-single-file-components/index.md
4.0K    vuehandbook/07-vue-single-file-components
4.0K    vuehandbook/19-vue-components-communication/index.md
4.0K    vuehandbook/19-vue-components-communication
36K     vuehandbook/20-vuex/vuex-store.png
12K     vuehandbook/20-vuex/index.md
36K     vuehandbook/20-vuex/codesandbox.png
84K     vuehandbook/20-vuex
12K     vuehandbook/.DS_Store
32K     vuehandbook/21-bonus-vue-router/banner.jpg
16K     vuehandbook/21-bonus-vue-router/index.md
```

A handy thing is to sort the directories by size:

```
du -h <directory> | sort -nr
```

and then piping to `head` to only get the first 10 results:

```
flavio — bash /Users/flavio — bash — 63x13
[bash-3.2$ du -h vuehandbook | sort -nr | head
932K  vuehandbook/05-vue-vscode
636K  vuehandbook/.git/objects/75
544K  vuehandbook/03-vue-cli
536K  vuehandbook/04-vue-devtools
120K  vuehandbook/02-vue-first-app
88K   vuehandbook/.git/objects/pack
88K   vuehandbook/.git/objects/b0
84K   vuehandbook/20-vuex
76K   vuehandbook/.git/objects/6f
64K   vuehandbook/.git/objects/41
bash-3.2$
```

df

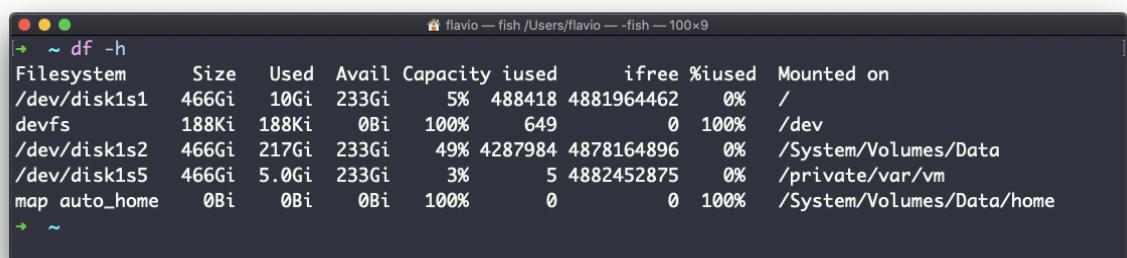
The `df` command is used to get disk usage information.

Its basic form will print information about the volumes mounted:



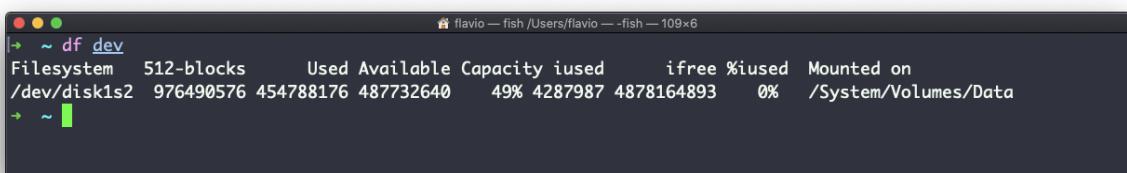
```
flavio ~ df
Filesystem 512-blocks Used Available Capacity iused ifree %iused Mounted on
/dev/disk1s1 976490576 21974760 487735816 5% 488418 4881964462 0% /
devfs 375 375 0 100% 649 0 100% /dev
/dev/disk1s2 976490576 454785000 487735816 49% 4287975 4878164905 0% /System/Volumes/Data
/dev/disk1s5 976490576 10485848 487735816 3% 5 4882452875 0% /private/var/vm
map auto_home 0 0 0 100% 0 0 100% /System/Volumes/Data/home
~
```

Using the `-h` option (`df -h`) will show those values in a human-readable format:



```
flavio ~ df -h
Filesystem Size Used Avail Capacity iused ifree %iused Mounted on
/dev/disk1s1 466Gi 10Gi 233Gi 5% 488418 4881964462 0% /
devfs 188Ki 188Ki 0Bi 100% 649 0 100% /dev
/dev/disk1s2 466Gi 217Gi 233Gi 49% 4287984 4878164896 0% /System/Volumes/Data
/dev/disk1s5 466Gi 5.0Gi 233Gi 3% 5 4882452875 0% /private/var/vm
map auto_home 0Bi 0Bi 0Bi 100% 0 0 100% /System/Volumes/Data/home
~
```

You can also specify a file or directory name to get information about the specific volume it lives on:



```
flavio ~ df dev
Filesystem 512-blocks Used Available Capacity iused ifree %iused Mounted on
/dev/disk1s2 976490576 454788176 487732640 49% 4287987 4878164893 0% /System/Volumes/Data
~
```

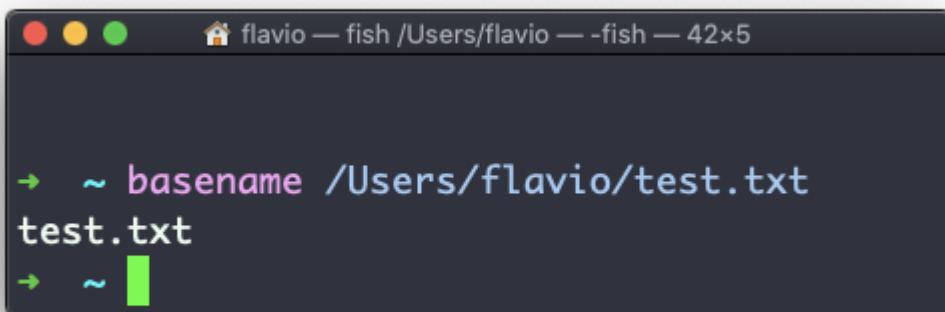
basename

Suppose you have a path to a file, for example `/Users/flavio/test.txt`.

Running

```
basename /Users/flavio/test.txt
```

will return the `test.txt` string:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 42x5". The command `~ basename /Users/flavio/test.txt` is entered, and the output `test.txt` is displayed below it.

```
→ ~ basename /Users/flavio/test.txt
test.txt
→ ~
```

If you run `basename` on a path string that points to a directory, you will get the last segment of the path. In this example, `/Users/flavio` is a directory:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 42x5". The command `~ basename /Users/flavio/` is entered, and the output `flavio` is displayed below it. A second command `~ basename /Users/flavio` is also shown, resulting in the same output `flavio`.

```
→ ~ basename /Users/flavio/
flavio
→ ~ basename /Users/flavio
flavio
→ ~
```

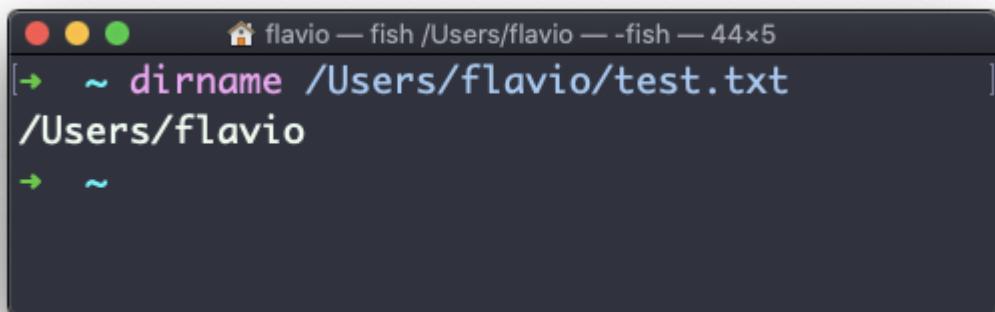
dirname

Suppose you have a path to a file, for example `/Users/flavio/test.txt`.

Running

```
dirname /Users/flavio/test.txt
```

will return the `/Users/flavio` string:

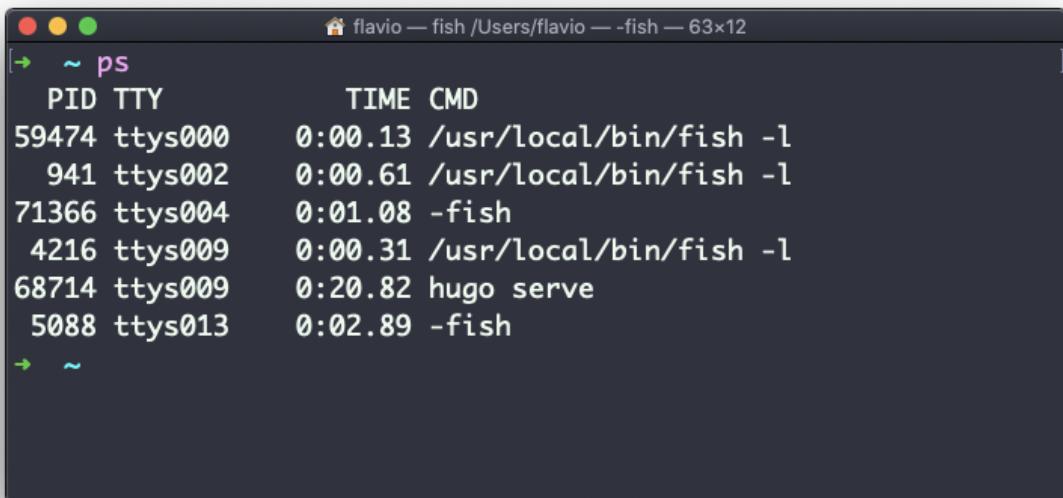


A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 44x5". The window shows the command `dirname /Users/flavio/test.txt` being run, and the output `/Users/flavio` is displayed below it. The terminal has a dark background with white text.

ps

Your computer is running, at all times, tons of different processes.

You can inspect them all using the `ps` command:



A screenshot of a terminal window titled "flavio — fish /Users/flavio — -fish — 63x12". The window shows the output of the `ps` command. The output is as follows:

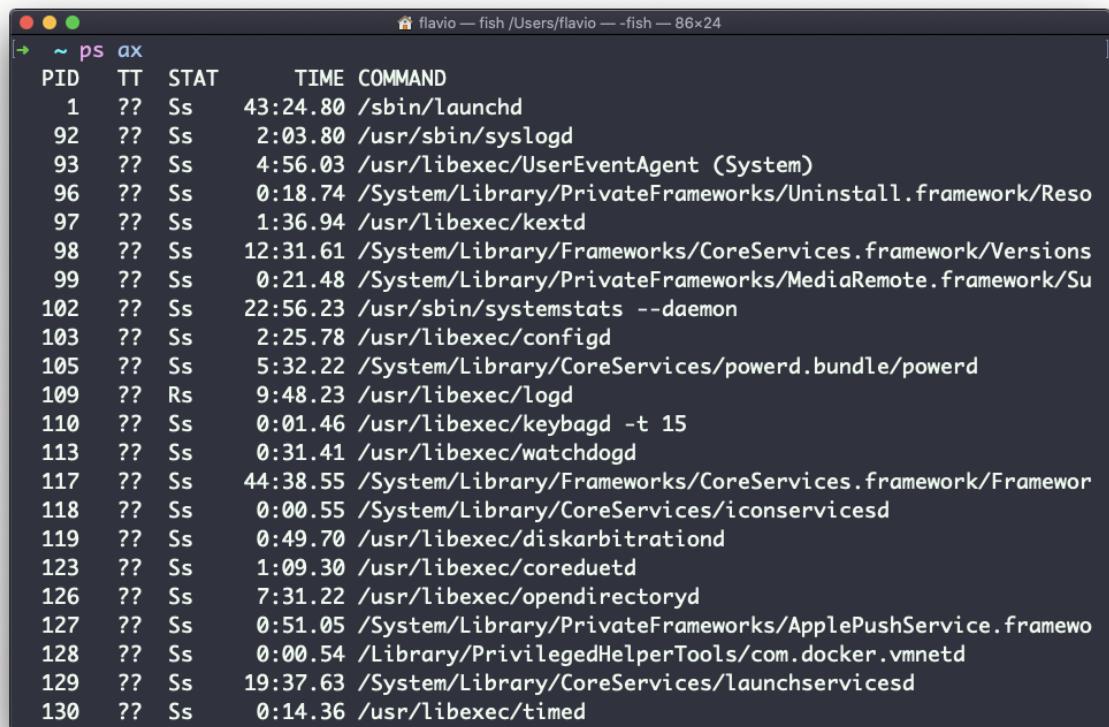
```
[~] ~ ps
PID TTY      TIME CMD
59474 ttys000 0:00.13 /usr/local/bin/fish -l
 941 ttys002 0:00.61 /usr/local/bin/fish -l
71366 ttys004 0:01.08 -fish
4216 ttys009 0:00.31 /usr/local/bin/fish -l
68714 ttys009 0:20.82 hugo serve
5088 ttys013 0:02.89 -fish
[~]
```

This is the list of user-initiated processes currently running in the current session.

Here I have a few `fish` shell instances, mostly opened by VS Code inside the editor, and an instances of Hugo running the development preview of a site.

Those are just the commands assigned to the current user. To list **all** processes we need to pass some options to `ps`.

The most common I use is `ps ax`:



A terminal window titled "flavio — fish /Users/flavio — -fish — 86x24" displaying the output of the command "ps ax". The output lists various processes with their PID, TTY, STAT, TIME, and COMMAND. The commands include launchd, syslogd, UserEventAgent, kextd, systemstats, configd, powerd, logd, keybagd, watchdogd, iconservicesd, diskarbitrationd, coreduetd, opendirectoryd, ApplePushService, docker, vmnetd, and launchservicesd.

PID	TT	STAT	TIME	COMMAND
1	??	Ss	43:24.80	/sbin/launchd
92	??	Ss	2:03.80	/usr/sbin/syslogd
93	??	Ss	4:56.03	/usr/libexec/UserEventAgent (System)
96	??	Ss	0:18.74	/System/Library/PrivateFrameworks/Uninstall.framework/Reso
97	??	Ss	1:36.94	/usr/libexec/kextd
98	??	Ss	12:31.61	/System/Library/Frameworks/CoreServices.framework/Versions
99	??	Ss	0:21.48	/System/Library/PrivateFrameworks/MediaRemote.framework/Su
102	??	Ss	22:56.23	/usr/sbin/systemstats --daemon
103	??	Ss	2:25.78	/usr/libexec/configd
105	??	Ss	5:32.22	/System/Library/CoreServices/powerd.bundle/powerd
109	??	Rs	9:48.23	/usr/libexec/logd
110	??	Ss	0:01.46	/usr/libexec/keybagd -t 15
113	??	Ss	0:31.41	/usr/libexec/watchdogd
117	??	Ss	44:38.55	/System/Library/Frameworks/CoreServices.framework/Framework
118	??	Ss	0:00.55	/System/Library/CoreServices/iconservicesd
119	??	Ss	0:49.70	/usr/libexec/diskarbitrationd
123	??	Ss	1:09.30	/usr/libexec/coreduetd
126	??	Ss	7:31.22	/usr/libexec/opendirectoryd
127	??	Ss	0:51.05	/System/Library/PrivateFrameworks/ApplePushService.framework
128	??	Ss	0:00.54	/Library/PrivilegedHelperTools/com.docker.vmnetd
129	??	Ss	19:37.63	/System/Library/CoreServices/launchservicesd
130	??	Ss	0:14.36	/usr/libexec/timed

The `a` option is used to also list other users processes, not just our own. `x` shows processes not linked to any terminal (not initiated by users through a terminal).

As you can see, the longer commands are cut. Use the command `ps axww` to continue the command listing on a new line instead of cutting it:

```

PID  TT  STAT      TIME COMMAND
 1  ??  Ss   43:25.81 /sbin/launchd
 92  ??  Ss   2:03.82 /usr/sbin/syslogd
 93  ??  Ss   4:56.05 /usr/libexec/UserEventAgent (System)
 96  ??  Ss   0:18.74 /System/Library/PrivateFrameworks/Uninstall.framework/Resources/uninstallld
 97  ??  Ss   1:36.94 /usr/libexec/kextd
 98  ??  Ss   12:31.92 /System/Library/Frameworks/CoreServices.framework/Versions/A/Frameworks/FSEvents.framework/Versions/A/Support/fsevents
 99  ??  Ss   0:21.48 /System/Library/PrivateFrameworks/MediaRemote.framework/Support/mediaremoted
102  ??  Ss   22:56.23 /usr/sbin/systemstats --daemon
103  ??  Ss   2:25.80 /usr/libexec/configd
105  ??  Ss   5:32.38 /System/Library/CoreServices/powerd.bundle/powerd
109  ??  Ss   9:48.48 /usr/libexec/logd
110  ??  Ss   0:01.46 /usr/libexec/keybagd -t 15
113  ??  Ss   0:31.42 /usr/libexec/watchdog
117  ??  Ss   44:38.88 /System/Library/Frameworks/CoreServices.framework/Frameworks/Metadata.framework/Support/mds
118  ??  Ss   0:00.55 /System/Library/CoreServices/iconservicesd

```

We need to specify `w` 2 times to apply this setting, it's not a typo.

You can search for a specific process combining `grep` with a pipe, like this:

```
ps axww | grep "Visual Studio Code"
```

```

[~] ~ ps axww | grep "Visual Studio Code"
367  ??  S    40:32.47 /Applications/Visual Studio Code.app/Contents/MacOS/Electron -psn_0_77843
566  ??  S    93:02.21 /Applications/Visual Studio Code.app/Contents/Frameworks/Code Helper (GPU).app/Contents/MacOS/Code Helper (GPU) --type=gpu-process --field-trial-handle=1718379636,8422946071360466993,8181735644596197527,131072 --disable-features=LayoutNG,PictureInPicture,SpareRendererForSitePerProcess --disable-color-correct-rendering --gpu-preferences=KAAAAAAAAGAAAAAAAYAAAAAEAAAAAAGAAAAAAgBAAgAAAAAAEAAAAAAIAQAAAAABABA

```

The columns returned by `ps` represent some key information.

The first information is `PID`, the process ID. This is key when you want to reference this process in another command, for example to kill it.

Then we have `TT` that tells us the terminal id used.

Then `STAT` tells us the state of the process:

`I` a process that is idle (sleeping for longer than about 20 seconds) `R` a runnable process `S` a process that is sleeping for less than about 20 seconds `T` a stopped process `U` a process in uninterruptible wait `Z` a dead process (a *zombie*)

If you have more than one letter, the second represents further information, which can be very technical.

It's common to have `+` which indicates the process is in the foreground in its terminal. `s` means the process is a [session leader](#).

`TIME` tells us how long the process has been running.

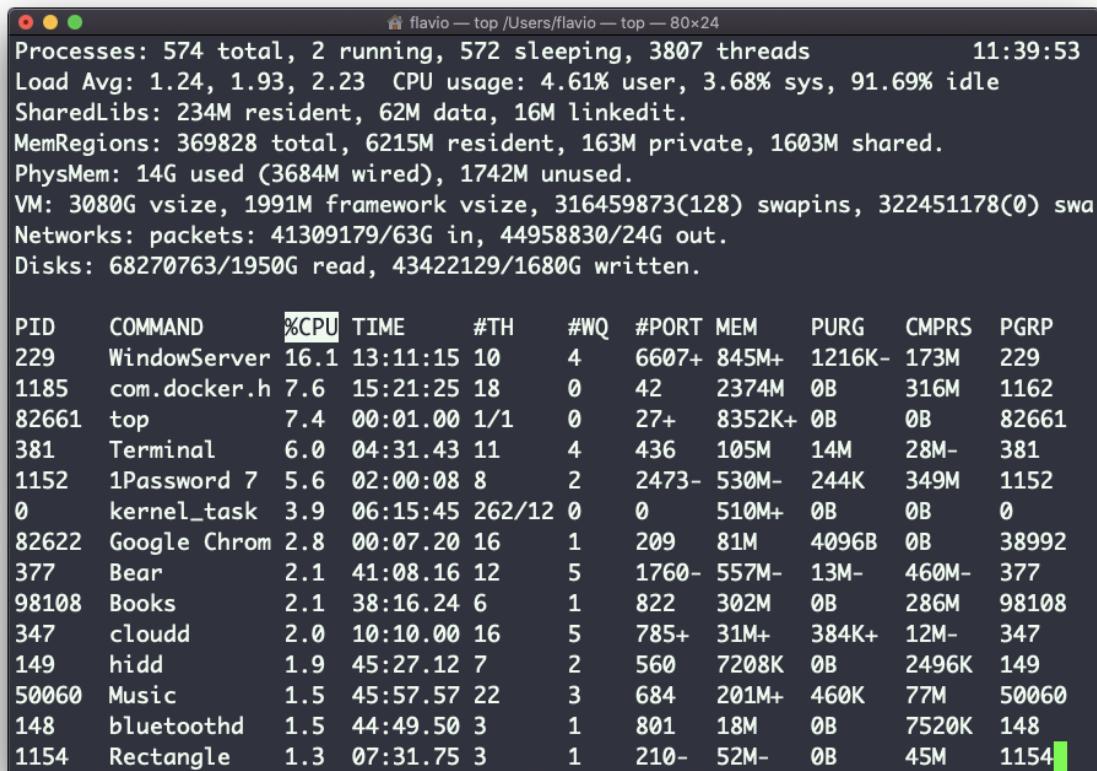
top

A quick guide to the `top` command, used to list the processes running in real time

The `top` command is used to display dynamic real-time information about running processes in the system.

It's really handy to understand what is going on.

Its usage is simple, you just type `top`, and the terminal will be fully immersed in this new view:



flavio — top /Users/flavio — top — 80x24

PID	COMMAND	%CPU	TIME	#TH	#WQ	#PORT	MEM	PURG	CMPRS	PGRP
229	WindowServer	16.1	13:11:15	10	4	6607+	845M+	1216K-	173M	229
1185	com.docker.h	7.6	15:21:25	18	0	42	2374M	0B	316M	1162
82661	top	7.4	00:01.00	1/1	0	27+	8352K+	0B	0B	82661
381	Terminal	6.0	04:31.43	11	4	436	105M	14M	28M-	381
1152	1Password	5.6	02:00:08	8	2	2473-	530M-	244K	349M	1152
0	kernel_task	3.9	06:15:45	262/12	0	0	510M+	0B	0B	0
82622	Google Chrom	2.8	00:07.20	16	1	209	81M	4096B	0B	38992
377	Bear	2.1	41:08.16	12	5	1760-	557M-	13M-	460M-	377
98108	Books	2.1	38:16.24	6	1	822	302M	0B	286M	98108
347	cloudd	2.0	10:10.00	16	5	785+	31M+	384K+	12M-	347
149	hidd	1.9	45:27.12	7	2	560	7208K	0B	2496K	149
50060	Music	1.5	45:57.57	22	3	684	201M+	460K	77M	50060
148	bluetoothd	1.5	44:49.50	3	1	801	18M	0B	7520K	148
1154	Rectangle	1.3	07:31.75	3	1	210-	52M-	0B	45M	1154

The process is long-running. To quit, you can type the `q` letter or `ctrl-C`.

There's a lot of information being given to us: the number of processes, how many are running or sleeping, the system load, the CPU usage, and a lot more.

Below, the list of processes taking the most memory and CPU is constantly updated.

By default, as you can see from the `%CPU` column highlighted, they are sorted by the CPU used.

You can add a flag to sort processes by memory utilized:

```
top -o mem
```

kill

Linux processes can receive **signals** and react to them.

That's one way we can interact with running programs.

The `kill` program can send a variety of signals to a program.

It's not just used to terminate a program, like the name would suggest, but that's its main job.

We use it in this way:

```
kill <PID>
```

By default, this sends the `TERM` signal to the process id specified.

We can use flags to send other signals, including:

```
kill -HUP <PID>
kill -INT <PID>
kill -KILL <PID>
kill -TERM <PID>
kill -CONT <PID>
kill -STOP <PID>
```

`HUP` means **hang up**. It's sent automatically when a terminal window that started a process is closed before terminating the process.

`INT` means **interrupt**, and it sends the same signal used when we press `ctrl-c` in the terminal, which usually terminates the process.

`KILL` is not sent to the process, but to the operating system kernel, which immediately stops and terminates the process.

`TERM` means **terminate**. The process will receive it and terminate itself. It's the default signal sent by `kill`.

`CONT` means **continue**. It can be used to resume a stopped process.

`STOP` is not sent to the process, but to the operating system kernel, which immediately stops (but does not terminate) the process.

You might see numbers used instead, like `kill -1 <PID>`. In this case,

`1` corresponds to `HUP` . `2` corresponds to `INT` . `9` corresponds to `KILL` . `15` corresponds to `TERM` . `18` corresponds to `CONT` . `15` corresponds to `STOP` .

killall

Similar to the `kill` command, `killall` instead of sending a signal to a specific process id will send the signal to multiple processes at once.

This is the syntax:

```
killall <name>
```

where `name` is the name of a program. For example you can have multiple instances of the `top` program running, and `killall top` will terminate them all.

You can specify the signal, like with `kill` (and check the `kill` tutorial to read more about the specific kinds of signals we can send), for example:

```
killall -HUP top
```

jobs

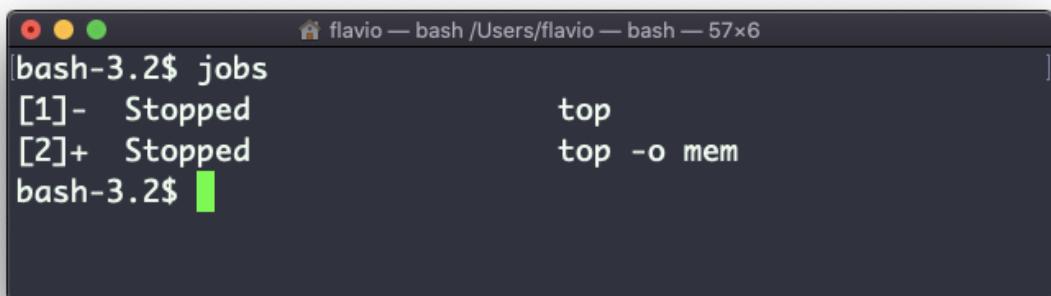
When we run a command in Linux / macOS, we can set it to run in the background using the `&` symbol after the command. For example we can run `top` in the background:

```
top &
```

This is very handy for long-running programs.

We can get back to that program using the `fg` command. This works fine if we just have one job in the background, otherwise we need to use the job number: `fg 1`, `fg 2` and so on. To get the job number, we use the `jobs` command.

Say we run `top &` and then `top -o mem &`, so we have 2 top instances running. `jobs` will tell us this:



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 57x6". The window contains the following text:

```
bash-3.2$ jobs
[1]-  Stopped                  top
[2]+  Stopped                  top -o mem
bash-3.2$
```

Now we can switch back to one of those using `fg <jobid>`. To stop the program again we can hit `cmd-Z`.

Running `jobs -l` will also print the process id of each job.

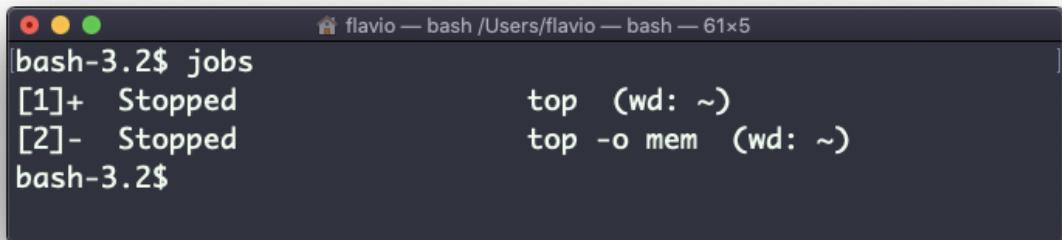
bg

When a command is running you can suspend it using `ctrl-Z`.

The command will immediately stop, and you get back to the shell terminal.

You can resume the execution of the command in the background, so it will keep running but it will not prevent you from doing other work in the terminal.

In this example I have 2 commands stopped:



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x5". The window shows the output of the command `jobs`. It lists two stopped processes: job [1] is a `top` process with arguments `(wd: ~)`, and job [2] is another `top` process with arguments `-o mem (wd: ~)`. The prompt `bash-3.2$` is visible at the bottom.

```
flavio — bash /Users/flavio — bash — 61x5
bash-3.2$ jobs
[1]+  Stopped                  top  (wd: ~)
[2]-  Stopped                  top -o mem  (wd: ~)
bash-3.2$
```

I can run `bg 1` to resume in the background the execution of the job #1.

I could have also said `bg` without any option, as the default is to pick the job #1 in the list.

fg

When a command is running in the background, because you started it with `&` at the end (example: `top &` or because you put it in the background with the `bg` command, you can put it to the foreground using `fg`.

Running

```
fg
```

will resume to the foreground the last job that was suspended.

You can also specify which job you want to resume to the foreground passing the job number, which you can get using the `jobs` command.



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x5". The window shows the output of the `jobs` command:

```
bash-3.2$ jobs
[1]+  Stopped                  top  (wd: ~)
[2]-  Stopped                  top -o mem  (wd: ~)
bash-3.2$
```

Running `fg 2` will resume job #2:

```
flavio — bash /Users/flavio — top — 61x23
Processes: 574 total, 2 running, 572 sleeping, 3823 threads
16:12:54 Load Avg: 1.44, 1.60, 1.74
CPU usage: 3.76% user, 2.99% sys, 93.23% idle
SharedLibs: 235M resident, 62M data, 16M linkedit.
MemRegions: 365072 total, 6752M resident, 166M private, 1835M
PhysMem: 15G used (3692M wired), 738M unused.
VM: 3092G vsize, 1991M framework vsize, 318057086(0) swapins,
Networks: packets: 43489522/66G in, 47248873/25G out.
Disks: 69434725/1968G read, 44158267/1695G written.

PID      COMMAND      %CPU TIME      #TH      #WQ      #PORT      MEM
1185     com.docker.h 9.1  15:40:34 18      0        42      2374M
566      Code Helper  0.0  93:50.08 8       1        267      1606M
85440    hugo         0.0  09:19.41 20      0        29      1029M
229      WindowServer 16.0 13:29:14 10      4        6193+    851M
1152     1Password 7   6.9   02:10:02 8       2        2400      581M
377      Bear          0.0  43:56.57 13      6        1763      570M+
605      Code Helper  0.1  63:35.69 27      1        226      557M
42433    Photos        0.0  02:37.69 7       1        535      524M
588      Figma Helper 0.0  26:13.88 8       1        219      522M
0        kernel_task   3.2  06:24:14 262/12 0       0        514M
38992    Google Chrom 0.6  02:52:53 35      2        1238      506M
594      Code Helper  0.3  54:59.85 27      1        228      471M
```

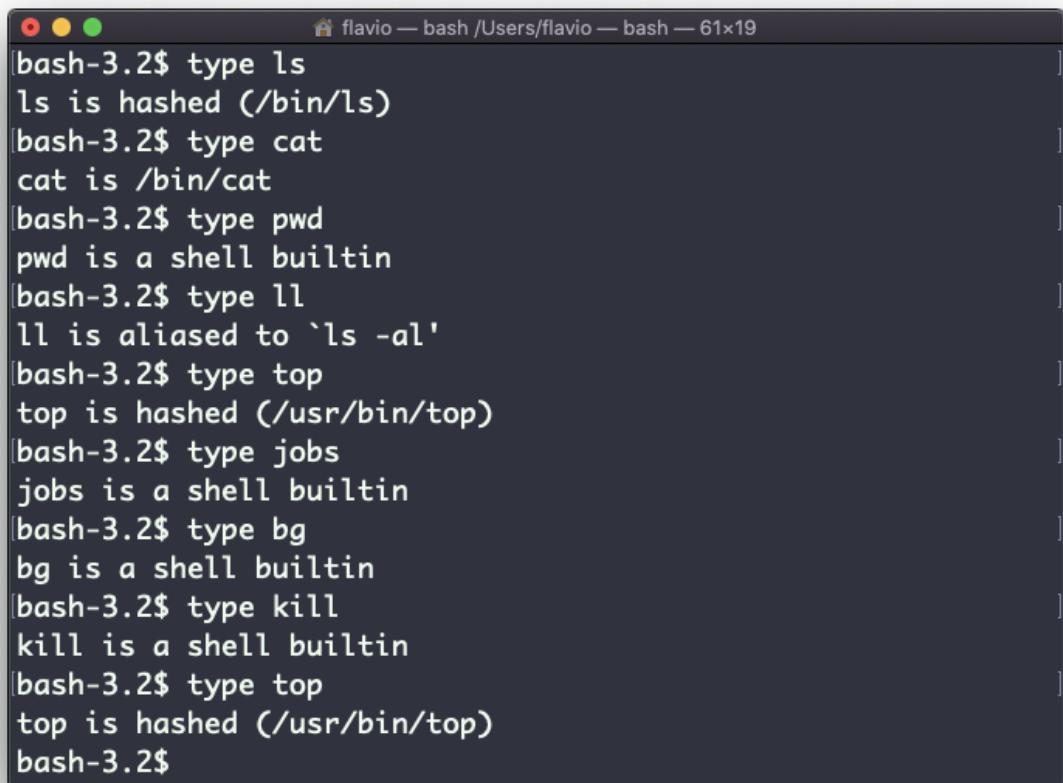
type

A command can be one of those 4 types:

- an executable
- a shell built-in program
- a shell function
- an alias

The `type` command can help figure out this, in case we want to know or we're just curious. It will tell you how the command will be interpreted.

The output will depend on the shell used. This is Bash:



```
flavio — bash /Users/flavio — bash — 61x19
bash-3.2$ type ls
ls is hashed (/bin/ls)
bash-3.2$ type cat
cat is /bin/cat
bash-3.2$ type pwd
pwd is a shell builtin
bash-3.2$ type ll
ll is aliased to `ls -al'
bash-3.2$ type top
top is hashed (/usr/bin/top)
bash-3.2$ type jobs
jobs is a shell builtin
bash-3.2$ type bg
bg is a shell builtin
bash-3.2$ type kill
kill is a shell builtin
bash-3.2$ type top
top is hashed (/usr/bin/top)
bash-3.2$
```

This is Zsh:

```
flavio@mbp ~ % type ls
ls is /bin/ls
flavio@mbp ~ % type cat
cat is /bin/cat
flavio@mbp ~ % type pwd
pwd is a shell builtin
flavio@mbp ~ % type ll
ll not found
flavio@mbp ~ % alias ll='ls -al'
flavio@mbp ~ % type ll
ll is an alias for ls -al
flavio@mbp ~ % type top
top is /usr/bin/top
flavio@mbp ~ % type jobs
jobs is a shell builtin
flavio@mbp ~ % type bg
bg is a shell builtin
flavio@mbp ~ % type kill
kill is a shell builtin
flavio@mbp ~ % type top
top is /usr/bin/top
flavio@mbp ~ %
```

This is Fish:

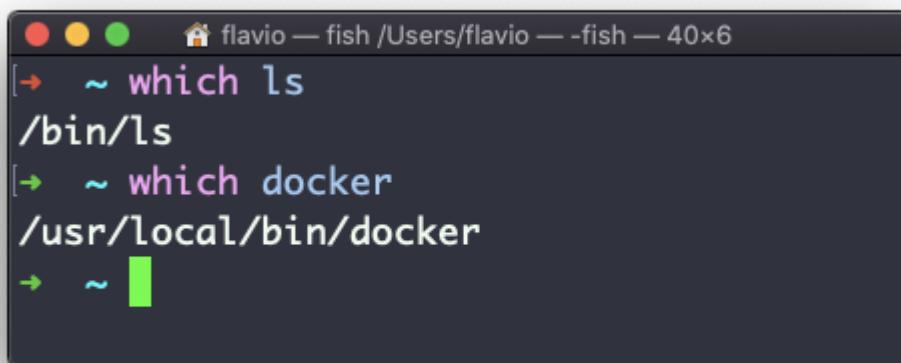
```
[~] flavio — fish /Users/flavio — -fish — 80x39
[~] ~ type ls
ls is a function with definition
# Defined in /usr/local/Cellar/fish/3.1.0/share/fish/functions/ls.fish @ line 13
function ls --description 'List contents of directory'
    set -l opt -G
        isatty stdout
        and set -a opt -F
            command ls $opt $argv
end
[~] ~ type cat
cat is /bin/cat
[~] ~ type pwd
pwd is a builtin
[~] ~ type ll
ll is a function with definition
# Defined in /usr/local/Cellar/fish/3.1.0/share/fish/functions/ll.fish @ line 4
function ll --description 'List contents of directory using long format'
    ls -lh $argv
end
[~] ~ type top
top is /usr/bin/top
[~] ~ type jobs
jobs is a builtin
[~] ~ type bg
bg is a function with definition
# Defined in /usr/local/Cellar/fish/3.1.0/share/fish/config.fish @ line 274
function bg
    set -l jobbltn bg
        builtin $jobbltn (__fish_expand_pid_args $argv)
end
[~] ~ type kill
kill is a function with definition
# Defined in /usr/local/Cellar/fish/3.1.0/share/fish/config.fish @ line 279
function kill
    command kill (__fish_expand_pid_args $argv)
end
[~] ~ type top
top is /usr/bin/top
[~]
```

One of the most interesting things here is that for aliases it will tell you what is aliasing to. You can see the `ll` alias, in the case of Bash and Zsh, but Fish provides it by default, so it will tell you it's a built-in shell function.

which

Suppose you have a command you can execute, because it's in the shell path, but you want to know where it is located.

You can do so using `which`. The command will return the path to the command specified:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 40x6". The window contains the following text:

```
[→ ~ which ls  
/bin/ls  
[→ ~ which docker  
/usr/local/bin/docker  
→ ~ █
```

`which` will only work for executables stored on disk, not aliases or built-in shell functions.

nohup

Sometimes you have to run a long-lived process on a remote machine, and then you need to disconnect.

Or you simply want to prevent the command to be halted if there's any network issue between you and the server.

The way to make a command run even after you log out or close the session to a server is to use the `nohup` command.

Use `nohup <command>` to let the process continue working even after you log out.

xargs

The `xargs` command is used in a UNIX shell to convert input from standard input into arguments to a command.

In other words, through the use of `xargs` the output of a command is used as the input of another command.

Here's the syntax you will use:

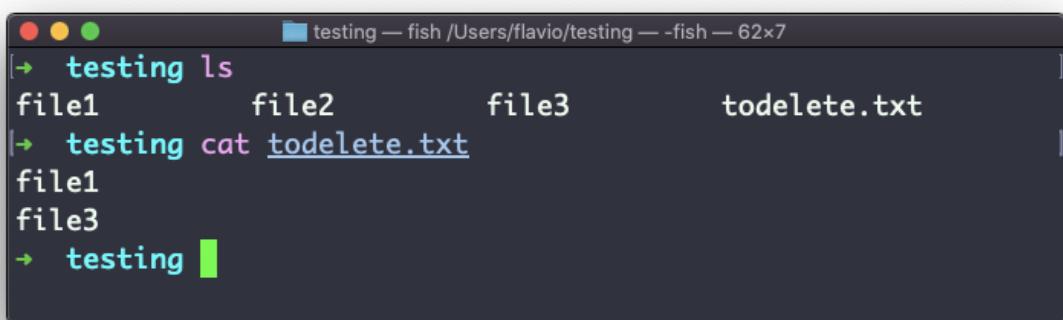
```
command1 | xargs command2
```

We use a pipe (`|`) to pass the output to `xargs`. That will take care of running the `command2` command, using the output of `command1` as its argument(s).

Let's do a simple example. You want to remove some specific files from a directory. Those files are listed inside a text file.

We have 3 files: `file1`, `file2`, `file3`.

In `todelete.txt` we have a list of files we want to delete, in this example `file1` and `file3`:



A screenshot of a macOS terminal window titled "testing — fish /Users/flavio/testing — -fish — 62x7". The window shows the following command history:

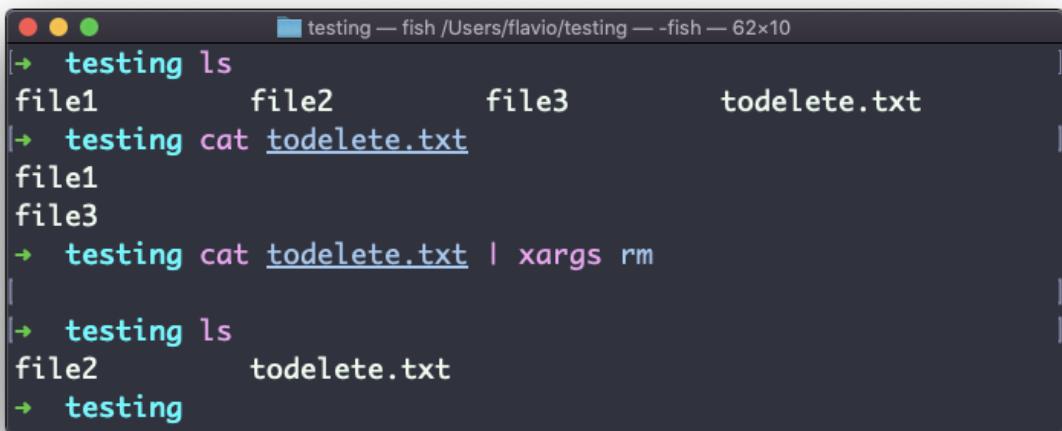
```
|> testing ls
file1      file2      file3      todelete.txt
|> testing cat todelete.txt
file1
file3
|> testing
```

We will channel the output of `cat todelete.txt` to the `rm` command, through `xargs`.

In this way:

```
cat todelete.txt | xargs rm
```

That's the result, the files we listed are now deleted:



The screenshot shows a terminal window titled "testing — fish /Users/flavio/testing — -fish — 62x10". The user has run the following commands:

```
testing ls
file1      file2      file3      todelete.txt
testing cat todelete.txt
file1
file3
testing cat todelete.txt | xargs rm
testing ls
file2      todelete.txt
testing
```

The "todelete.txt" file was present in the directory, but after running the command, it is no longer listed in the "ls" output.

The way it works is that `xargs` will run `rm` 2 times, one for each line returned by `cat`.

This is the simplest usage of `xargs`. There are several options we can use.

One of the most useful in my opinion, especially when starting to learn `xargs`, is `-p`. Using this option will make `xargs` print a confirmation prompt with the action it's going to take:



The screenshot shows a terminal window titled "testing — cat /Users/flavio/testing — xargs -p rm — 44x5". The user has run the following command:

```
testing cat todelete.txt | xargs -p rm
```

The command includes a pipe operator (`|`) before `xargs -p rm`. The prompt "rm file1 file3?..." is visible at the bottom of the terminal window, indicating that the user is about to confirm the deletion of the files "file1" and "file3".

The `-n` option lets you tell `xargs` to perform one iteration at a time, so you can individually confirm them with `-p`. Here we tell `xargs` to perform one iteration at a time with `-n1`:



```
testing — cat /Users/flavio/testing — xargs -p -n1 rm — 55x5
|→ testing cat todelete.txt | xargs -p -n1 rm
rm file1?...
```

The `-I` option is another widely used one. It allows you to get the output into a placeholder, and then you can do various things.

One of them is to run multiple commands:

```
command1 | xargs -I % /bin/bash -c 'command2 %; command3 %'
```



```
testing — cat /Users/flavio/testing — xargs -p -I % sh -c ls %; rm % — 67x5
|→ testing cat todelete.txt | xargs -p -I % sh -c 'ls %; rm %'
sh -c ls file1; rm file1?...
```

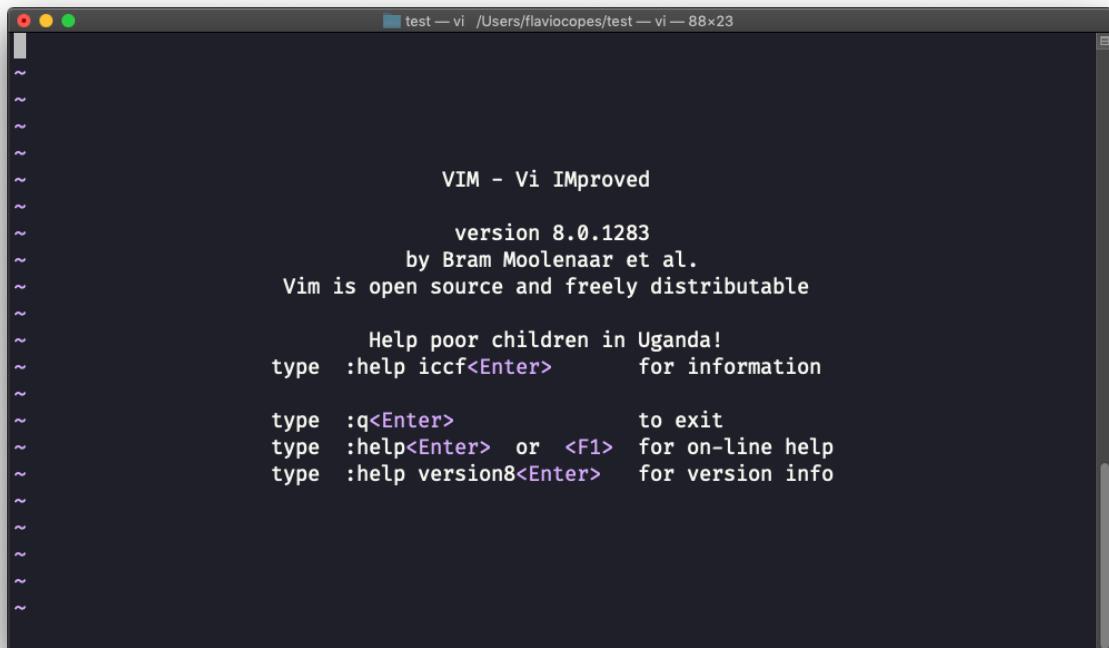
You can swap the `%` symbol I used above with anything else, it's a variable

vim

`vim` is a **very** popular file editor, especially among programmers. It's actively developed and frequently updated, and there's a very big community around it. There's even a [Vim conference!](#)

`vi` in modern systems is just an alias to `vim`, which means `vi` improved.

You start it by running `vi` on the command line.



A screenshot of a Mac OS X terminal window titled "test — vi /Users/flaviocopes/test — vi — 88x23". The window displays the Vim 8.0.1283 startup message. The text reads:

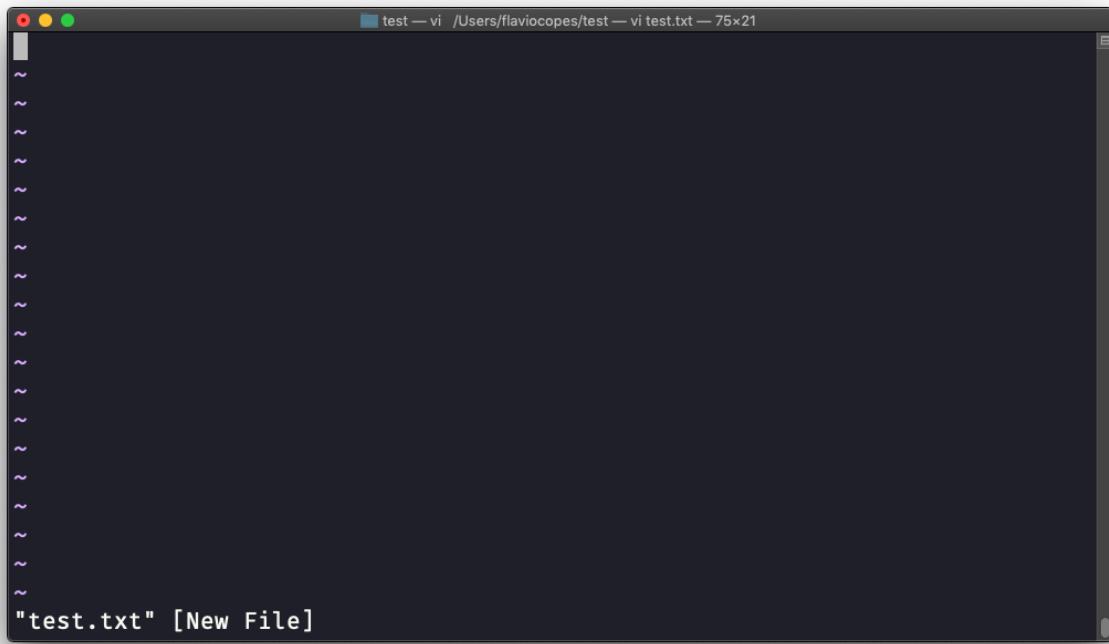
```
VIM - Vi IMproved
version 8.0.1283
by Bram Moolenaar et al.
Vim is open source and freely distributable

Help poor children in Uganda!
type :help iccf<Enter>      for information

type :q<Enter>              to exit
type :help<Enter> or <F1> for on-line help
type :help version8<Enter>   for version info
```

You can specify a filename at invocation time to edit that specific file:

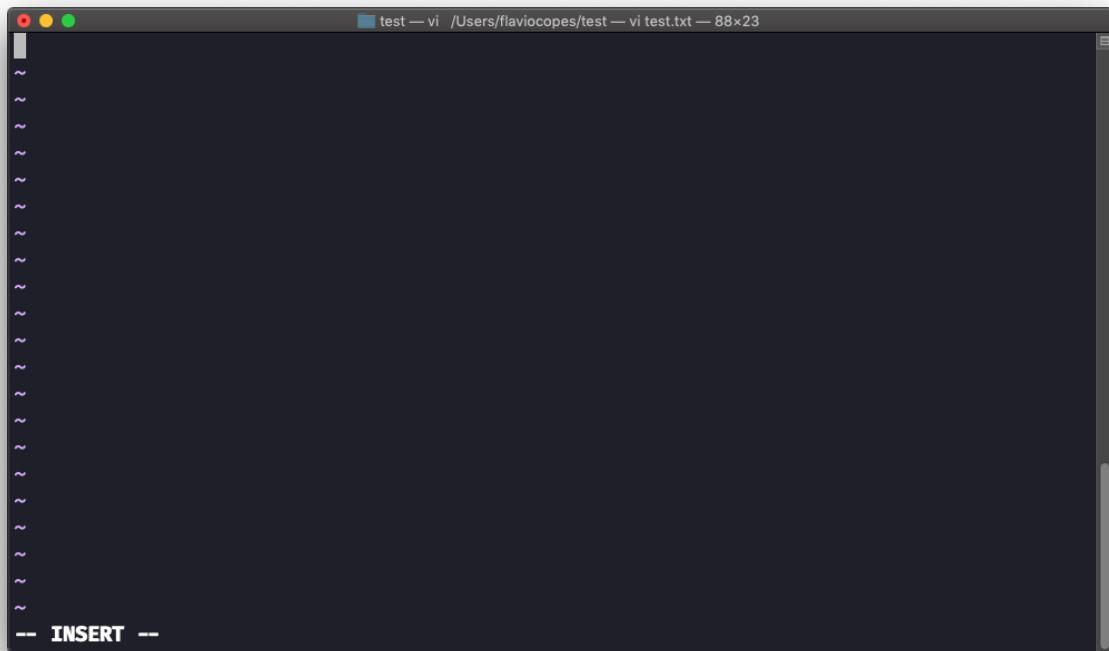
```
vi test.txt
```



You have to know that Vim has 2 main modes:

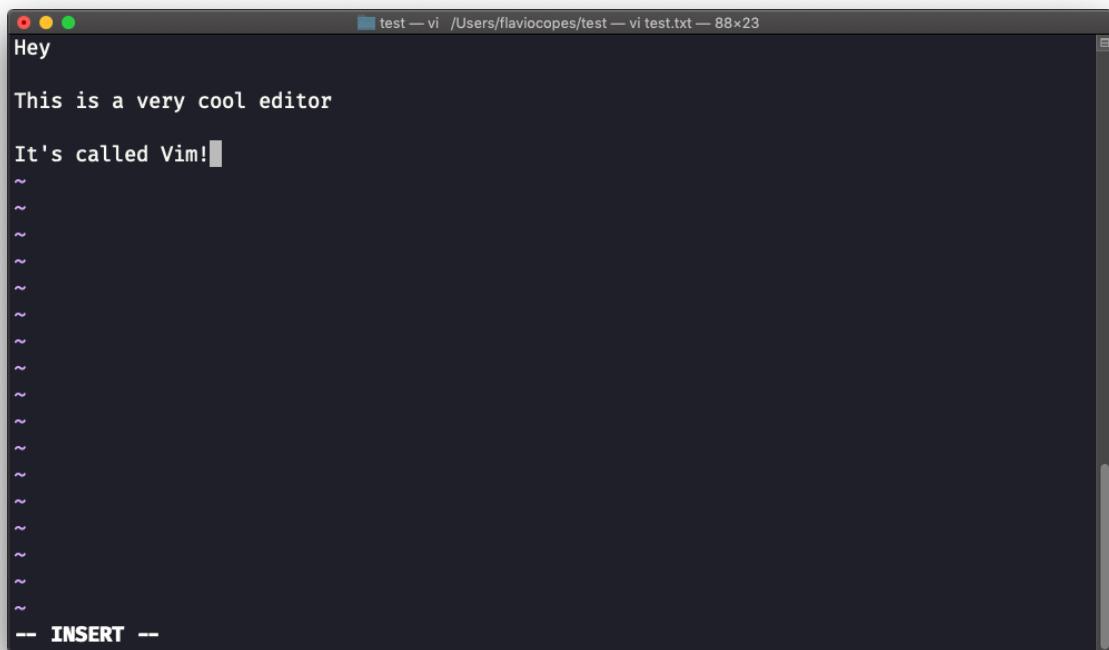
- *command (or normal) mode*
- *insert mode*

When you start the editor, you are in command mode. You can't enter text like you expect from a GUI-based editor. You have to enter **insert mode**. You can do this by pressing the `i` key. Once you do so, the `-- INSERT --` word appear at the bottom of the editor:



```
-- INSERT --
```

Now you can start typing and filling the screen with the file contents:



```
Hey  
This is a very cool editor  
It's called Vim!
```

```
-- INSERT --
```

You can move around the file with the arrow keys, or using the `h` - `j` - `k` - `l` keys. `h-l` for left-right, `j-k` for down-up.

Once you are done editing you can press the `esc` key to exit insert mode, and go back to **command mode**.

The screenshot shows a terminal window titled "test — vi /Users/flaviocopes/test — vi test.txt — 88x23". The window contains the following text:

```
Hey
This is a very cool editor
It's called Vim!
```

The cursor is at the end of the line "It's called Vim!". There are approximately 20 blank lines below the cursor, each preceded by a tilde (~).

At this point you can navigate the file, but you can't add content to it (and be careful which keys you press as they might be commands).

One thing you might want to do now is **saving the file**. You can do so by pressing `:` (colon), then `w`.

You can **save and quit** pressing `:` then `w` and `q : :wq`

You can **quit without saving**, pressing `:` then `q` and `! : :q!`

You can **undo** and edit by going to command mode and pressing `u`. You can **redo** (cancel an undo) by pressing `ctrl-r`.

Those are the basics of working with Vim. From here starts a rabbit hole we can't go into in this little introduction.

I will only mention those commands that will get you started editing with Vim:

- pressing the `x` key deletes the character currently highlighted
- pressing `A` goes at the end of the currently selected line
- press `0` to go to the start of the line
- go to the first character of a word and press `d` followed by `w` to delete that word. If you follow it with `e` instead of `w`, the white space before

the next word is preserved

- use a number between `d` and `w` to delete more than 1 word, for example use `d3w` to delete 3 words forward
- press `d` followed by `d` to delete a whole entire line. Press `d` followed by `$` to delete the entire line from where the cursor is, until the end

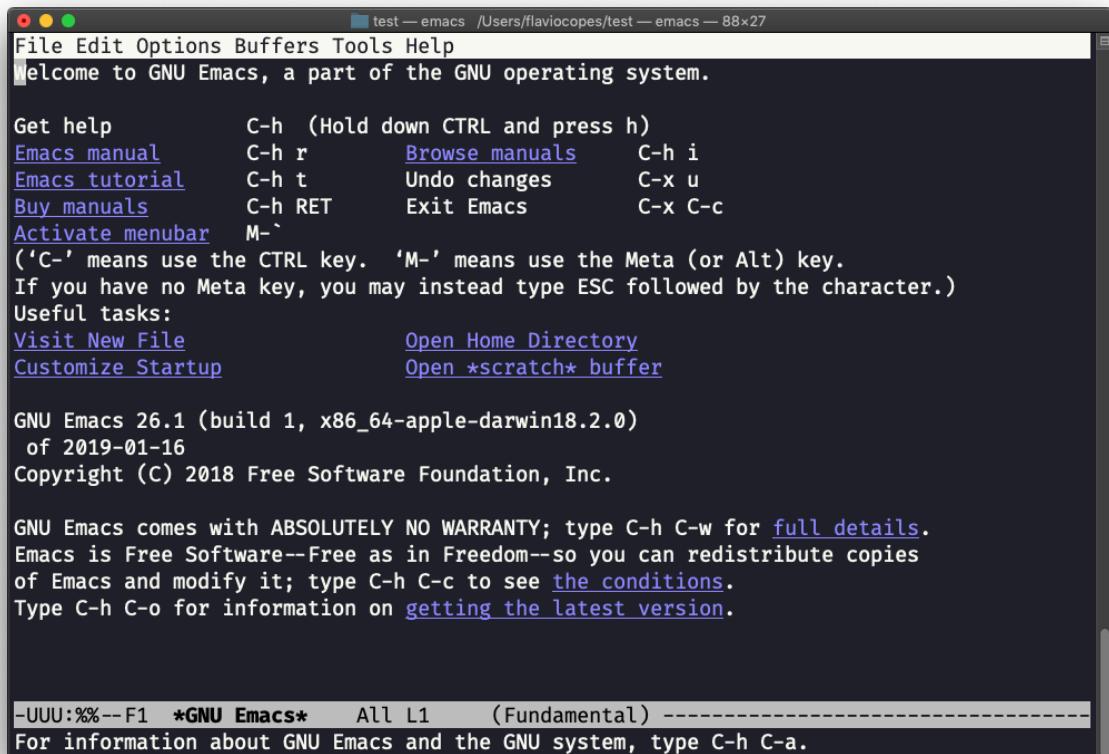
To find out more about Vim I can recommend the [Vim FAQ](#) and especially running the `vimtutor` command, which should already be installed in your system and will greatly help you start your `vim` explorations.

emacs

`emacs` is an awesome editor and it's historically regarded as *the* editor for UNIX systems. Famously `vi` vs `emacs` flame wars and heated discussions caused many unproductive hours for developers around the world.

`emacs` is very powerful. Some people use it all day long as a kind of operating system (<https://news.ycombinator.com/item?id=19127258>). We'll just talk about the basics here.

You can open a new emacs session simply by invoking `emacs`:



The screenshot shows a terminal window titled "test — emacs /Users/flaviocopes/test — emacs — 88x27". The window displays the Emacs welcome message:

```
Welcome to GNU Emacs, a part of the GNU operating system.

Get help      C-h (Hold down CTRL and press h)
Emacs manual  C-h r      Browse manuals  C-h i
Emacs tutorial C-h t      Undo changes    C-x u
Buy manuals   C-h RET    Exit Emacs      C-x C-c
Activate menubar M-` 

('C-' means use the CTRL key. 'M-' means use the Meta (or Alt) key.
If you have no Meta key, you may instead type ESC followed by the character.)
Useful tasks:
Visit New File          Open Home Directory
Customize Startup        Open *scratch* buffer

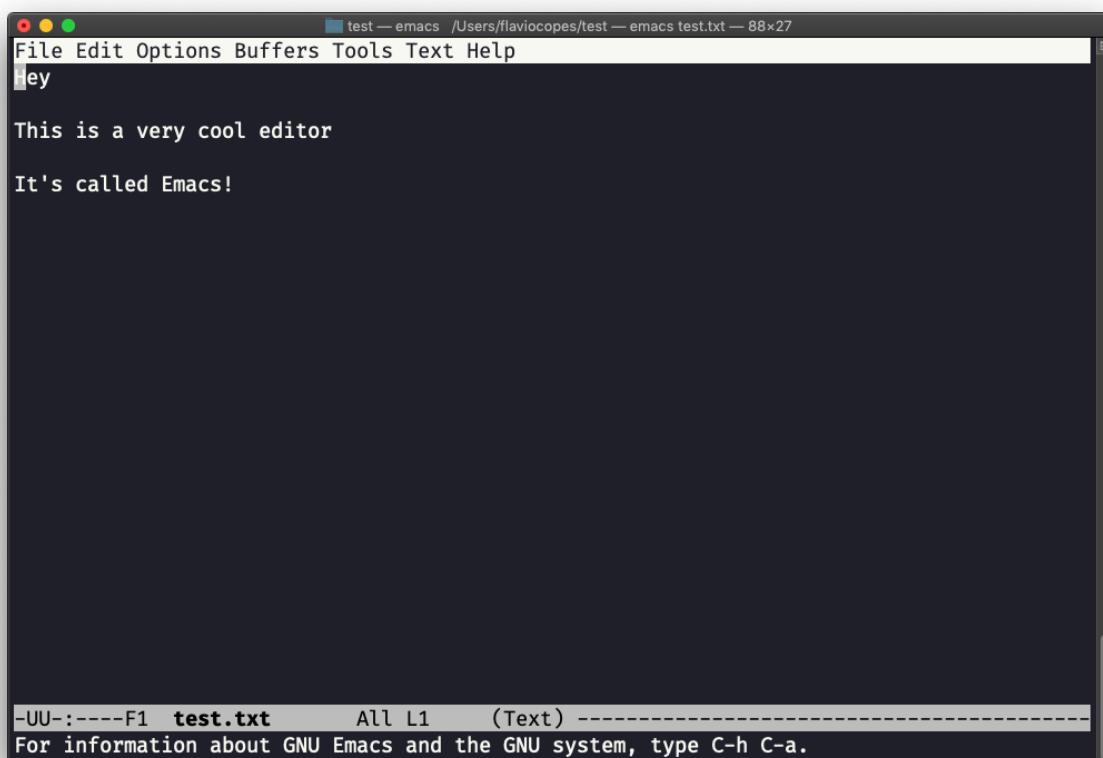
GNU Emacs 26.1 (build 1, x86_64-apple-darwin18.2.0)
of 2019-01-16
Copyright (C) 2018 Free Software Foundation, Inc.

GNU Emacs comes with ABSOLUTELY NO WARRANTY; type C-h C-w for full details.
Emacs is Free Software--Free as in Freedom--so you can redistribute copies
of Emacs and modify it; type C-h C-c to see the conditions.
Type C-h C-o for information on getting the latest version.

-UUU:%%--F1  *GNU Emacs*  All L1  (Fundamental) -----
For information about GNU Emacs and the GNU system, type C-h C-a.
```

macOS users, stop a second now. If you are on Linux there are no problems, but macOS does not ship applications using GPLv3, and every built-in UNIX command that has been updated to GPLv3 has not been updated. While there is a little problem with the commands I listed up to now, in this case using an emacs version from 2007 is not exactly the same as using a version with 12 years of improvements and change. This is not a problem with Vim, which is up to date. To fix this, run `brew install emacs` and running `emacs` will use the new version from Homebrew (make sure you have [Homebrew](#) installed)

You can also edit an existing file calling `emacs <filename>` :



You can start editing and once you are done, press `ctrl-x` followed by `ctrl-w`. You confirm the folder:

A screenshot of the Emacs 24.4 interface. The window title bar reads "test — emacs /Users/flaviocopes/test — emacs test.txt — 88x27". The menu bar includes "File", "Edit", "Options", "Buffers", "Tools", "Minibuf", and "Help". The main buffer area contains the text:

```
Hey
This is a very cool editor
It's called Emacs!
```

The minibuffer at the bottom shows the file name "test.txt" and the path "/Users/flaviocopes/test/".

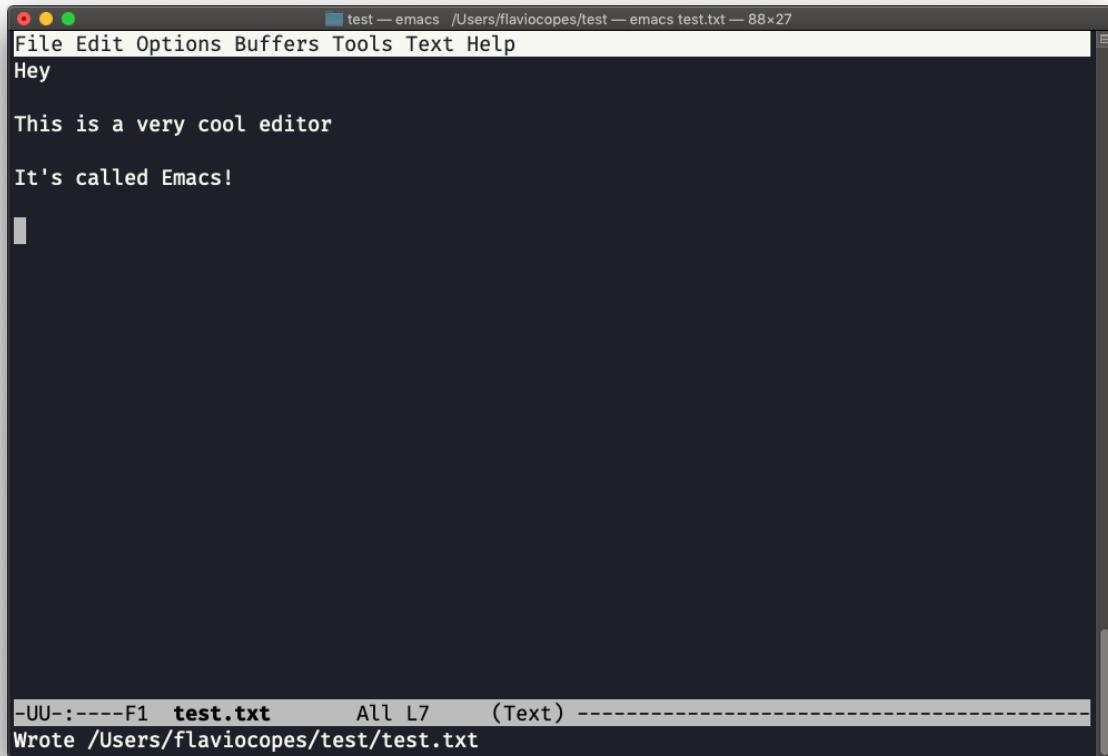
and Emacs tell you the file exists, asking you if it should overwrite it:

A screenshot of the Emacs 24.4 interface. The window title bar reads "test — emacs /Users/flaviocopes/test — emacs test.txt — 88x27". The menu bar includes "File", "Edit", "Options", "Buffers", "Tools", "Text", and "Help". The main buffer area contains the text:

```
Hey
This is a very cool editor
It's called Emacs!
```

The minibuffer at the bottom shows the file name "test.txt" and the path "/Users/flaviocopes/test/". Below the path, a message asks: "File '~/test/test.txt' exists; overwrite? (y or n)".

Answer `y`, and you get a confirmation of success:



The screenshot shows a terminal window titled "test — emacs /Users/flaviocopes/test — emacs test.txt — 88x27". The window contains the following text:
Hey
This is a very cool editor
It's called Emacs!
A cursor is visible at the end of the third line.
At the bottom of the window, there is a status bar with the following information:
-UU-:----F1 test.txt All L7 (Text) -----
Wrote /Users/flaviocopes/test/test.txt

You can exit Emacs pressing `ctrl-x` followed by `ctrl-c`. Or `ctrl-x` followed by `c` (keep `ctrl` pressed).

There is a lot to know about Emacs. More than I am able to write in this little introduction. I encourage you to open Emacs and press `ctrl-h r` to open the built-in manual and `ctrl-h t` to open the official tutorial.

nano

`nano` is a beginner friendly editor.

Run it using `nano <filename>`.

You can directly type characters into the file without worrying about modes.

You can quit without editing using `ctrl-x`. If you edited the file buffer, the editor will ask you for confirmation and you can save the edits, or discard them. The help at the bottom shows you the keyboard commands that let you work with the file:

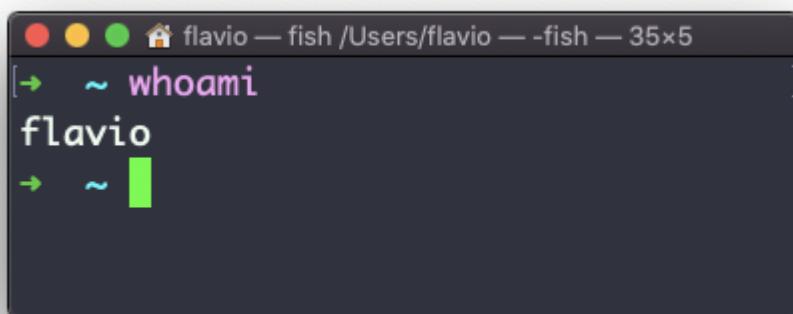
The screenshot shows a terminal window titled "GNU nano 2.0.6". The status bar at the top displays "test — nano /Users/flaviocopes/test — nano test2 — 82x23". Below the title, it says "New Buffer" and "Modified". The main area contains the text "testing". At the bottom, there is a command line with various keyboard shortcuts:

<code>^G</code>	Get Help	<code>^O</code>	WriteOut	<code>^R</code>	Read File	<code>^Y</code>	Prev Page	<code>^K</code>	Cut Text	<code>^C</code>	Cur Pos
<code>^X</code>	Exit	<code>^J</code>	Justify	<code>^W</code>	Where Is	<code>^V</code>	Next Page	<code>^U</code>	UnCut Text	<code>^T</code>	To Spell

`pico` is more or less the same, although `nano` is the GNU version of `pico` which at some point in history was not open source and the `nano` clone was made to satisfy the GNU operating system license requirements.

whoami

Type `whoami` to print the user name currently logged in to the terminal session:



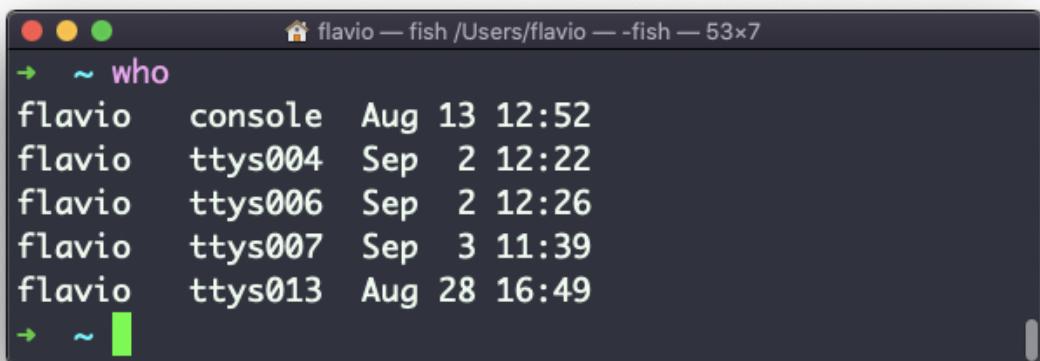
A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 35x5". The window shows the command `[→ ~ whoami]` and its output `flavio`. The terminal has a dark background with light-colored text and icons.

Note: this is different from the `who am i` command, which prints more information

who

The `who` command displays the users logged in to the system.

Unless you're using a server multiple people have access to, chances are you will be the only user logged in, multiple times:

A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 53x7". The window shows the output of the "who" command, which lists five entries for the user "flavio" on different terminals: "console", "ttys004", "ttys006", "ttys007", and "ttys013". Each entry includes the date and time of log-in.

```
flavio  console  Aug 13 12:52
flavio  ttys004  Sep  2 12:22
flavio  ttys006  Sep  2 12:26
flavio  ttys007  Sep  3 11:39
flavio  ttys013  Aug 28 16:49
```

Why multiple times? Because each shell opened will count as an access.

You can see the name of the terminal used, and the time/day the session was started.

The `-aH` flags will tell `who` to display more information, including the idle time and the process ID of the terminal:

```
flavio — fish /Users/flavio — -fish — 66x15
[~] ~ who -ah
USER    LINE    WHEN      IDLE      PID  COMMENT
reboot  ~        Aug 13 12:52 00:01      1
flavio   console Aug 13 12:52 old      167
flavio   ttys000 Aug 16 18:39 old      70258 term=0 exit=0
flavio   ttys004 Sep  2 12:22 .       71365
flavio   ttys006 Sep  2 12:26 00:41  71675
flavio   ttys007 Sep  3 11:39 00:01  82656
flavio   ttys008 Aug 21 14:33 04:15  25883 term=0 exit=0
flavio   ttys009 Aug 15 19:36 old      52214 term=0 exit=0
flavio   ttys010 Aug 23 16:32 .       38649 term=0 exit=0
flavio   ttys011 Aug 21 10:20 .       18855 term=0 exit=0
flavio   ttys013 Aug 28 16:49 01:33  5086
.          run-level 3
[~] ~
```

The special `who am i` command will list the current terminal session details:

```
flavio — fish /Users/flavio — -fish — 45x5
[~] ~ who am i
flavio  ttys004  Sep  2 12:22
[~] ~
```

```
flavio — fish /Users/flavio — -fish — 65x5
[~] ~ who -ah am i
USER    LINE    WHEN      IDLE      PID      COMMENT
flavio  ttys004  Sep  2 12:22  .       71365
[~] ~
```

SU

While you're logged in to the terminal shell with one user, you might have the need to switch to another user.

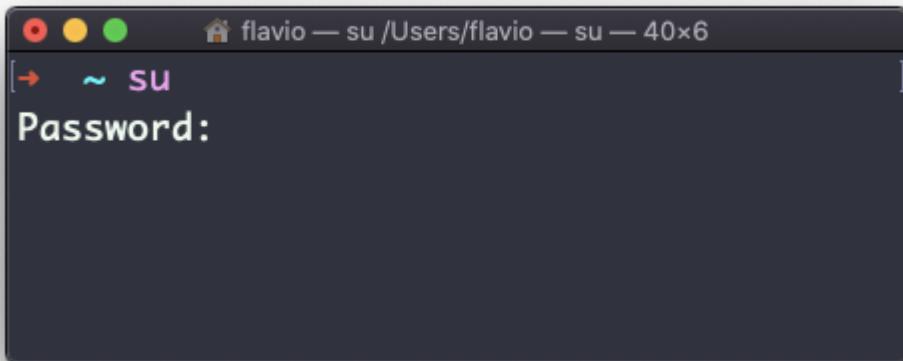
For example you're logged in as root to perform some maintenance, but then you want to switch to a user account.

You can do so with the `su` command:

```
su <username>
```

For example: `su flavio`.

If you're logged in as a user, running `su` without anything else will prompt to enter the `root` user password, as that's the default behavior.



`su` will start a new shell as another user.

When you're done, typing `exit` in the shell will close that shell, and will return back to the current user's shell.

sudo

`sudo` is commonly used to run a command as root.

You must be enabled to use `sudo`, and once you do, you can run commands as root by entering your user's password (*not* the root user password).

The permissions are highly configurable, which is great especially in a multi-user server environment, and some users can be granted access to running specific commands through `sudo`.

For example you can edit a system configuration file:

```
sudo nano /etc/hosts
```

which would otherwise fail to save since you don't have the permissions for it.

You can run `sudo -i` to start a shell as root:



```
[~] ~ sudo -i
[Password:]
mbp:~ root#
```

You can use `sudo` to run commands as any user. `root` is the default, but use the `-u` option to specify another user:

```
sudo -u flavio ls /Users/flavio
```

passwd

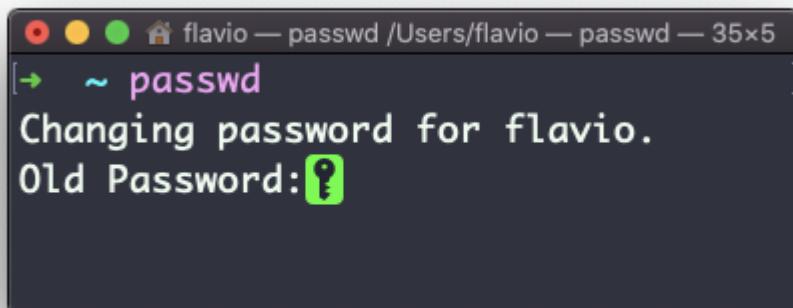
Users in Linux have a password assigned. You can change the password using the `passwd` command.

There are two situations here.

The first is when you want to change your password. In this case you type:

```
passwd
```

and an interactive prompt will ask you for the old password, then it will ask you for the new one:



When you're `root` (or have superuser privileges) you can set the username of which you want to change the password:

```
passwd <username> <new password>
```

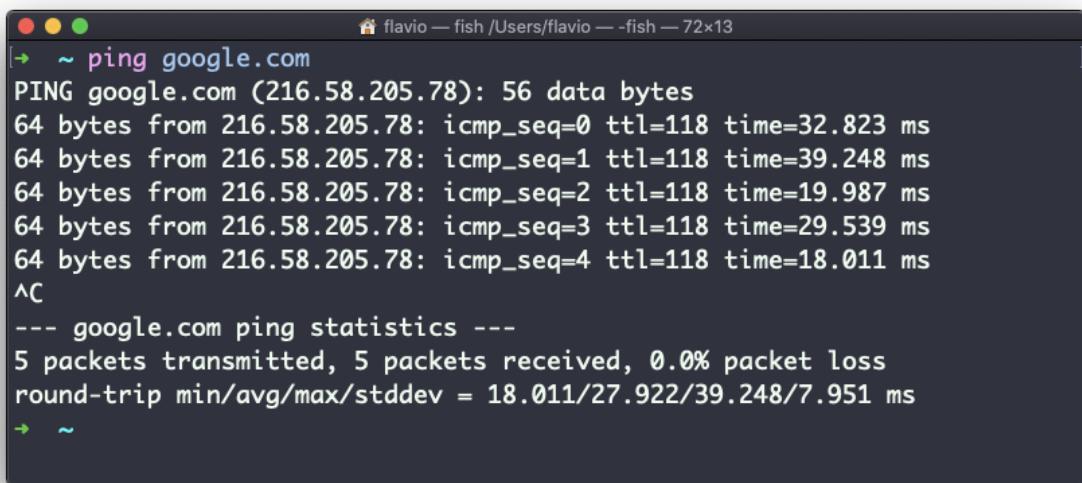
In this case you don't need to enter the old one.

ping

The `ping` command pings a specific network host, on the local network or on the Internet.

You use it with the syntax `ping <host>` where `<host>` could be a domain name, or an IP address.

Here's an example pinging `google.com`:



```
flavio — fish /Users/flavio — -fish — 72x13
~ ping google.com
PING google.com (216.58.205.78): 56 data bytes
64 bytes from 216.58.205.78: icmp_seq=0 ttl=118 time=32.823 ms
64 bytes from 216.58.205.78: icmp_seq=1 ttl=118 time=39.248 ms
64 bytes from 216.58.205.78: icmp_seq=2 ttl=118 time=19.987 ms
64 bytes from 216.58.205.78: icmp_seq=3 ttl=118 time=29.539 ms
64 bytes from 216.58.205.78: icmp_seq=4 ttl=118 time=18.011 ms
^C
--- google.com ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 18.011/27.922/39.248/7.951 ms
~
```

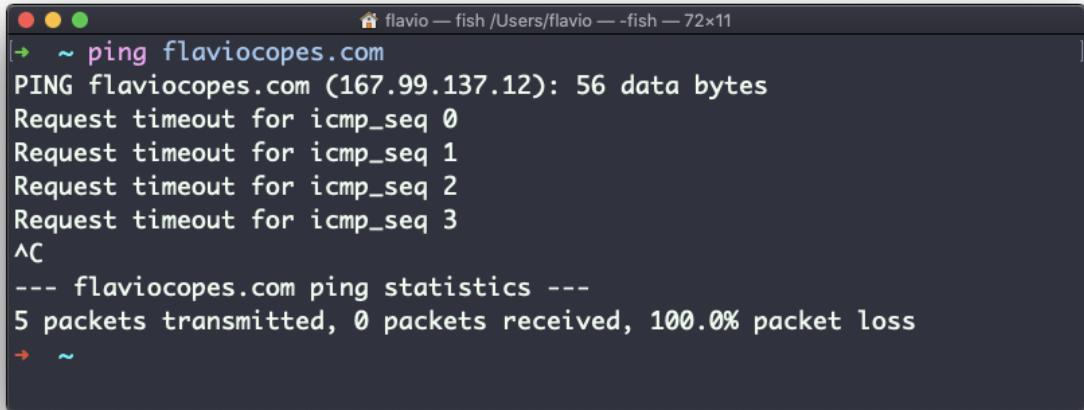
The command sends a request to the server, and the server returns a response.

`ping` keeps sending the request every second, by default, and will keep running until you stop it with `ctrl-C`, unless you pass the number of times you want to try with the `-c` option: `ping -c 2 google.com`.

Once `ping` is stopped, it will print some statistics about the results: the percentage of packages lost, and statistics about the network performance.

As you can see the screen prints the host IP address, and the time that it took to get the response back.

Not all servers support pinging, in case the requests times out:



```
flavio — fish /Users/flavio — -fish — 72x11
[~] ~ ping flaviocopes.com
PING flaviocopes.com (167.99.137.12): 56 data bytes
Request timeout for icmp_seq 0
Request timeout for icmp_seq 1
Request timeout for icmp_seq 2
Request timeout for icmp_seq 3
^C
--- flaviocopes.com ping statistics ---
5 packets transmitted, 0 packets received, 100.0% packet loss
→ ~
```

Sometimes this is done on purpose, to "hide" the server, or just to reduce the load. The ping packets can also be filtered by firewalls.

`ping` works using the **ICMP protocol** (*Internet Control Message Protocol*), a network layer protocol just like TCP or UDP.

The request sends a packet to the server with the `ECHO_REQUEST` message, and the server returns a `ECHO_REPLY` message. I won't go into details, but this is the basic concept.

Pinging a host is useful to know if the host is reachable (supposing it implements ping), and how distant it is in terms of how long it takes to get back to you. Usually the nearest the server is geographically, the less time it will take to return back to you, for simple physical laws that cause a longer distance to introduce more delay in the cables.

traceroute

When you try to reach a host on the Internet, you go through your home router, then you reach your ISP network, which in turn goes through its own upstream network router, and so on, until you finally reach the host.

Have you ever wanted to know what are the steps that your packets go through to do that?

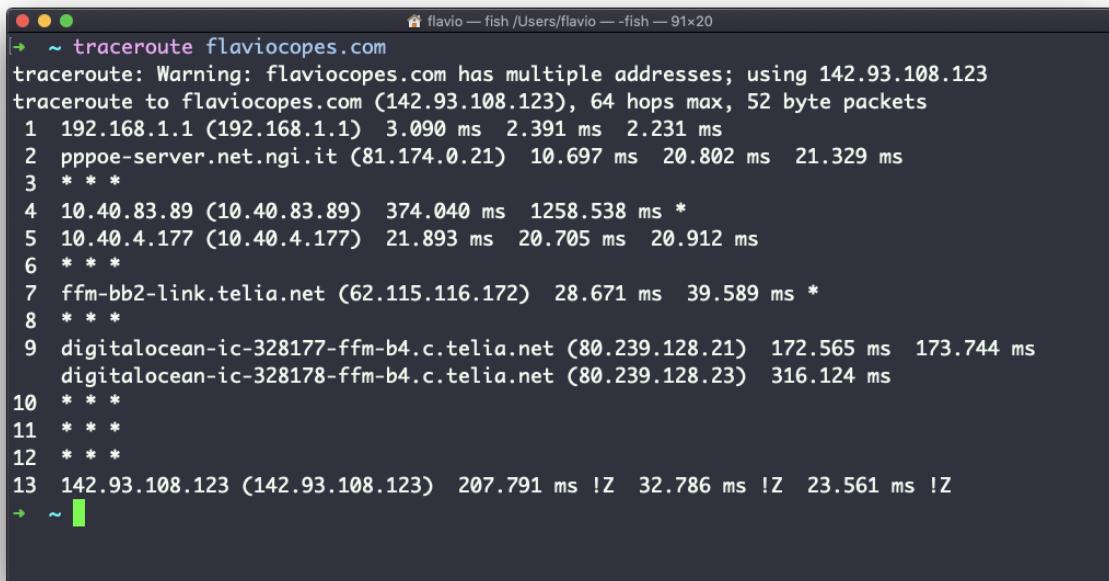
The `traceroute` command is made for this.

You invoke

```
traceroute <host>
```

and it will (slowly) gather all the information while the packet travels.

In this example I tried reaching for my blog with `traceroute flaviocopes.com`:



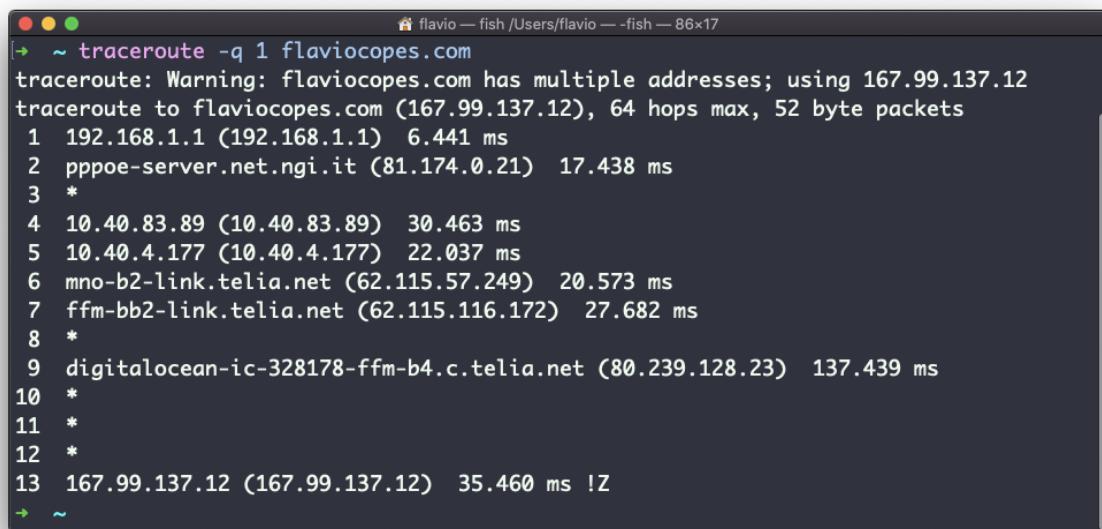
```
flavio — fish /Users/flavio — -fish — 91x20
[~] ~ traceroute flaviocopes.com
traceroute: Warning: flaviocopes.com has multiple addresses; using 142.93.108.123
traceroute to flaviocopes.com (142.93.108.123), 64 hops max, 52 byte packets
 1  192.168.1.1 (192.168.1.1)  3.090 ms  2.391 ms  2.231 ms
 2  pppoe-server.net.ngi.it (81.174.0.21)  10.697 ms  20.802 ms  21.329 ms
 3  * * *
 4  10.40.83.89 (10.40.83.89)  374.040 ms  1258.538 ms *
 5  10.40.4.177 (10.40.4.177)  21.893 ms  20.705 ms  20.912 ms
 6  * * *
 7  ffm-bb2-link.telia.net (62.115.116.172)  28.671 ms  39.589 ms *
 8  * * *
 9  digitalocean-ic-328177-ffm-b4.c.telia.net (80.239.128.21)  172.565 ms  173.744 ms
   digitalocean-ic-328178-ffm-b4.c.telia.net (80.239.128.23)  316.124 ms
10  * * *
11  * * *
12  * * *
13  142.93.108.123 (142.93.108.123)  207.791 ms !Z  32.786 ms !Z  23.561 ms !Z
[~] ~
```

Not every router travelled returns us information. In this case, `traceroute` prints `* * *`. Otherwise, we can see the hostname, the IP address, and some performance indicator.

For every router we can see 3 samples, which means traceroute tries by default 3 times to get you a good indication of the time needed to reach it. This is why it takes this long to execute `traceroute` compared to simply doing a `ping` to that host.

You can customize this number with the `-q` option:

```
traceroute -q 1 flaviocopes.com
```

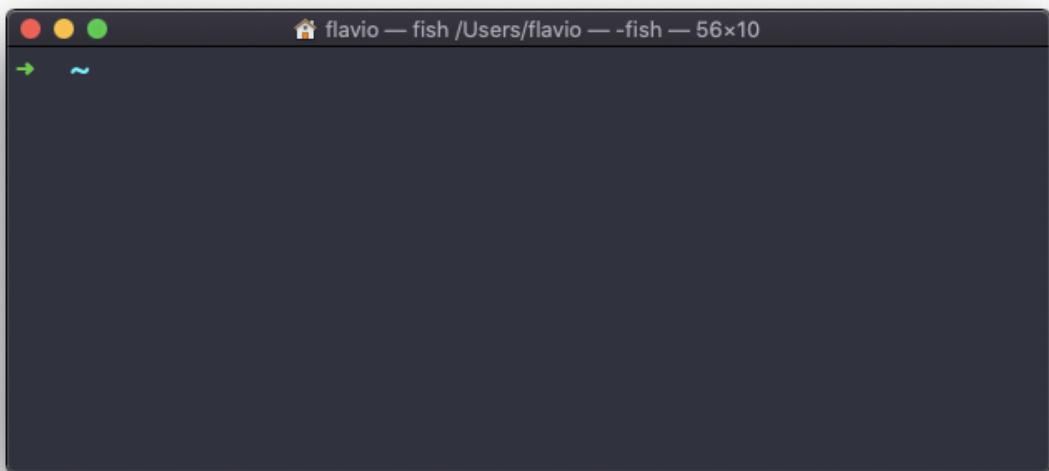


```
~ traceroute -q 1 flaviocopes.com
traceroute: Warning: flaviocopes.com has multiple addresses; using 167.99.137.12
traceroute to flaviocopes.com (167.99.137.12), 64 hops max, 52 byte packets
 1 192.168.1.1 (192.168.1.1)  6.441 ms
 2 pppoe-server.net.ngi.it (81.174.0.21)  17.438 ms
 3 *
 4 10.40.83.89 (10.40.83.89)  30.463 ms
 5 10.40.4.177 (10.40.4.177)  22.037 ms
 6 mno-b2-link.telia.net (62.115.57.249)  20.573 ms
 7 ffm-bb2-link.telia.net (62.115.116.172)  27.682 ms
 8 *
 9 digitalocean-ic-328178-ffm-b4.c.telia.net (80.239.128.23)  137.439 ms
10 *
11 *
12 *
13 167.99.137.12 (167.99.137.12)  35.460 ms !Z
```

clear

Type `clear` to clear all the previous commands that were ran in the current terminal.

The screen will clear and you will just see the prompt at the top:



Note: this command has a handy shortcut: `ctrl-L`

Once you do that, you will lose access to scrolling to see the output of the previous commands entered.

So you might want to use `clear -x` instead, which still clears the screen, but lets you go back to see the previous work by scrolling up.

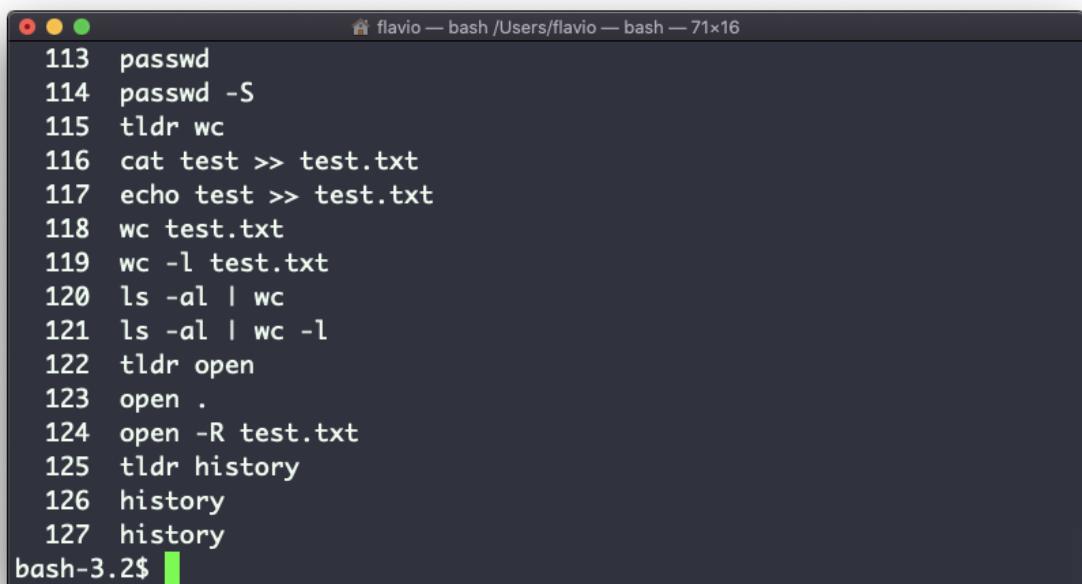
history

Every time we run a command, that's memorized in the history.

You can display all the history using:

```
history
```

This shows the history with numbers:



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 71x16". The window displays a numbered list of commands from 113 to 127. The commands listed are:

```
113 passwd
114 passwd -S
115 tldr wc
116 cat test >> test.txt
117 echo test >> test.txt
118 wc test.txt
119 wc -l test.txt
120 ls -al | wc
121 ls -al | wc -l
122 tldr open
123 open .
124 open -R test.txt
125 tldr history
126 history
127 history
bash-3.2$
```

You can use the syntax `!<command number>` to repeat a command stored in the history, in the above example typing `!121` will repeat the `ls -al | wc -l` command.

Typically the last 500 commands are stored in the history.

You can combine this with `grep` to find a command you ran:

```
history | grep docker
```



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 71x8". The window shows the output of the command "history | grep docker", which lists several commands related to Docker. The window has a dark theme with red, yellow, and green window controls.

```
bash-3.2$ history | grep docker
 7 git clone https://github.com/docker/getting-started.git
 8 git clone https://github.com/docker/getting-started.git
14 docker container stop $(docker container ls)
15 docker container stop $(docker container ls)
16 docker container stop $(docker container ls -aq)
130 history | grep docker
bash-3.2$
```

To clear the history, run `history -c`

export

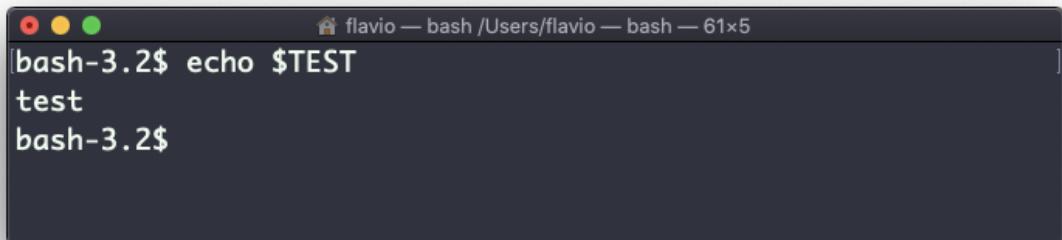
The `export` command is used to export variables to child processes.

What does this mean?

Suppose you have a variable TEST defined in this way:

```
TEST="test"
```

You can print its value using `echo $TEST`:



```
flavio — bash /Users/flavio — bash — 61x5
[bash-3.2$ echo $TEST
test
bash-3.2$
```

But if you try defining a Bash script in a file `script.sh` with the above command:



```
flavio — bash /Users/flavio — nano script.sh — 61x12
GNU nano 2.0.6          File: script.sh          Modified

#!/bin/bash
echo $TEST
```

[Read 2 lines]
^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where Is ^V Next Page ^U Uncut T ^T To Spell

Then you set `chmod u+x script.sh` and you execute this script with `./script.sh`, the `echo $TEST` line will print nothing!

This is because in Bash the `TEST` variable was defined local to the shell. When executing a shell script or another command, a subshell is launched to execute it, which does not contain the current shell local variables.

To make the variable available there we need to define `TEST` not in this way:

```
TEST="test"
```

but in this way:

```
export TEST="test"
```

Try that, and running `./script.sh` now should print "test":



A screenshot of a macOS terminal window titled "flavio — bash /Users/flavio — bash — 61x6". The window shows the following command and its output:
bash-3.2\$ export TEST="test"
bash-3.2\$./script.sh
test
bash-3.2\$

Sometimes you need to append something to a variable. It's often done with the `PATH` variable. You use this syntax:

```
export PATH=$PATH:/new/path
```

It's common to use `export` when you create new variables in this way, but also when you create variables in the `.bash_profile` or `.bashrc` configuration files with Bash, or in `.zshenv` with Zsh.

To remove a variable, use the `-n` option:

```
export -n TEST
```

Calling `export` without any option will list all the exported variables.

crontab

Cron jobs are jobs that are scheduled to run at specific intervals. You might have a command perform something every hour, or every day, or every 2 weeks. Or on weekends. They are very powerful, especially on servers to perform maintenance and automations.

The `crontab` command is the entry point to work with cron jobs.

The first thing you can do is to explore which cron jobs are defined by you:

```
crontab -l
```

You might have none, like me:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 62x7". The window shows the command `~ crontab -l` being run, followed by the output: "crontab: no crontab for flavio". The terminal has a dark theme with red, yellow, and green window controls.

Run

```
crontab -e
```

to edit the cron jobs, and add new ones.

By default this opens with the default editor, which is usually `vim`. I like `nano` more, you can use this line to use a different editor:

```
EDITOR=nano crontab -e
```

Now you can add one line for each cron job.

The syntax to define cron jobs is kind of scary. This is why I usually use a website to help me generate it without errors: <https://crontab-generator.org/>

The screenshot shows the Crontab Generator interface. At the top, there's a message: "Get frustrated with Cron on your server? Try our [Webcron Service](#)." Below it, a note says: "If you want to periodically perform a task (e.g. sending Emails, backing up database, doing regular maintenance, etc.) at specified times and dates, there are two ways to set scheduled tasks: Method 1: Use our [online cron job service](#) that will save you a headache. Method 2: Use Cron available in Unix/Linux systems." A note below that says: "If you go with method 2, the following generator can help you produce a crontab syntax that you can copy & paste to your crontab file (You can open the file by using command `crontab -e`). Below the generated crontab syntax, a list of run times will be displayed too. The predictions will help you ensure that you set the time and date right." A section titled "Complete the following form to generate a crontab line" follows. There are four main sections for setting intervals:

- Minutes:** Offers radio buttons for "Every Minute", "Even Minutes", "Odd Minutes", "Every 5 Minutes", "Every 15 Minutes", and "Every 30 Minutes". To the right is a dropdown menu with options from 0 to 9.
- Hours:** Offers radio buttons for "Every Hour", "Even Hours", "Odd Hours", "Every 6 Hours", and "Every 12 Hours". To the right is a dropdown menu with options for "Midnight", "1am", "2am", "3am", "4am", "5am", "6am", "7am", "8am", and "9am".
- Days:** Offers radio buttons for "Every Day", "Even Days", "Odd Days", "Every 5 Days", "Every 10 Days", and "Every Half Month". To the right is a dropdown menu with options from 1 to 10.
- Months:** Offers radio buttons for "Every Month", "Even Months", "Odd Months", "Every 4 Months", and "Every Half Year". To the right is a dropdown menu with options for Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, and Oct.

Below these is a "Weekday" section with radio buttons for "Every Weekday", "Monday-Friday", and "Weekend Days". To the right is a dropdown menu with options for Sun, Mon, Tue, Wed, Thu, Fri, and Sat.

At the bottom, there's a "Command To Execute" input field containing the placeholder "Command Examples: Execute PHP script: /usr/bin/php /home/username/public_html/cron.php".

You pick a time interval for the cron job, and you type the command to execute.

I chose to run a script located in `/Users/flavio/test.sh` every 12 hours. This is the crontab line I need to run:

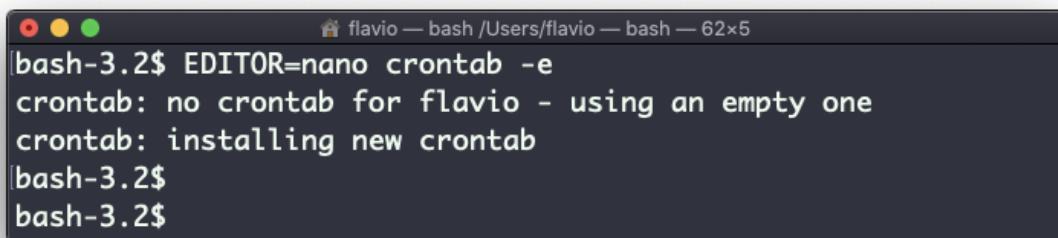
```
* */12 * * * /Users/flavio/test.sh >/dev/null 2>&1
```

I run `crontab -e`:

```
EDITOR=nano crontab -e
```

and I add that line, then I press `ctrl-X` and press `y` to save.

If all goes well, the cron job is set up:



```
flavio — bash /Users/flavio — bash — 62x5
bash-3.2$ EDITOR=nano crontab -e
crontab: no crontab for flavio - using an empty one
crontab: installing new crontab
bash-3.2$
bash-3.2$
```

Once this is done, you can see the list of active cron jobs by running:

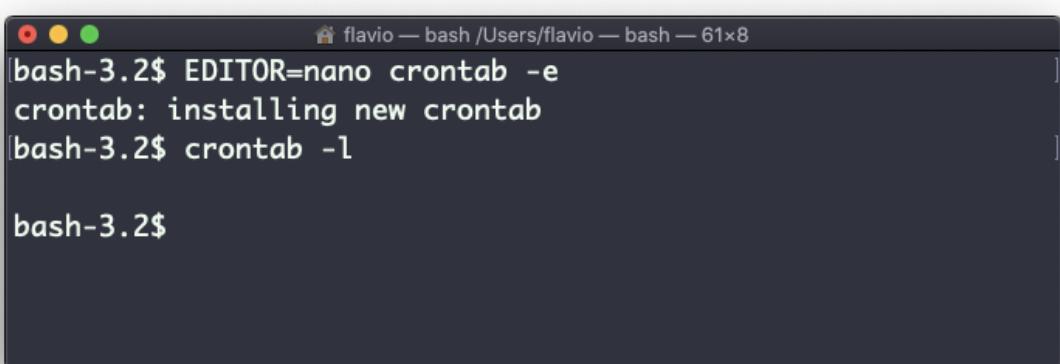
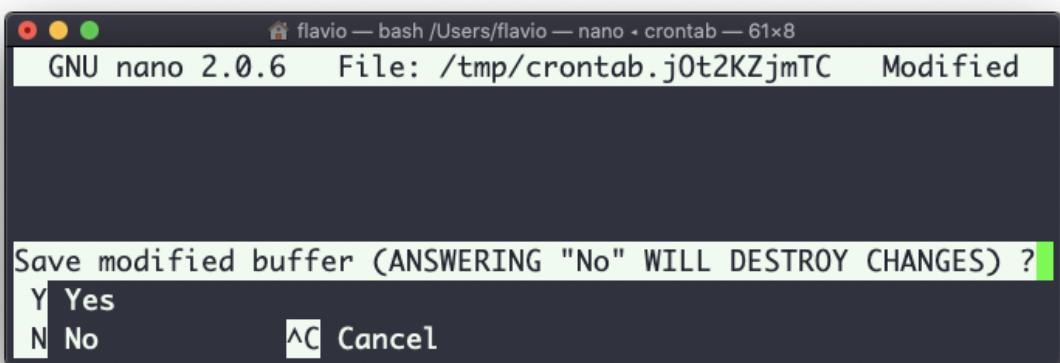
```
crontab -l
```



```
flavio — bash /Users/flavio — bash — 61x8
bash-3.2$ crontab -l
* */12 * * * /Users/flavio/test.sh >/dev/null 2>&1

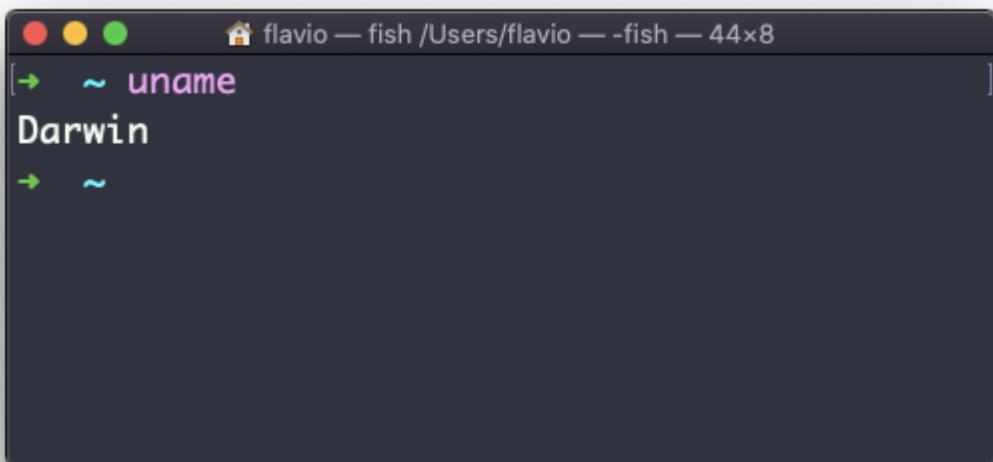
bash-3.2$
```

You can remove a cron job running `crontab -e` again, removing the line and exiting the editor:



uname

Calling `uname` without any options will return the Operating System codename:



```
flavio — fish /Users/flavio — -fish — 44x8
[→ ~ uname
Darwin
→ ~ ]
```

A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 44x8". The window shows the command "uname" being run, followed by the output "Darwin". The prompt then changes to "→ ~".

The `m` option shows the hardware name (`x86_64` in this example) and the `p` option prints the processor architecture name (`i386` in this example):



```
flavio — fish /Users/flavio — -fish — 44x8
[→ ~ uname -mp
x86_64 i386
→ ~ ]
```

A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 44x8". The window shows the command "uname -mp" being run, followed by the output "x86_64 i386". The prompt then changes to "→ ~".

The `s` option prints the Operating System name. `r` prints the release, `v` prints the version:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 44x8". The window shows the command "uname -s" being run, followed by the output "Darwin 19.6.0 Darwin Kernel Version 19.6.0: Thu Jun 18 20:49:00 PDT 2020; root:xnu-6153.141.1~1/RELEASE_X86_64". The terminal has a dark background with light-colored text.

```
[→ ~ uname -s]
Darwin 19.6.0 Darwin Kernel Version 19.6.0:
Thu Jun 18 20:49:00 PDT 2020; root:xnu-6153.
141.1~1/RELEASE_X86_64
→ ~
```

The `n` option prints the node network name:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 44x8". The window shows the command "uname -n" being run, followed by the output "mbp.local". The terminal has a dark background with light-colored text.

```
[→ ~ uname -n
mbp.local
→ ~
```

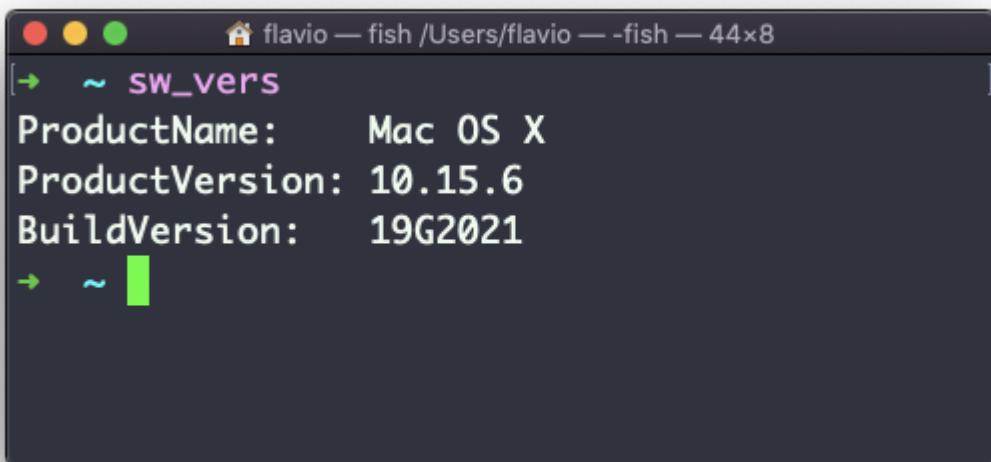
The `a` option prints all the information available:



```
flavio — fish /Users/flavio — -fish — 44x8
[→ ~ uname -a
Darwin mbp.local 19.6.0 Darwin Kernel Version 19.6.0: Thu Jun 18 20:49:00 PDT 2020; root
:xnu-6153.141.1~1/RELEASE_X86_64 x86_64
→ ~
```

On macOS you can also use the `sw_vers` command to print more information about the macOS Operating System. Note that this differs from the Darwin (the Kernel) version, which above is `19.6.0`.

Darwin is the name of the kernel of macOS. The kernel is the "core" of the Operating System, while the Operating System as a whole is called macOS. In Linux, Linux is the kernel, GNU/Linux would be the Operating System name, although we all refer to it as "Linux"



```
flavio — fish /Users/flavio — -fish — 44x8
[→ ~ sw_vers
ProductName: Mac OS X
ProductVersion: 10.15.6
BuildVersion: 19G2021
→ ~
```

env

The `env` command can be used to pass environment variables without setting them on the outer environment (the current shell).

Suppose you want to run a Node.js app and set the `USER` variable to it.

You can run

```
env USER=flavio node app.js
```

and the `USER` environment variable will be accessible from the Node.js app via the Node `process.env` interface.

You can also run the command clearing all the environment variables already set, using the `-i` option:

```
env -i node app.js
```

In this case you will get an error saying `env: node: No such file or directory` because the `node` command is not reachable, as the `PATH` variable used by the shell to look up commands in the common paths is unset.

So you need to pass the full path to the `node` program:

```
env -i /usr/local/bin/node app.js
```

Try with a simple `app.js` file with this content:

```
console.log(process.env.NAME)
console.log(process.env.PATH)
```

You will see the output being

```
undefined  
undefined
```

You can pass an env variable:

```
env -i NAME=flavio node app.js
```

and the output will be

```
flavio  
undefined
```

Removing the `-i` option will make `PATH` available again inside the program:



A screenshot of a macOS terminal window titled "flavio — fish /Users/flavio — -fish — 73x5". The window shows the command `~ env NAME=flavio node app.js` being run. The output is "flavio" followed by the system's `PATH` environment variable, which includes `/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin`. The prompt then changes back to the user's home directory (~).

The `env` command can also be used to print out all the environment variables, if ran with no options:

```
env
```

it will return a list of the environment variables set, for example:

```
HOME=/Users/flavio  
LOGNAME=flavio  
PATH=/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin  
PWD=/Users/flavio  
SHELL=/usr/local/bin/fish
```

You can also make a variable inaccessible inside the program you run, using the `-u` option, for example this code removes the `HOME` variable from the command environment:

```
env -u HOME node app.js
```

printenv

A quick guide to the `printenv` command, used to print the values of environment variables

In any shell there are a good number of environment variables, set either by the system, or by your own shell scripts and configuration.

You can print them all to the terminal using the `printenv` command. The output will be something like this:

```
HOME=/Users/flavio
LOGNAME=flavio
PATH=/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin
PWD=/Users/flavio
SHELL=/usr/local/bin/fish
```

with a few more lines, usually.

You can append a variable name as a parameter, to only show that variable value:

```
printenv PATH
```



The screenshot shows a terminal window titled "flavio — fish /Users/flavio — -fish — 46x5". The command `printenv PATH` is entered and its output is displayed: `/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin`. The terminal uses the Fish shell, as indicated by the "fish" icon in the title bar and the green status bar at the bottom.

Conclusion

Thanks a lot for reading this book.

I hope it will inspire you to know more about Linux and its capabilities.

To learn more, check out my blog flaviocopes.com.

Send any feedback, errata or opinions at hey@flaviocopes.com