

THE LINUX



COMMANDS HANDBOOK

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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.

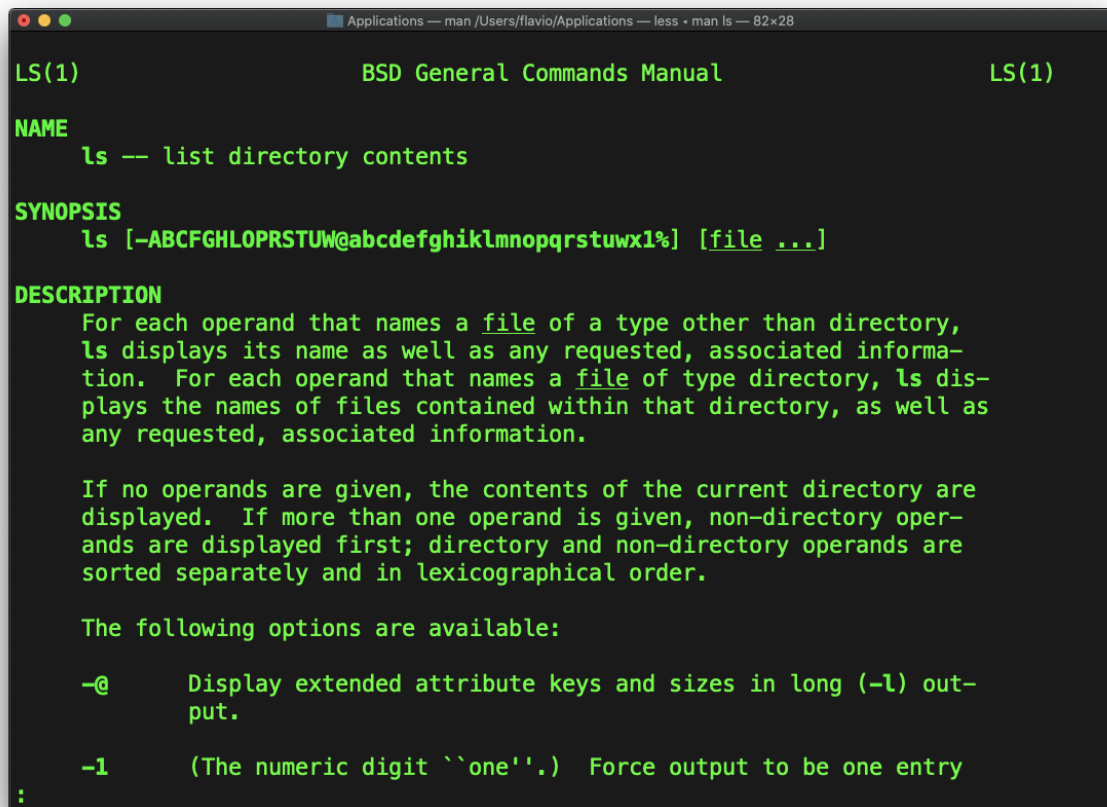
Each single shell has its own unique features and advanced usage, but they all share a common functionality: they can let you execute programs, and they can be programmed.

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:



```
Applications — man /Users/flavio/Applications — less - man ls — 82x28
LS(1)                                BSD General Commands Manual                                LS(1)

NAME
  ls -- list directory contents

SYNOPSIS
  ls [-ABCFGHLOPRSTUW@abcdefghiklmnopqrstuwx1] [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 informa-
  tion. 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:

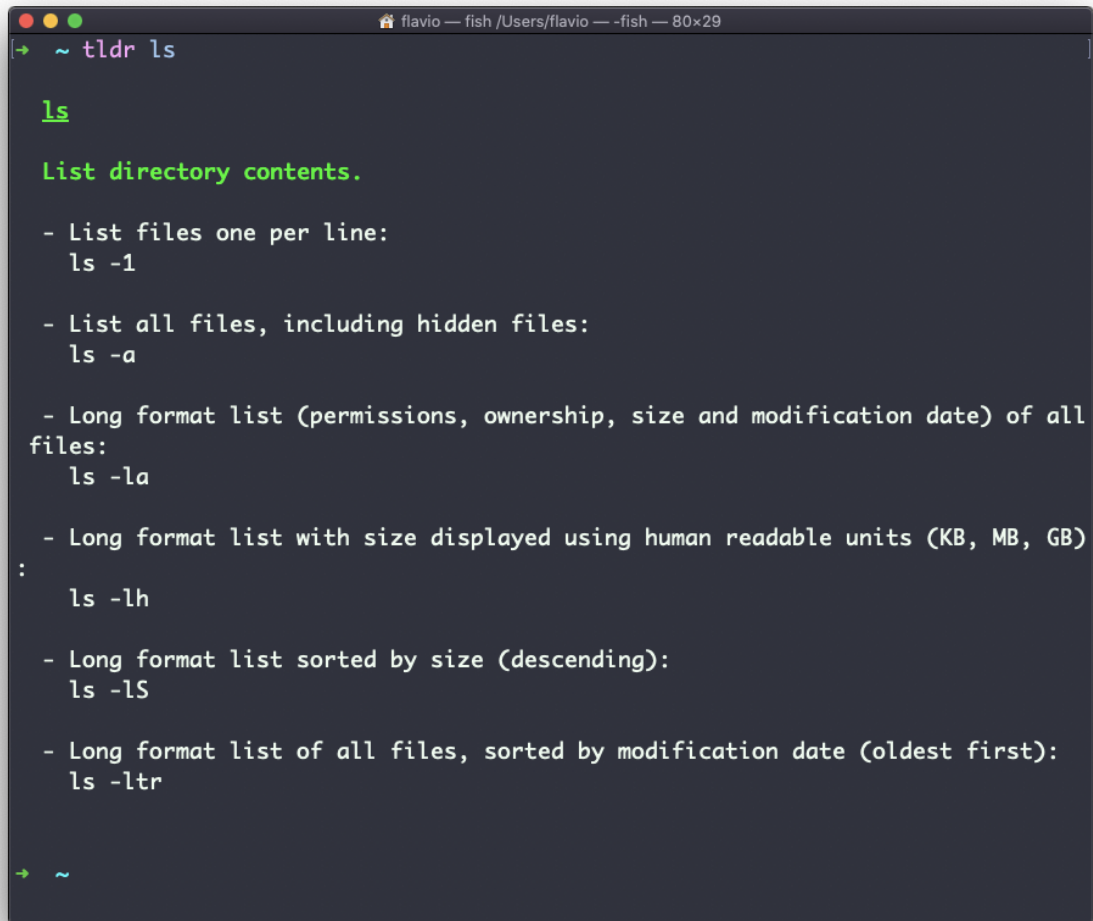
  -@      Display extended attribute keys and sizes in long (-l) out-
          put.

  -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:



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

ls

List directory contents.

- List files one per line:
  ls -l

- 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 terminal window with a dark background and light-colored text. The title bar shows 'flaviocopes — fish /Users/flaviocopes — -fish — 72x9'. The prompt is '~' followed by the command 'ls /bin'. The output is a grid of 42 system binaries in the /bin directory, arranged in 7 rows and 6 columns. The files listed are: csh, ed, launchctl, mv, rmdir, 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. The 'ps' file is highlighted with a red selection box. The prompt is now '~' followed by a cursor.

```
flaviocopes — fish /Users/flaviocopes — -fish — 72x9
→ ~ ls /bin
[
bash      date      expr      launchctl mv        rmdir     tcsh
cat       dd        hostname  ln        pax      sh         test
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
```

```
flaviocopes — fish /Users/flaviocopes — -fish — 72x20
➔ ~ 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 ..
-rwxr-xr-x  1 root wheel 22704 Jan 16 02:21 [
-r-xr-xr-x  1 root wheel 618416 Jan 16 02:21 bash
-rwxr-xr-x  1 root wheel 23648 Jan 16 02:21 cat
-rwxr-xr-x  1 root wheel 34144 Jan 16 02:21 chmod
-rwxr-xr-x  1 root wheel 29024 Jan 16 02:21 cp
-rwxr-xr-x  1 root wheel 379952 Jan 16 02:21 csh
-rwxr-xr-x  1 root wheel 28608 Jan 16 02:21 date
-rwxr-xr-x  1 root wheel 32000 Jan 16 02:21 dd
-rwxr-xr-x  1 root wheel 23392 Jan 16 02:21 df
-rwxr-xr-x  1 root wheel 18128 Jan 16 02:21 echo
-rwxr-xr-x  1 root wheel 54080 Jan 16 02:21 ed
-rwxr-xr-x  1 root wheel 23104 Jan 16 02:21 expr
-rwxr-xr-x  1 root wheel 18288 Jan 16 02:21 hostname
-rwxr-xr-x  1 root wheel 18688 Jan 16 02:21 kill
-r-xr-xr-x  1 root wheel 1282864 Jan 16 02:21 ksh
-rwxr-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 **current** 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.

rmmdir

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
```

open

The `open` command lets you open a file using this syntax:

```
open <filename>
```

You can also open a directory, which on macOS opens the Finder app with the current directory open:

```
open <directory name>
```

I use it all the time to open the current directory:

```
open .
```

The special `.` symbol points to the current directory, as `..` points to the parent directory

The same command can also be used to run an application:

```
open <application name>
```

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.

ln

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).

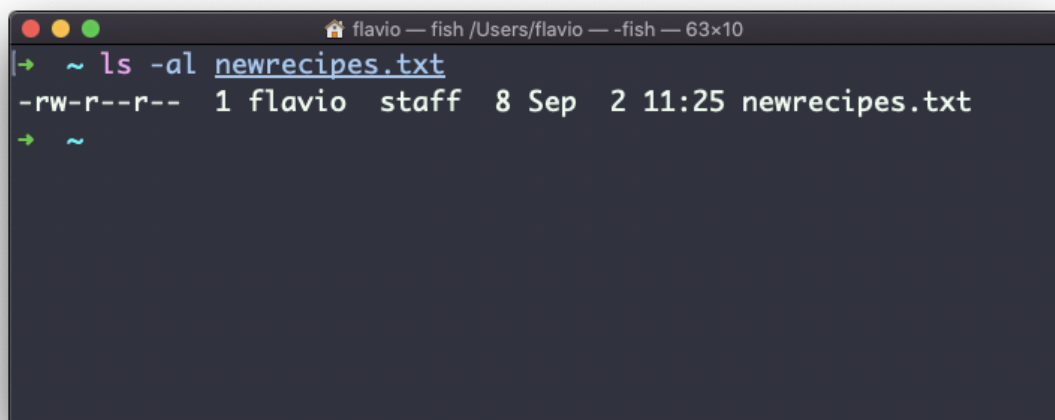
A hard link is created using

```
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
```

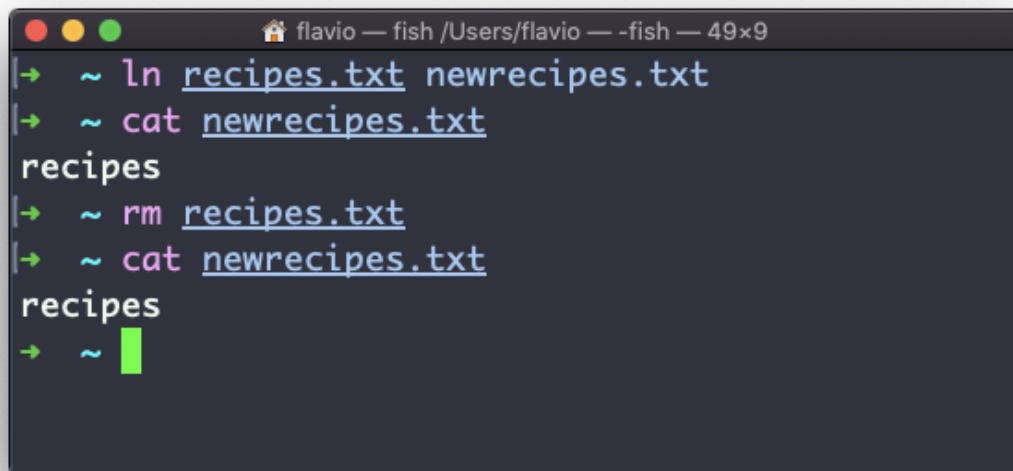
The new hard link you created is indistinguishable from a regular file:

A terminal window with a dark background and light text. The title bar shows 'flavio — fish /Users/flavio — -fish — 63x10'. The prompt is '~'. The command entered is 'ls -al newrecipes.txt'. The output is '-rw-r--r-- 1 flavio staff 8 Sep 2 11:25 newrecipes.txt'. The prompt is '~'.

```
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.

A terminal window with a dark background and light-colored text. The window title bar shows a home icon, the name 'flavio', and the path '— fish /Users/flavio — -fish — 49x9'. The terminal contains the following commands and output:

```
→ ~ 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.

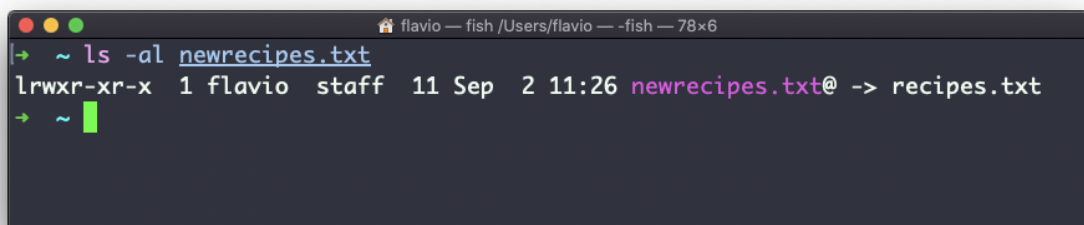
You create soft links using the `-s` option of `ln` :

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

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

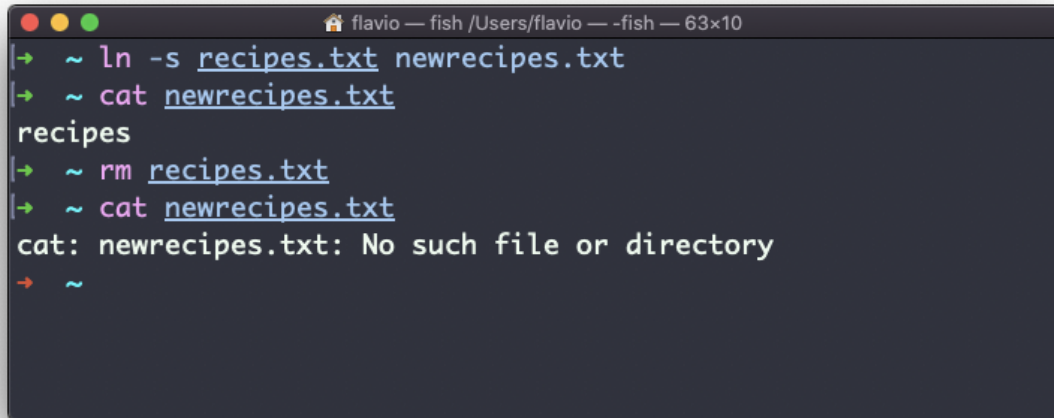
```
ln -s recipes.txt newrecipes.txt
```

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:

A terminal window with a dark background and light text. The title bar shows 'flavio — fish /Users/flavio — -fish — 78x6'. The prompt is '~'. The command entered is 'ls -al newrecipes.txt'. The output is 'lrwxr-xr-x 1 flavio staff 11 Sep 2 11:26 newrecipes.txt@ -> recipes.txt'. The file name 'newrecipes.txt' is highlighted in blue, and the '@' symbol is highlighted in green. The prompt is '~' followed by a green cursor.

```
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
```

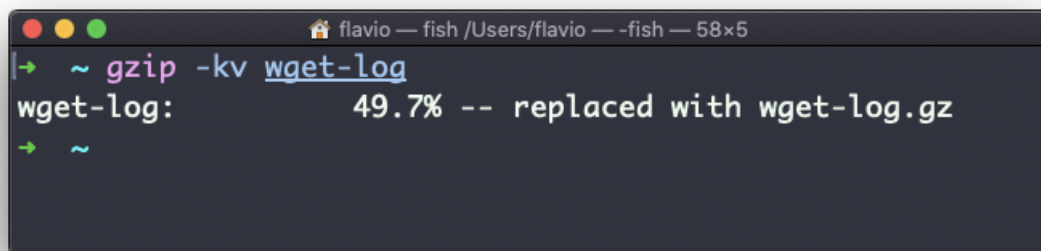
You can compress multiple files by listing them:

```
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 terminal window with a dark background and light text. The title bar shows 'flavio — fish /Users/flavio — -fish — 58x5'. The prompt is '~'. The command entered is 'gzip -kv wget-log'. The output is 'wget-log: 49.7% -- replaced with wget-log.gz'. The prompt is '~'.

```
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:

A terminal window with a dark background and light text. The title bar at the top shows a home icon, the name 'flavio', and the path '— fish /Users/flavio — -fish — 55x5'. The terminal content shows a prompt '→ ~' followed by the command 'tar -tf archive.tar'. The output of the command is 'file1' and 'file2' on separate lines. A second prompt '→ ~' is shown at the bottom with a green cursor block.

```
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.

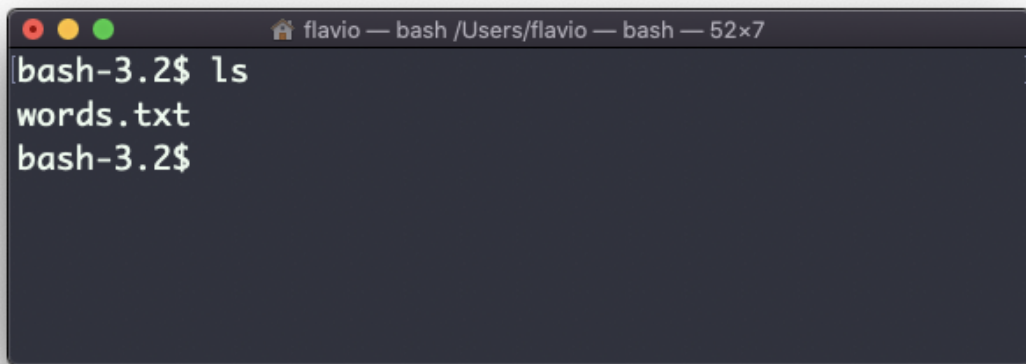
To unarchive a gzipped archive, you can use `gunzip`, or `gzip -d`, and then unarchive it, but `tar -xf` will recognize it's a gzipped archive, and do it for you:

```
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:

A terminal window with a dark background and light text. The title bar at the top shows a home icon, the name 'flavio', and the path '— bash /Users/flavio — bash — 52x7'. The terminal content shows the prompt 'bash-3.2\$' followed by the command 'ls'. The output of the command is 'words.txt'. The prompt 'bash-3.2\$' appears again on the next line.

```
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`.

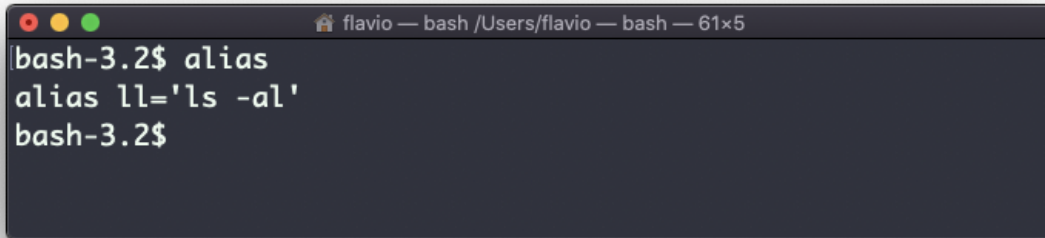
You do it in this way:

```
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$
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:

A terminal window with a dark background. The title bar shows a home icon, the name 'flavio', and the path 'bash /Users/flavio'. The terminal content shows the prompt 'bash-3.2\$' followed by the command 'alias'. The output is 'alias ll='ls -al'' on the next line, followed by the prompt 'bash-3.2\$' again.

```
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
```

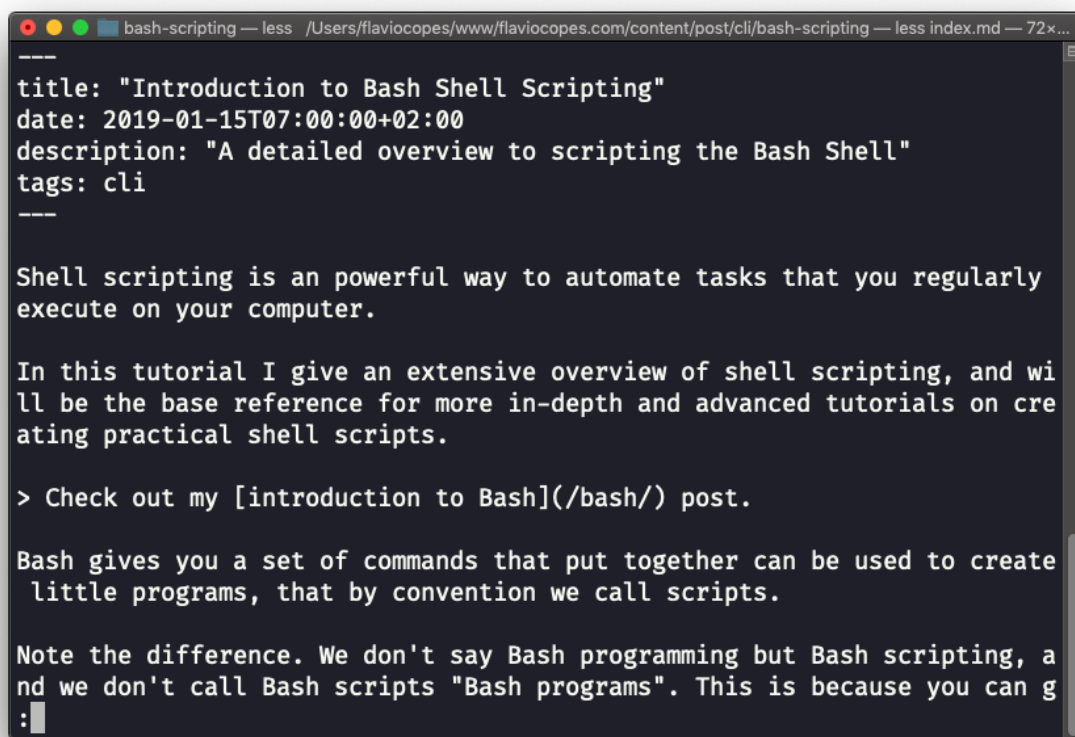
You can only add a number to non-blank lines using `-b` , or you can also remove all the multiple empty lines using `-s` .

`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 with a dark background. The window title bar shows 'bash-scripting — less /Users/flaviocopes/www/flaviocopes.com/content/post/cli/bash-scripting — less index.md — 72x...'. The terminal content shows the output of the 'less' command for 'index.md'. It starts with a separator '---', followed by metadata: 'title: "Introduction to Bash Shell Scripting"', 'date: 2019-01-15T07:00:00+02:00', 'description: "A detailed overview to scripting the Bash Shell"', and 'tags: cli'. Another separator '---' follows. The main content begins with 'Shell scripting is an powerful way to automate tasks that you regularly execute on your computer.' (note the typo 'an' in the original image), then '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.' (note the typo 'wi' in the original image). This is followed by a line '> Check out my [introduction to Bash](/bash/) post.' and then 'Bash gives you a set of commands that put together can be used to create little programs, that by convention we call scripts.' (note the typo 'put' in the original image). The final line is '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' (note the typo 'g' in the original image). The cursor is at the end of the last line.

```
---
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
---

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

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

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

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

Note the difference. We don't say Bash programming but Bash scripting, a
nd 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

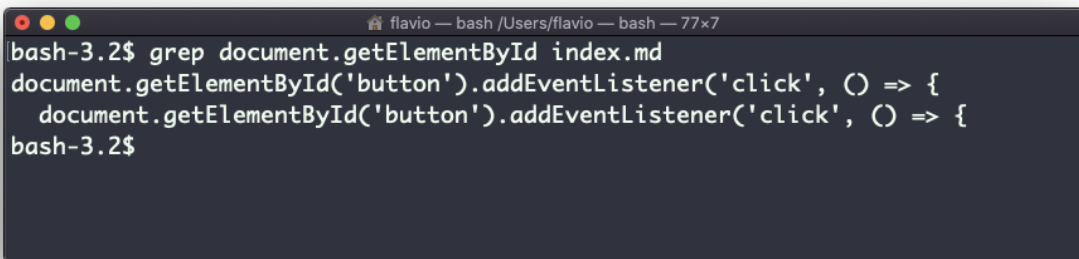
The `grep` command is a very useful tool, that when you master will help you tremendously in your day to day.

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 terminal window with a dark background. The title bar shows 'flavio — bash /Users/flavio — bash — 77x7'. The terminal content shows the command 'bash-3.2\$ grep document.getElementById index.md' followed by two lines of JavaScript code: 'document.getElementById('button').addEventListener('click', () => {' and 'document.getElementById('button').addEventListener('click', () => {'. The prompt 'bash-3.2\$' is visible at the end of the second line.

```
flavio — bash /Users/flavio — bash — 77x7
bash-3.2$ grep document.getElementById index.md
document.getElementById('button').addEventListener('click', () => {
  document.getElementById('button').addEventListener('click', () => {
bash-3.2$
```

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

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

```
flavio — bash /Users/flavio — bash — 77x7
bash-3.2$ grep -n document.getElementById index.md
60:document.getElementById('button').addEventListener('click', () => {
128: document.getElementById('button').addEventListener('click', () => {
bash-3.2$
```

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:

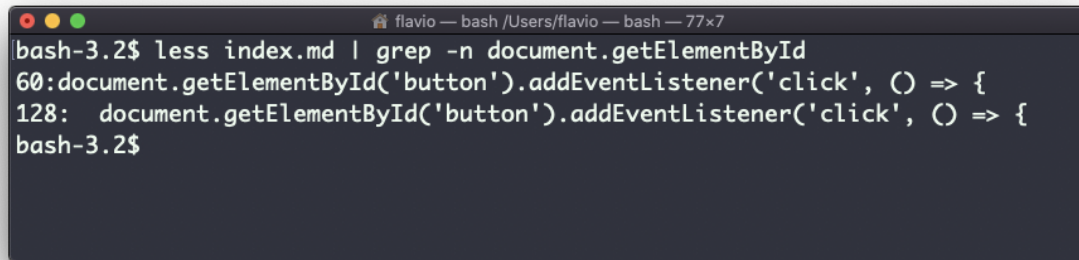
```
grep -nC 2 document.getElementById index.md
```

```
flavio — bash /Users/flavio — bash — 76x16
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:

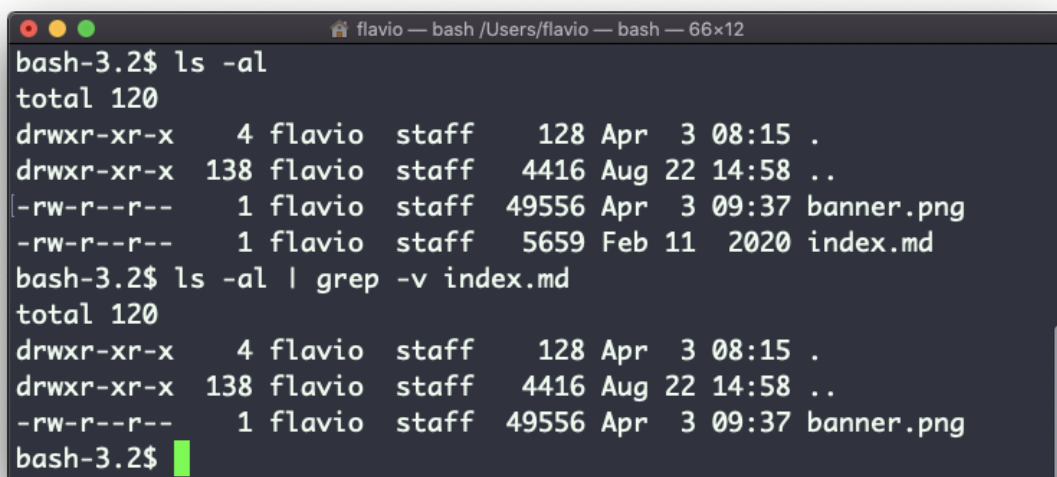
```
less index.md | grep -n document.getElementById
```



```
flavio — bash /Users/flavio — bash — 77x7
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.

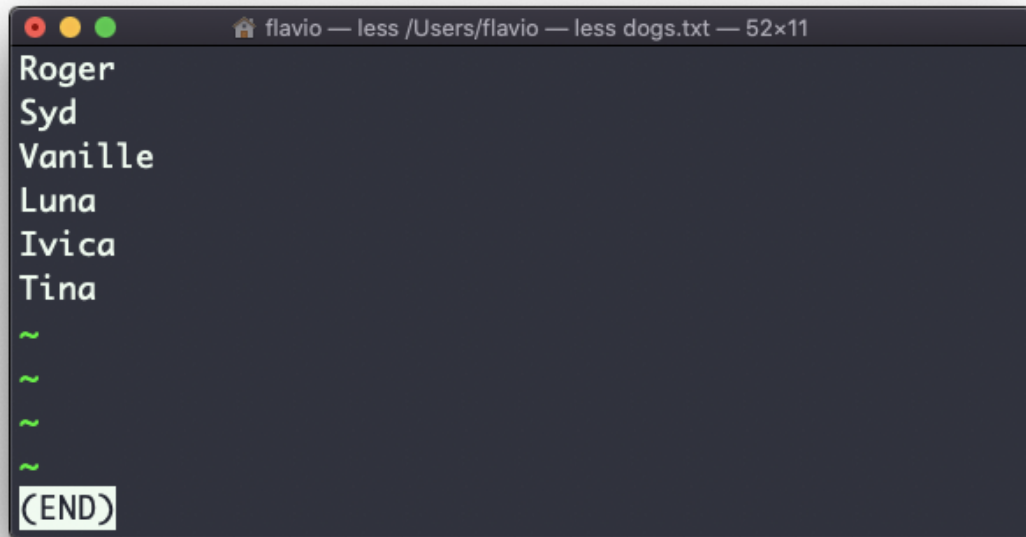
Another thing you might find very useful is to invert the result, excluding the lines that match a particular string, using the `-v` option:



```
flavio — bash /Users/flavio — bash — 66x12
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

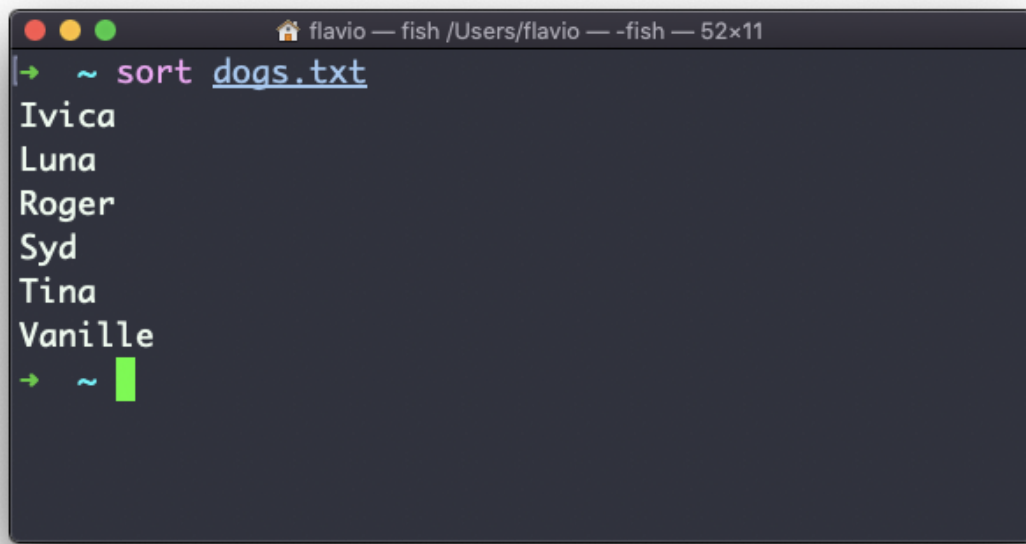
Suppose you have a text file which contains the names of dogs:



```
flavio — less /Users/flavio — less dogs.txt — 52x11
Roger
Syd
Vanille
Luna
Ivica
Tina
~
~
~
~
(END)
```

This list is unordered.

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



```
flavio — fish /Users/flavio — -fish — 52x11
→ ~ sort dogs.txt
Ivica
Luna
Roger
Syd
Tina
Vanille
→ ~
```

A terminal window with a dark background. The title bar shows 'flavio — fish /Users/flavio — -fish — 52x11'. The prompt is '~'. The command 'sort dogs.txt' has been executed, resulting in the following output: Ivica, Luna, Roger, Syd, Tina, and Vanille. The prompt is now '~' with a green cursor bar.

Use the `r` option to reverse the order:

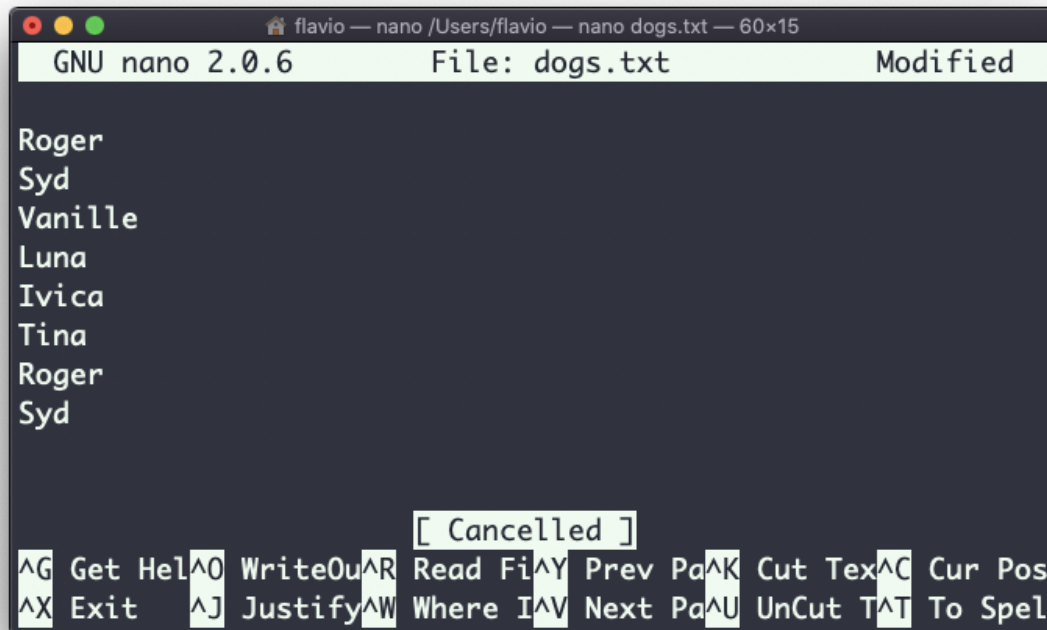


```
flavio — fish /Users/flavio — -fish — 51x9
→ ~ sort -r dogs.txt
Vanille
Tina
Syd
Roger
Luna
Ivica
→ ~
```

A terminal window with a dark background. The title bar shows 'flavio — fish /Users/flavio — -fish — 51x9'. The prompt is '~'. The command 'sort -r dogs.txt' has been executed, resulting in the following output: Vanille, Tina, Syd, Roger, Luna, and Ivica. The prompt is now '~' with a green cursor bar.

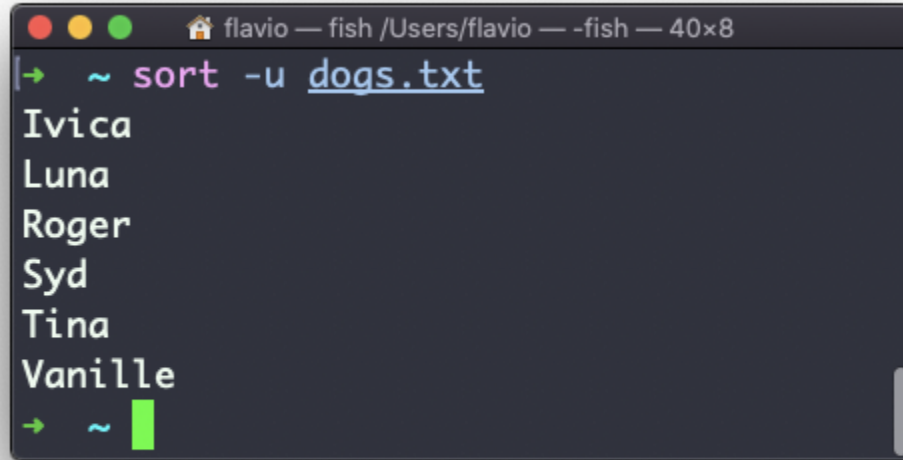
Sorting by default is case sensitive, and alphabetic. Use the `--ignore-case` option to sort case insensitive, and the `-n` option to sort using a numeric order.

If the file contains duplicate lines:



The screenshot shows a terminal window with the nano text editor open. The title bar indicates the user is 'flavio' and the file is '/Users/flavio/nano dogs.txt' with dimensions '60x15'. The editor's status bar shows 'GNU nano 2.0.6', 'File: dogs.txt', and 'Modified'. The file content consists of the following lines: Roger, Syd, Vanille, Luna, Ivica, Tina, Roger, and Syd. At the bottom of the editor, a '[Cancelled]' message is displayed. Below the editor, a row of keyboard shortcuts is visible, including ^G Get Help, ^O Write Out, ^R Read File, ^Y Prev Page, ^K Cut Text, ^C Cur Pos, ^X Exit, ^J Justify, ^W Where Is, ^V Next Page, ^U UnCut Text, and ^T To Spell.

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

A terminal window with a dark background. The title bar shows 'flavio — fish /Users/flavio — -fish — 40x8'. The prompt is '~'. The command 'sort -u dogs.txt' has been entered. The output is a list of names: Ivica, Luna, Roger, Syd, Tina, and Vanille. The prompt is now '~' with a green cursor.

```
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`.

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

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

SYNOPSIS
  sort [-bcCdFghiRMmnrsvZz] [-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 sub-
  sequent 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 tempo-
      rary 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 environ-
      ment 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
```

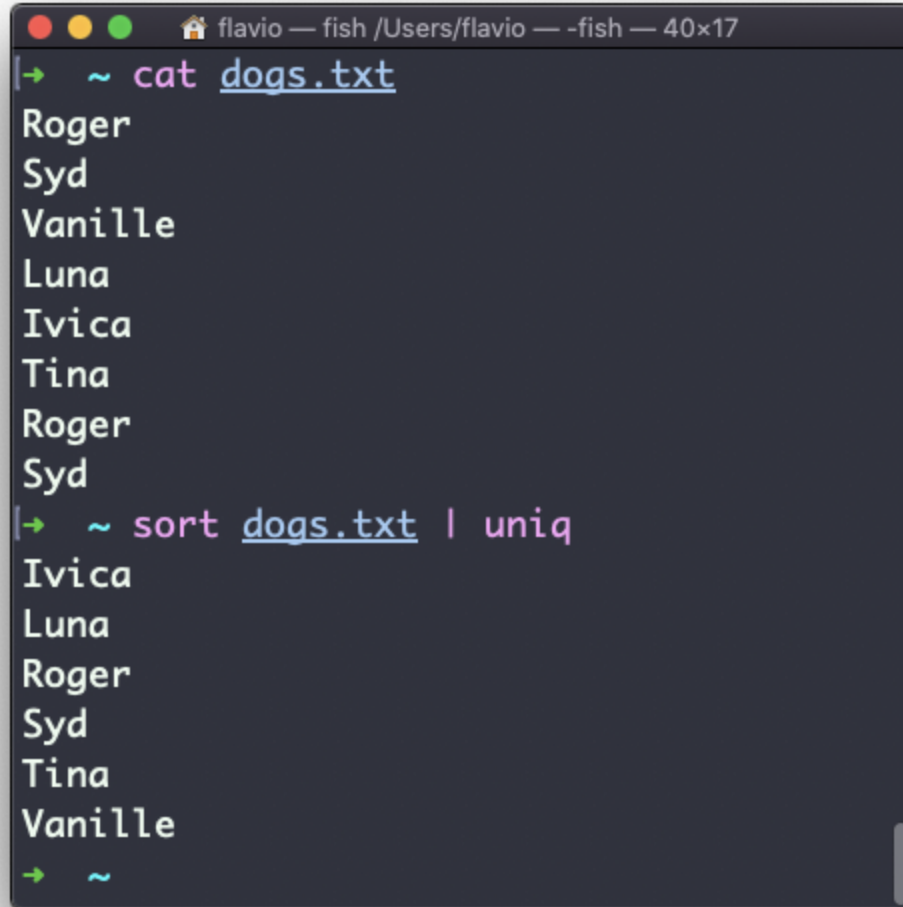
You need to consider this key thing: `uniq` will only detect adjacent duplicate lines.

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.

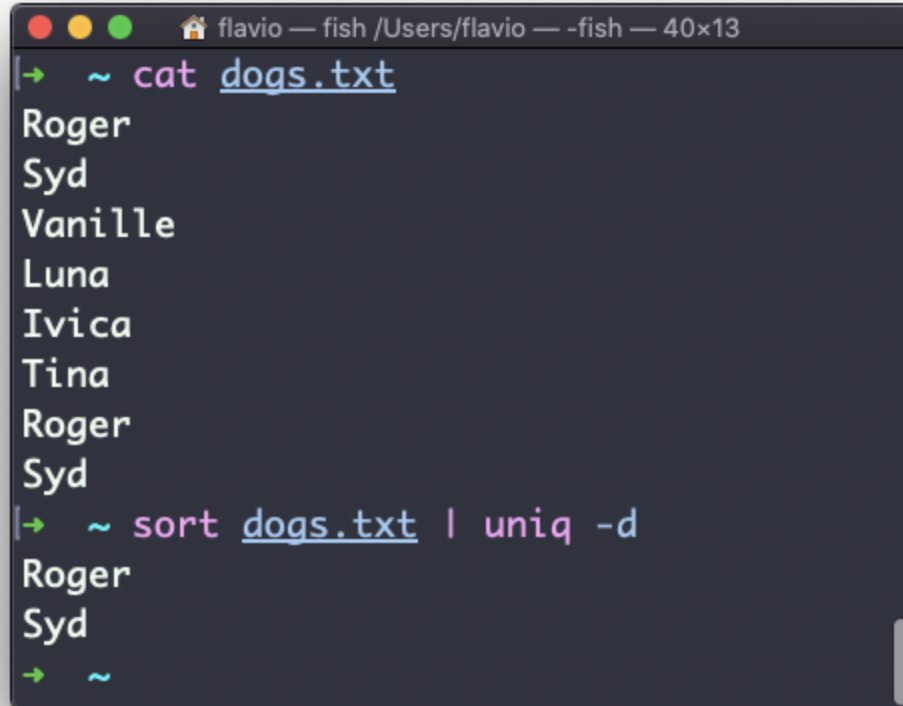
By default it removes duplicate lines:



```
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:


```
flavio — fish /Users/flavio — -fish — 40x17
→ ~ 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:

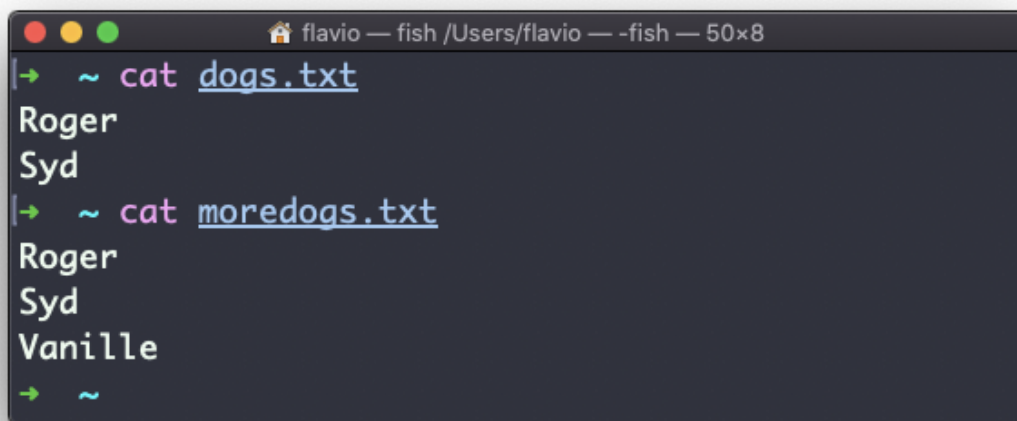
```
flavio — fish /Users/flavio — -fish — 44x8  
→ ~ sort dogs.txt | uniq -c | sort -nr  
2 Syd  
2 Roger  
1 Vanille  
1 Tina  
1 Luna  
1 Ivica  
→ ~
```

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:

A terminal window with a dark background and light text. The window title bar shows a home icon, the name 'flavio', and the path '— fish /Users/flavio — -fish — 50x8'. The terminal shows two commands being executed. The first command is '~ cat dogs.txt', followed by the output 'Roger' and 'Syd'. The second command is '~ cat moredogs.txt', followed by the output 'Roger', 'Syd', and 'Vanille'. The prompt '~' is shown at the bottom left.

```
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
~
```

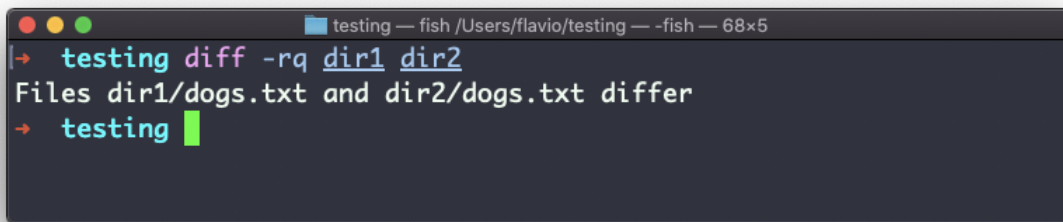
The `-u` option however will be more familiar to you, because that's the same used by the Git version control system to display differences between versions:

```
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 — fish /Users/flavio/testing — -fish — 68x13
→ 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:

A terminal window with a dark background and light-colored text. The window title bar shows 'testing — fish /Users/flavio/testing — -fish — 68x5'. The prompt is 'testing'. The user has entered 'diff -rq dir1 dir2'. The output is 'Files dir1/dogs.txt and dir2/dogs.txt differ'. The prompt is now 'testing' with a green cursor.

```
testing — fish /Users/flavio/testing — -fish — 68x5
→ 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"
```

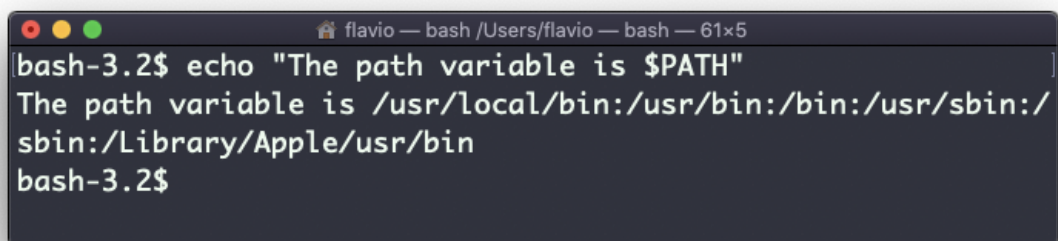
will print `hello` to the terminal.

We can append the output to a file:

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

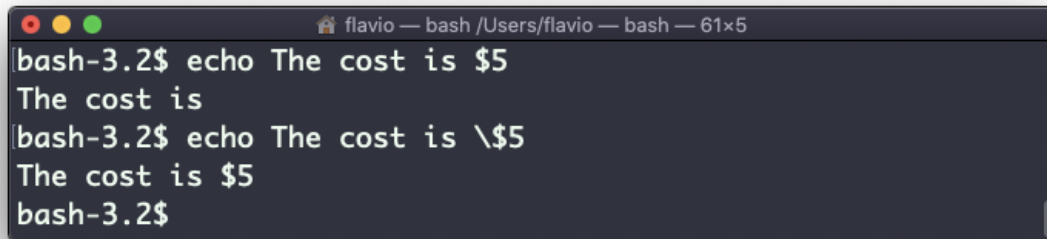
We can interpolate environment variables:

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

A screenshot of a macOS terminal window. The title bar shows 'flavio — bash /Users/flavio — bash — 61x5'. The terminal content shows a prompt 'bash-3.2\$' followed by the command 'echo "The path variable is \$PATH"'. The output is 'The path variable is /usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin'. The prompt 'bash-3.2\$' appears again on the next line.

```
flavio — bash /Users/flavio — bash — 61x5
bash-3.2$ echo "The path variable is $PATH"
The path variable is /usr/local/bin:/usr/bin:/bin:/usr/sbin:/
sbin:/Library/Apple/usr/bin
bash-3.2$
```


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

A terminal window with a dark background and light text. The title bar shows 'flavio — bash /Users/flavio — bash — 61x5'. The terminal content shows three lines of input and output: 'bash-3.2\$ echo The cost is \$5' followed by 'The cost is', 'bash-3.2\$ echo The cost is \\$5' followed by 'The cost is \$5', and 'bash-3.2\$' on the final line.

```
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 *
```

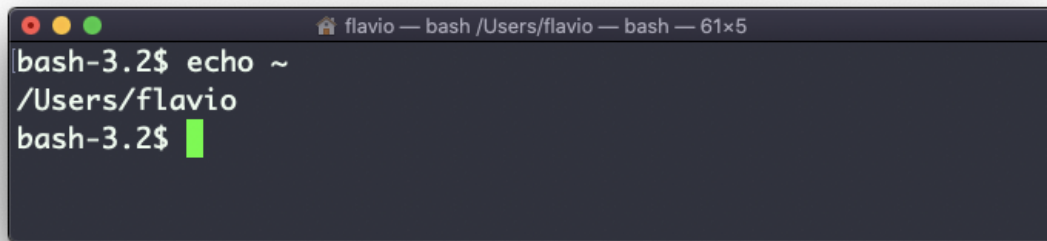
We can echo the files in the current folder that start with the letter `o` :

```
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:

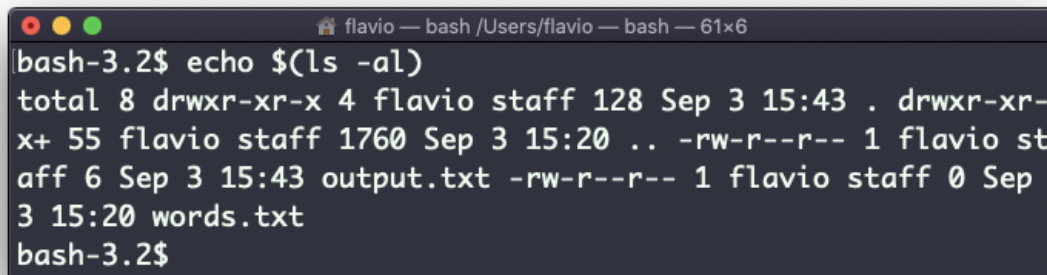
```
echo ~
```



```
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)
```



```
flavio — bash /Users/flavio — bash — 61x6
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:

```
flavio — bash /Users/flavio — bash — 61x7
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}
```

```
flavio — bash /Users/flavio — bash — 61x5
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.

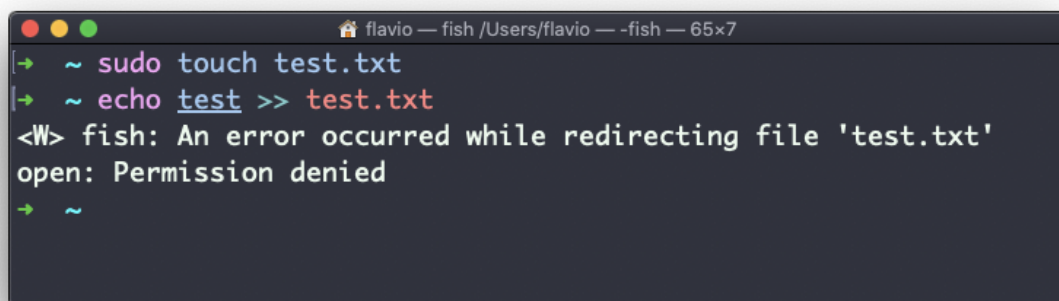
The owner (and the `root` user) can change the owner to another user, too, using the `chown` command:

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

Like this:

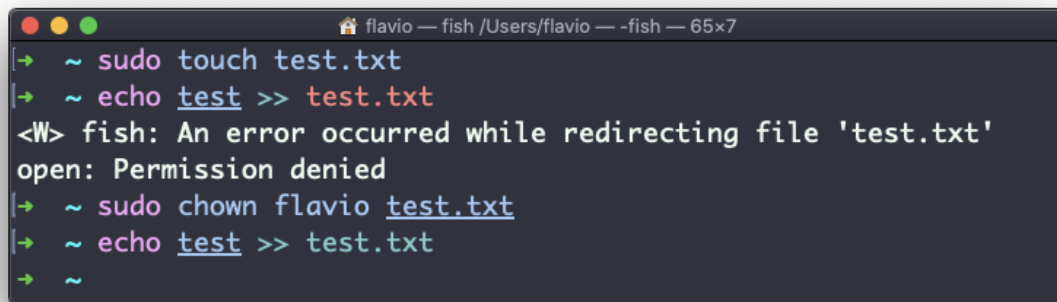
```
chown flavio test.txt
```

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

A terminal window titled 'flavio — fish /Users/flavio — -fish — 65x7' showing a sequence of commands and an error. The user runs 'sudo touch test.txt' successfully. Then they run 'echo test >> test.txt', which fails with the message 'fish: An error occurred while redirecting file 'test.txt' open: Permission denied'.

```
flavio — fish /Users/flavio — -fish — 65x7
[~] ~ 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:



```
flavio — fish /Users/flavio — -fish — 65x7
→ ~ 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
```

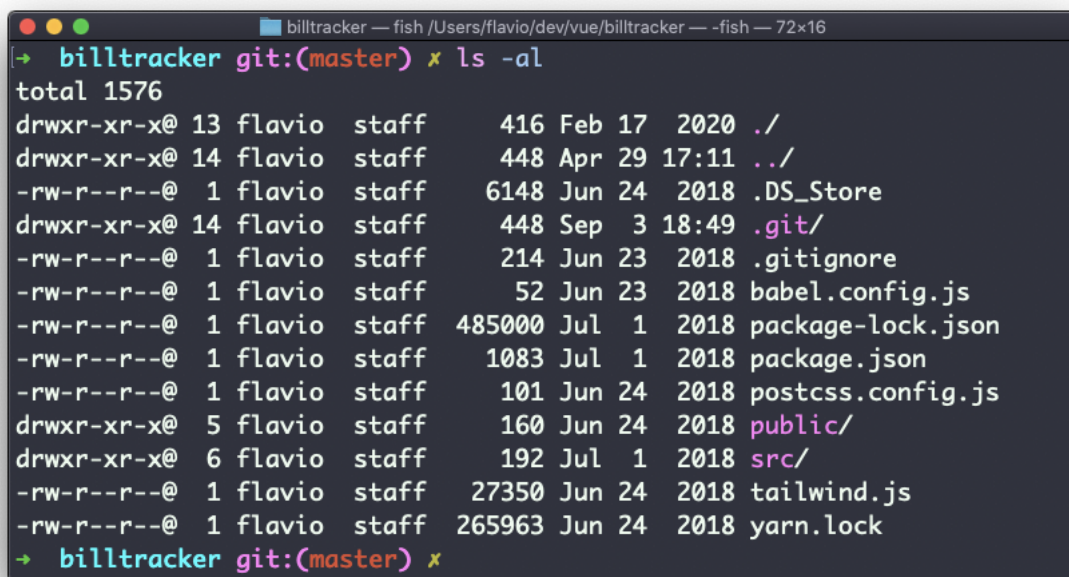
You can also just change the group of a file using the `chgrp` command:

```
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

- `1` 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 file) cannot read, write or execute the file
```

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:

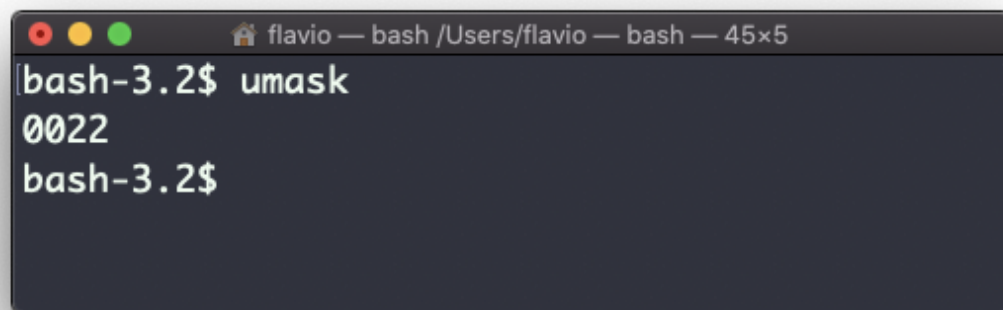
```
chmod 777 filename  
chmod 755 filename  
chmod 644 filename
```

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` :

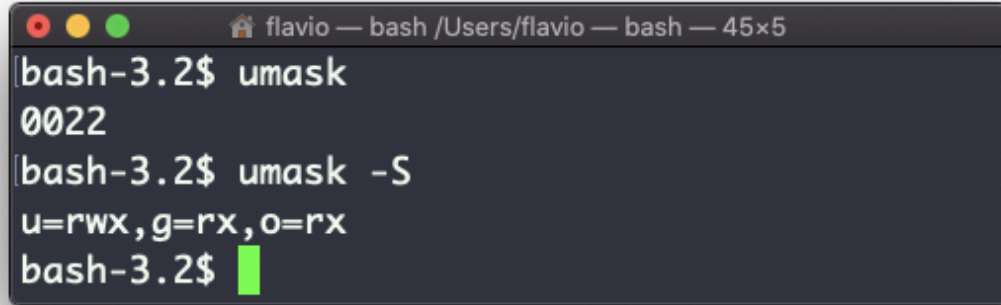
A terminal window with a dark background and light text. The title bar at the top shows a home icon, the name 'flavio', and the path '— bash /Users/flavio — bash — 45x5'. The terminal content shows the command 'umask' being entered at the 'bash-3.2\$' prompt, followed by the output '0022' on the next line, and the prompt 'bash-3.2\$' on the third line.

```
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:

A terminal window with a dark background and light text. The title bar shows 'flavio — bash /Users/flavio — bash — 45x5'. The terminal content shows the following sequence: 'bash-3.2\$ umask' followed by '0022' on the next line. Then 'bash-3.2\$ umask -S' followed by 'u=rwx,g=rx,o=rx' on the next line. Finally, 'bash-3.2\$' followed by a green cursor block on the next line.

```
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
```

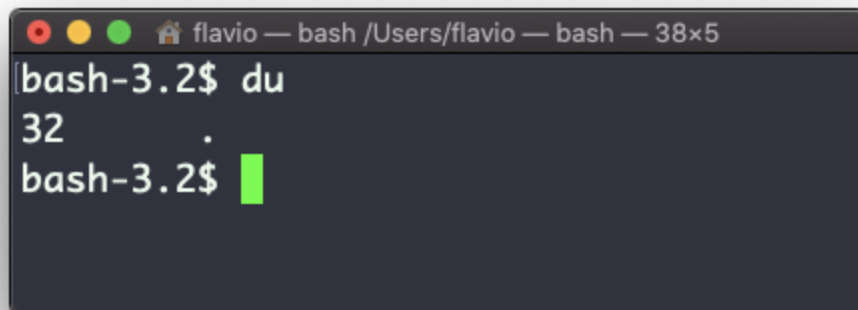
or you can change a specific role's permission:

```
umask g+r
```

du

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

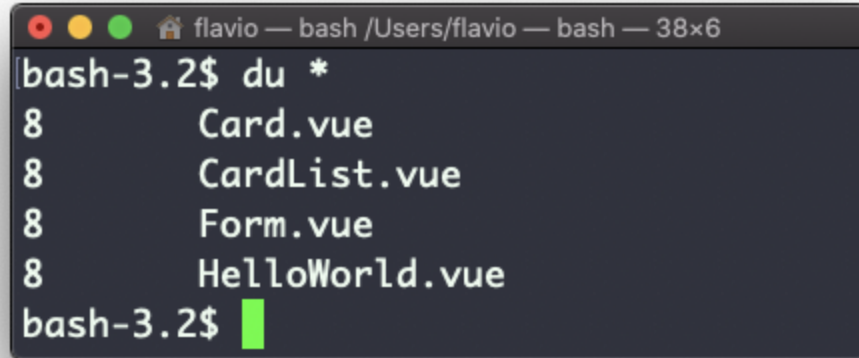
```
du
```

A screenshot of a macOS terminal window. The title bar shows 'flavio — bash /Users/flavio — bash — 38x5'. The terminal content shows the command 'du' being executed, resulting in the output '32' followed by a dot '.' on the next line. The prompt 'bash-3.2\$' is visible before and after the command.

```
bash-3.2$ du
32
.
```

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

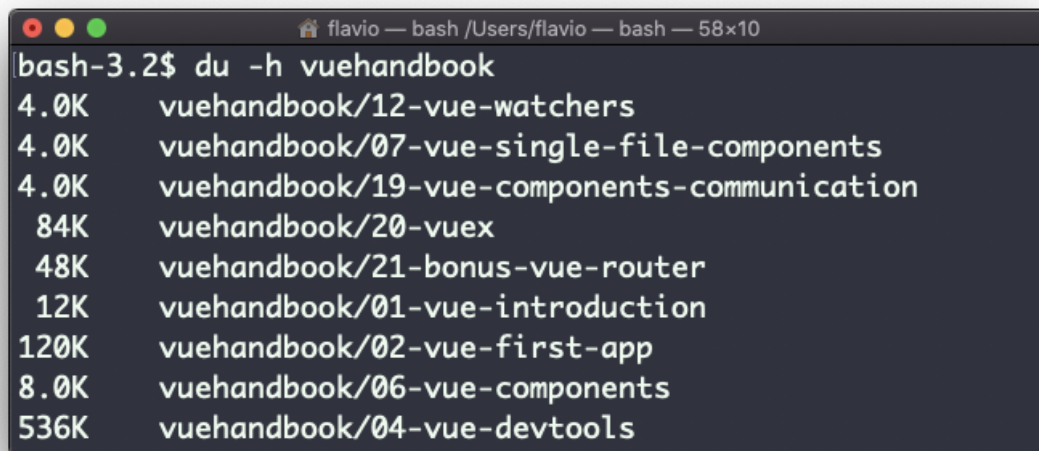
Running `du *` will calculate the size of each file individually:

A terminal window titled 'flavio — bash /Users/flavio — bash — 38x6'. The prompt is 'bash-3.2\$'. The command 'du *' has been entered, and the output shows four files: 'Card.vue', 'CardList.vue', 'Form.vue', and 'HelloWorld.vue', each with a size of 8.

```
bash-3.2$ du *
8      Card.vue
8      CardList.vue
8      Form.vue
8      HelloWorld.vue
bash-3.2$
```

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:

A terminal window titled 'flavio — bash /Users/flavio — bash — 58x10'. The prompt is 'bash-3.2\$'. The command 'du -h vuehandbook' has been entered, and the output shows the size of various subdirectories in the 'vuehandbook' directory in human-readable format (K for Kilobytes, M for Megabytes).

```
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
```

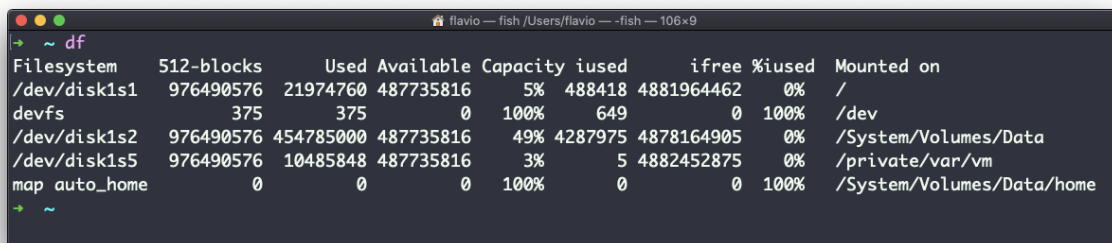
and then piping to `head` to only get the first 10 results:


```
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 — fish /Users/flavio — -fish — 106x9
~ 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 — fish /Users/flavio — -fish — 100x9
~ 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 — fish /Users/flavio — -fish — 109x6
~ 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
~
```

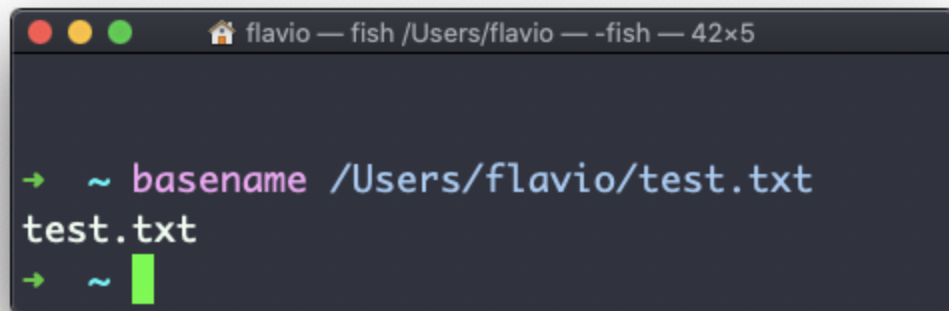
basename

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 terminal window with a dark background and light-colored text. The title bar at the top shows a home icon, the name 'flavio', and the path '— fish /Users/flavio — -fish — 42x5'. The terminal content shows a prompt '→ ~' followed by the command 'basename /Users/flavio/test.txt' in a light blue color. The output 'test.txt' is displayed on the next line. A second prompt '→ ~' is visible on the line below, followed by a green cursor block.

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:

```
flavio — fish /Users/flavio — -fish — 42x5
→ ~ 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 terminal window with a dark background. The window title bar shows a home icon, the name 'flavio', and the path '— fish /Users/flavio — -fish — 44x5'. The terminal shows a prompt '~' followed by the command 'dirname /Users/flavio/test.txt' in pink. The output '/Users/flavio' is displayed below the command. A second prompt '~' is visible on the next line.

```
flavio — fish /Users/flavio — -fish — 44x5  
[→ ~ dirname /Users/flavio/test.txt  
/Users/flavio  
→ ~
```

ps

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

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

A terminal window titled 'flavio — fish /Users/flavio — -fish — 63x12' showing the output of the 'ps' command. The output is a table with four columns: PID, TTY, TIME, and CMD. The processes listed are several instances of fish and one instance of hugo serve.

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` :

```
flavio — fish /Users/flavio — -fish — 86x24
~ ps ax
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.vmmnetd
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:


```
flavio — fish /Users/flavio — -fish — 84x21
~ ps axww
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/Res
sources/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/watchdogd
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"
```

```
flavio — fish /Users/flavio — -fish — 84x21
➔ ~ ps axww | grep "Visual Studio Code"
367  ??  S    40:32.47 /Applications/Visual Studio Code.app/Contents/MacOS/Elect
ron -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-tr
ial-handle=1718379636,8422946071360466993,8181735644596197527,131072 --disable-featu
res=LayoutNG,PictureInPicture,SpareRendererForSitePerProcess --disable-color-correct
-rendering --gpu-preferences=KAAAAAAAAAgAAAAAAAAAYAAAAAAEAAAAAAAAAAAAAAAAAAAAg
BAAAgAAAAAEAAAAAAAAIAQAAAAAABABAAAAAAGAEAAAAAAAgAQAAAAACgBAAAAAAMAEAAAAAA
4AQAAAAAAEABAAAAAASAEAAAAAABQAQAAAAAFgBAAAAAAAYEAAAAAABoAQAAAAAHABAAAAAA
AeAEAAAAAAACAAQAAAAAAIgBAAAAAAAKAEAAAAAACYAQAAAAAAKABAAAAAAAgAEAAAAAACwAQAAAA
AALgBAAAAAAAwAEAAAAAADIAQAAAAAANABAAAAAAAZAEAAAAAADgAQAAAAAAOgBAAAAAA8AEAAAA
AAAD4AQAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAACAAAAEAAAAAABgAAABAAAA
AAAAAAAAAAcAAAAQAAAAAIAAAAEAAAAAAGAAAAAAcGAAABAAAAAASAAAAQAAA
AAAAAAAAAANAAAAEAAAAAABAAAAAABAAAAAQAQAAAAIAAAQAAAAAAEAAAAGAAAAEAA
AAAAAABAAAAAwAAABAAAAAQAQAAAgAAAAQAAAAAAEAAAAKAAAAEAAAAAABAAAAcWAAABA
AAAAAQAQAAAA0AAAAQAAAAAQAQAAAAAAEAAAAAAEAAAAAgAAABAAAAAABAAAAAYAAA
QAAAAAQAQAAAAHAHAEEAAAAAAEAAAAcAAAABAAAAAABAAAAoAAAAQAAAAAQAQAAALAA
AEAAAAAAAEAAAAADQAAABAAAAAABgAAAAAAQAQAAAAAAYAAAAcAAAAEAAAAAAGAAAABgA
AABAAAAAABgAAAAcAAAAQAAAAAAYAAAAIAAAEAAAAAAGAAAAcGAAABAAAAAABgAAAAs
AAAAQAAAAAAYAAAAA --service-request-channel-token=4754214311225613582
```

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.

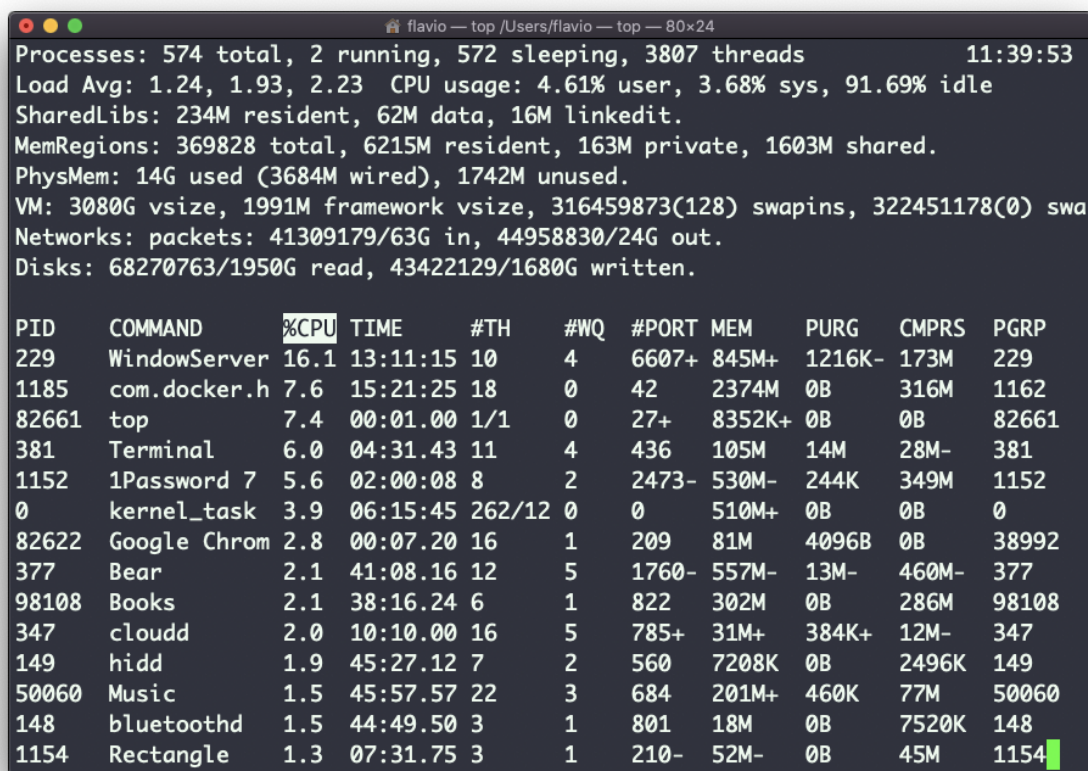
top

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
Processes: 574 total, 2 running, 572 sleeping, 3807 threads      11:39:53
Load Avg: 1.24, 1.93, 2.23  CPU usage: 4.61% user, 3.68% sys, 91.69% idle
SharedLibs: 234M resident, 62M data, 16M linkedit.
MemRegions: 369828 total, 6215M resident, 163M private, 1603M shared.
PhysMem: 14G used (3684M wired), 1742M unused.
VM: 3080G vsize, 1991M framework vsize, 316459873(128) swapins, 322451178(0) swa
Networks: packets: 41309179/63G in, 44958830/24G out.
Disks: 68270763/1950G read, 43422129/1680G written.

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 7     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`. `19` 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

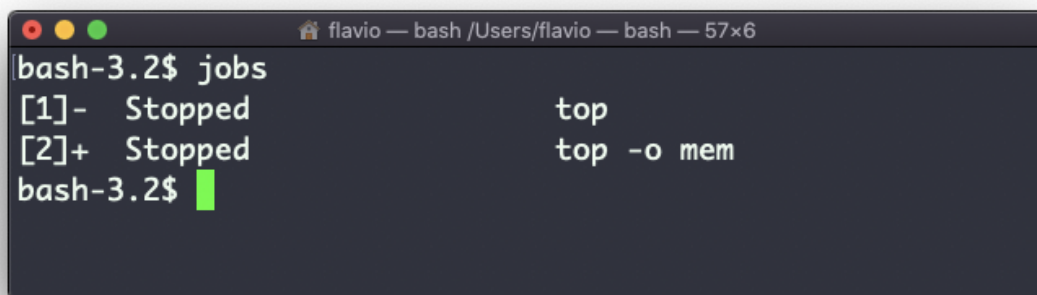
When we run a command in Linux / macOS, we can set it to run in the background using the `&` symbol after the command. For example we can run `top` in the background:

```
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 terminal window titled 'flavio — bash /Users/flavio — bash — 57x6' showing the output of the 'jobs' command. The output lists two stopped jobs: [1]- Stopped top and [2]+ Stopped top -o mem. The prompt 'bash-3.2\$' is followed by a green cursor.

```
flavio — bash /Users/flavio — bash — 57x6
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.

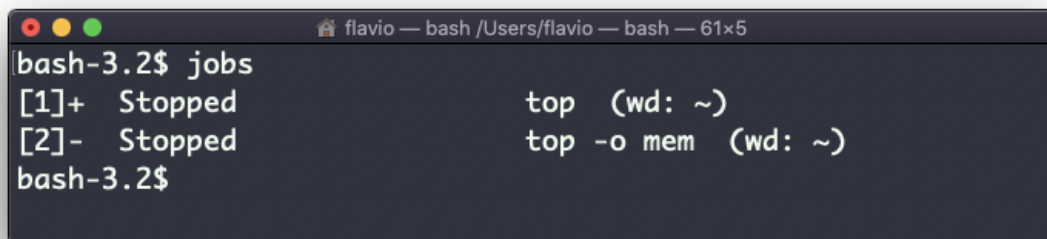
bg

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 terminal window with a dark background and light text. The title bar at the top reads 'flavio — bash /Users/flavio — bash — 61x5'. The terminal content shows the command 'jobs' being executed, which lists two stopped jobs: '[1]+ Stopped' and '[2]- Stopped'. To the right of the job list, the details for each job are shown: 'top (wd: ~)' for job 1 and 'top -o mem (wd: ~)' for job 2. The prompt 'bash-3.2\$' is visible at the bottom.

```
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

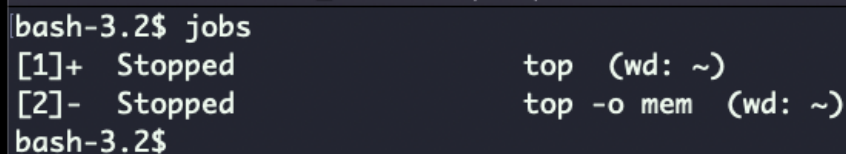
When a command is running in the background, because you started it with `&` at the end (example: `top &` or because you put it in the background with the `bg` command, you can put it to the foreground using `fg`.

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.



```
flavio — bash /Users/flavio — bash — 61x5
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:

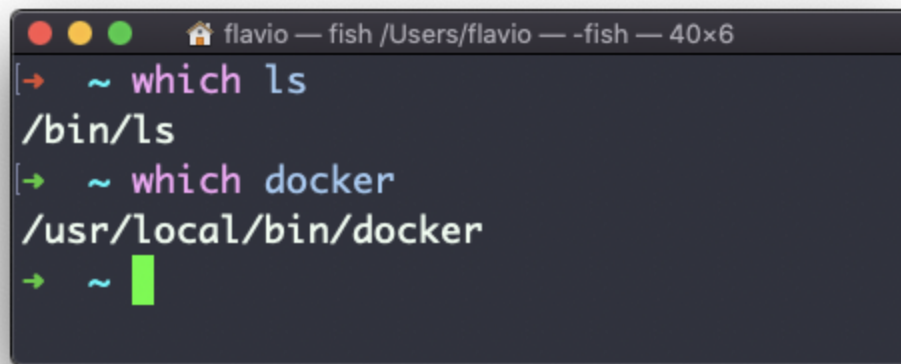

```
flavio — fish /Users/flavio — -fish — 80x39
→ ~ type ls
ls is a function with definition
# Defined in /usr/local/Cellar/fish/3.1.0/share/fish/functions/ls.fish @ line 13
function ls --description 'List contents of directory'
    set -l opt -G
        isatty stdout
        and set -a opt -F
        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 terminal window with a dark background and light-colored text. The window title bar shows 'flavio — fish /Users/flavio — -fish — 40x6'. The terminal content shows three commands being executed: 'which ls' returns '/bin/ls', 'which docker' returns '/usr/local/bin/docker', and the third command is partially visible as 'which' followed by a green cursor.

```
flavio — fish /Users/flavio — -fish — 40x6
[→ ~ 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` :



```
testing — fish /Users/flavio/testing — -fish — 62x7
→ 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:

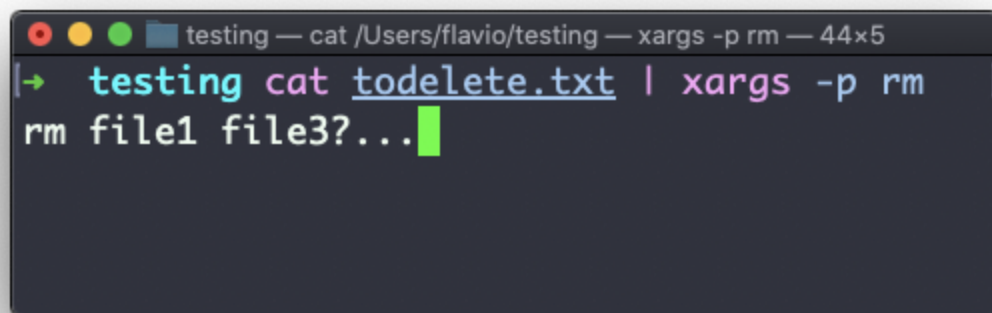


```
testing — fish /Users/flavio/testing — -fish — 62x10
→ testing ls
file1          file2          file3          todelete.txt
→ testing cat todelete.txt
file1
file3
→ testing cat todelete.txt | xargs rm
→ testing ls
file2          todelete.txt
→ testing
```

The 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:

A terminal window with a dark background. The title bar shows 'testing — cat /Users/flavio/testing — xargs -p rm — 44x5'. The prompt is a green arrow. The command 'testing cat todelete.txt | xargs -p rm' is entered. The output 'rm file1 file3?...' is shown with a green cursor at the end.

```
testing — cat /Users/flavio/testing — xargs -p rm — 44x5
→ testing cat todelete.txt | xargs -p rm
rm file1 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` :

A terminal window with a dark background. The title bar shows 'testing — cat /Users/flavio/testing — xargs -p -n1 rm — 55x5'. The prompt is a green arrow. The command 'testing cat todelete.txt | xargs -p -n1 rm' is entered. The output 'rm file1?...' is shown with a green cursor at the end.

```
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 %'
```

A terminal window with a dark background. The title bar shows 'testing — cat /Users/flavio/testing — xargs -p -I % sh -c ls %; rm % — 67x5'. The prompt is a red arrow. The command entered is 'testing cat todelete.txt | xargs -p -I % sh -c 'ls %; rm %''. The output is 'sh -c ls file1; rm file1?...' followed by a green cursor.

```
testing cat todelete.txt | xargs -p -I % sh -c 'ls %; rm %'  
sh -c ls file1; rm file1?...
```

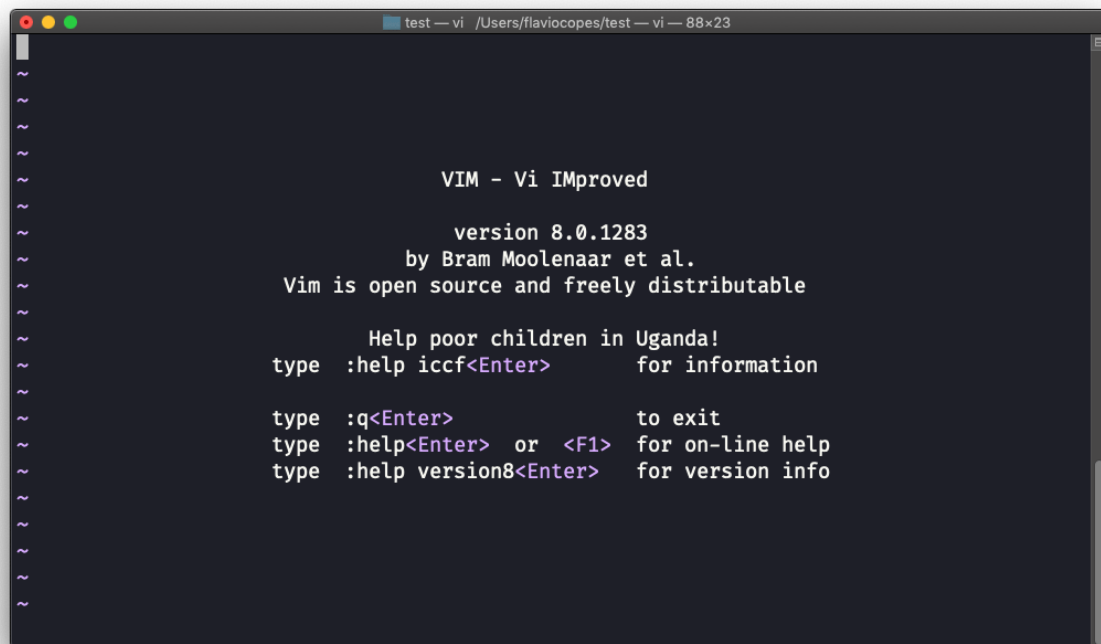
You can swap the `%` symbol I used above with anything else, it's a variable

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](#)!

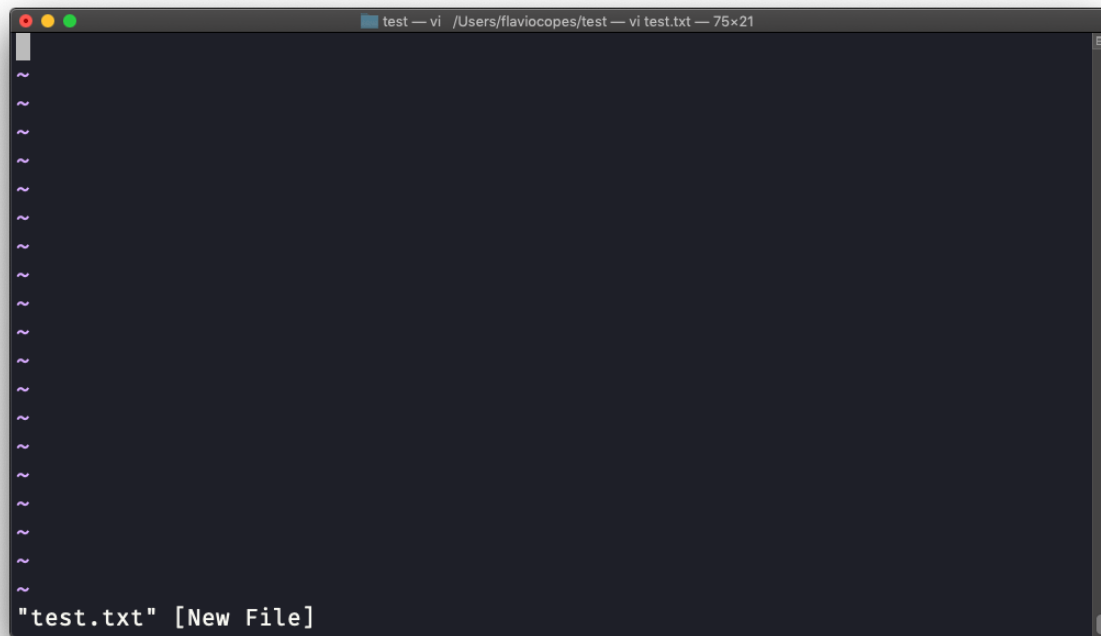
`vi` in modern systems is just an alias to `vim`, which means `vi` is improved.

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



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

```
vi test.txt
```

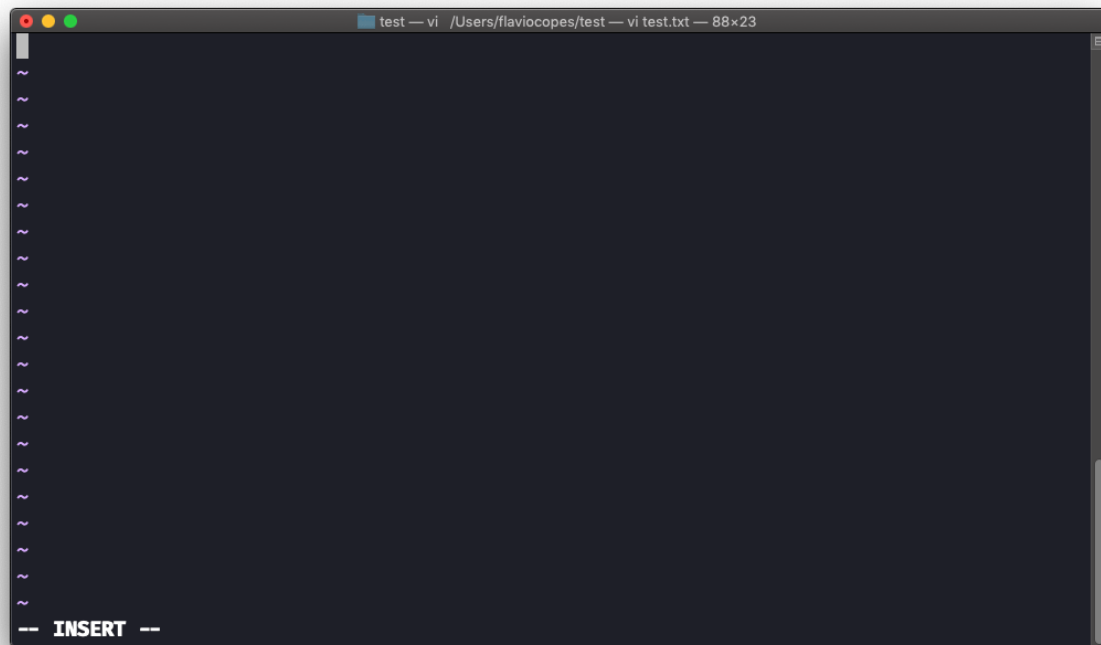



You have to know that Vim has 2 main modes:

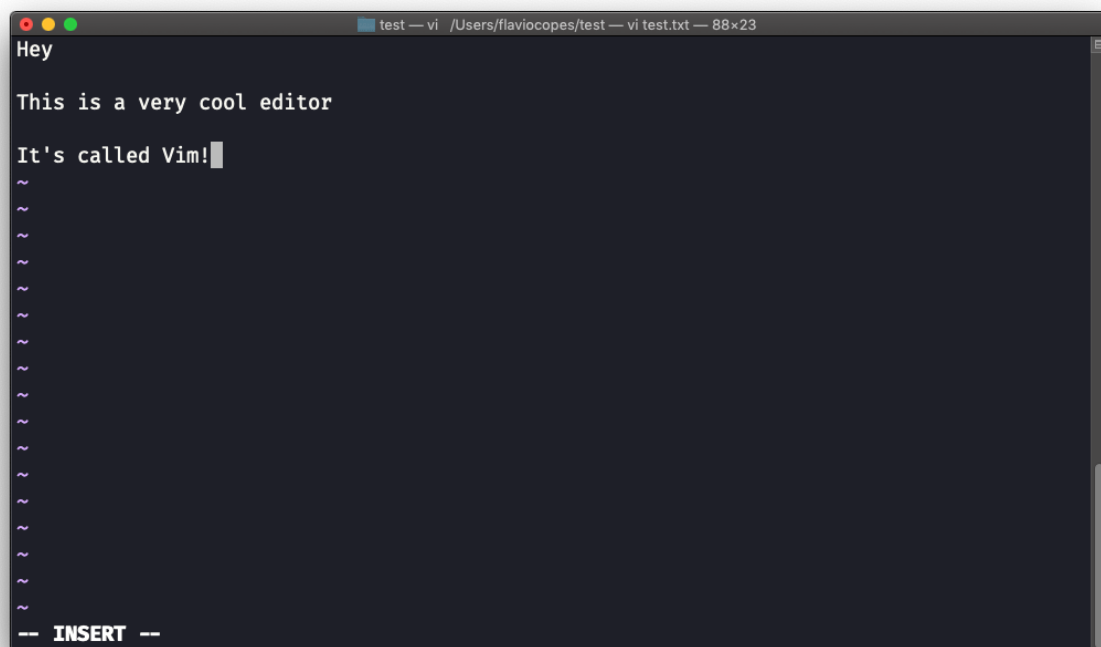
- *command* (or *normal*) mode
- *insert* mode

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:

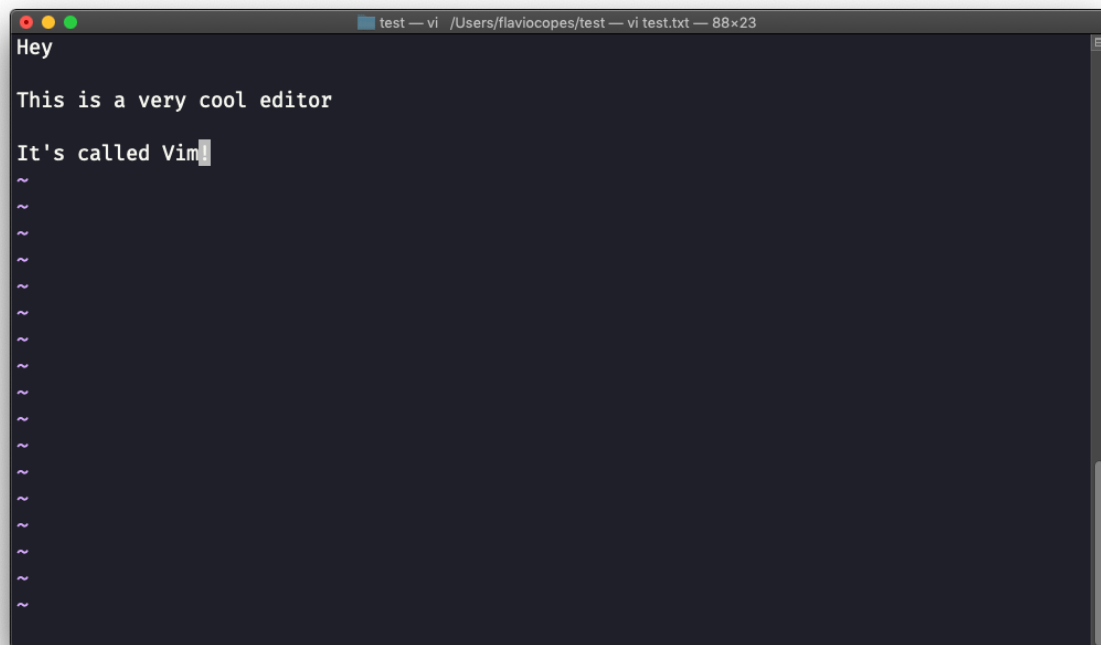


Now you can start typing and filling the screen with the file contents:



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**.



```
test — vi /Users/flaviocopes/test — vi test.txt — 88x23
Hey
This is a very cool editor
It's called Vim~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
```

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 `o` 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

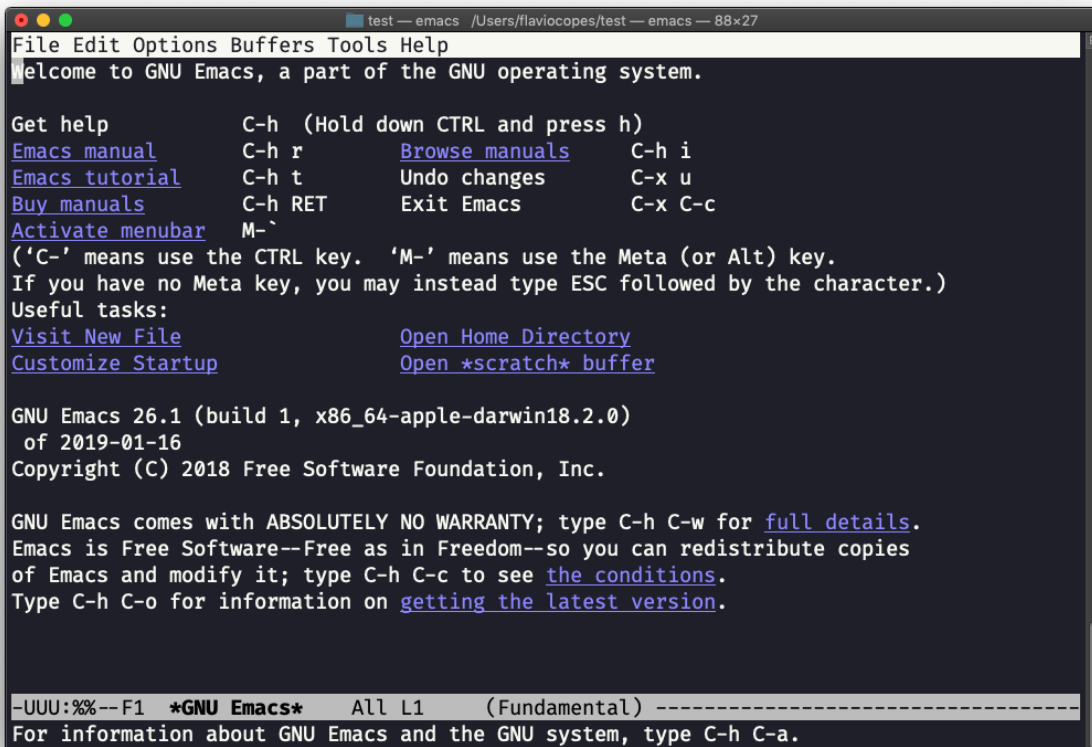
To find out more about Vim I can recommend the [Vim FAQ](#) and especially running the `vimtutor` command, which should already be installed in your system and will greatly help you start your `vim` explorations.

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 :

A screenshot of a GNU Emacs window on a macOS system. The window title bar shows "test — emacs /Users/flaviocopes/test — emacs — 88x27". The menu bar includes "File Edit Options Buffers Tools Help". The main text area displays the Emacs welcome message: "Welcome to GNU Emacs, a part of the GNU operating system." followed by a list of commands and their shortcuts (e.g., "Get help C-h (Hold down CTRL and press h)", "Emacs manual C-h r", "Browse manuals C-h i", etc.). It also includes information about the version (GNU Emacs 26.1) and copyright (© 2018 Free Software Foundation, Inc.). At the bottom, a status bar shows "-UUU:%--F1 *GNU Emacs* All L1 (Fundamental) -----" and a message "For information about GNU Emacs and the GNU system, type C-h C-a."

```
test — emacs /Users/flaviocopes/test — emacs — 88x27
File Edit Options Buffers Tools Help
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

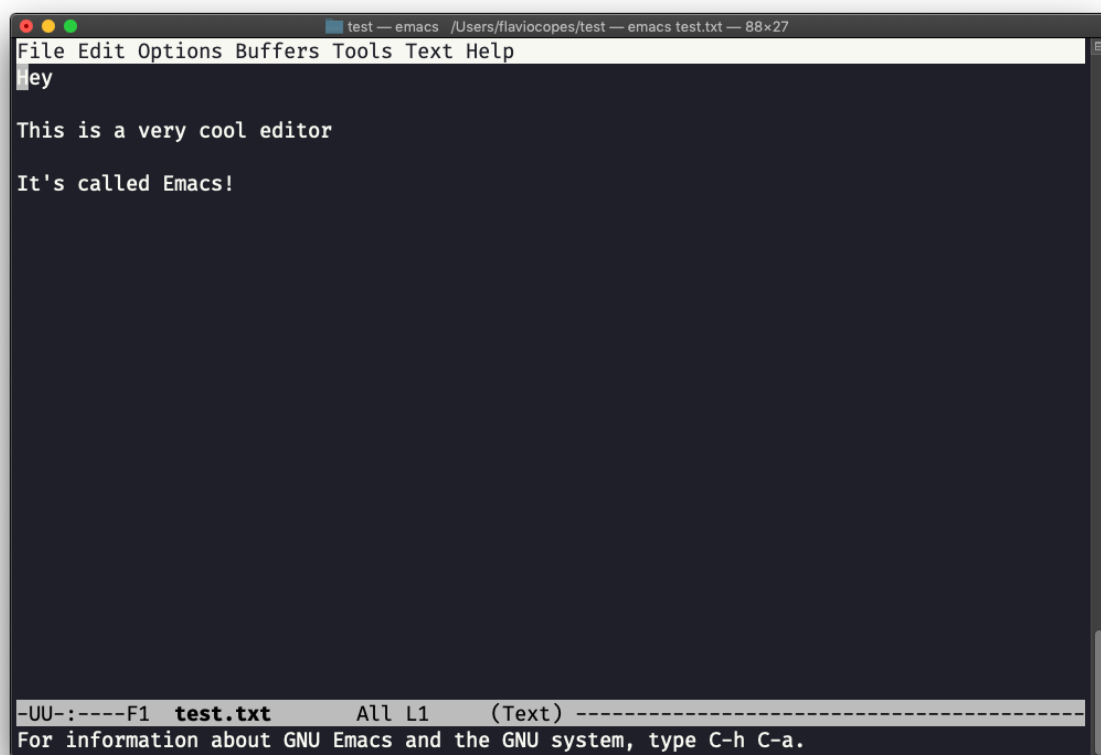
GNU Emacs 26.1 (build 1, x86_64-apple-darwin18.2.0)
of 2019-01-16
Copyright (C) 2018 Free Software Foundation, Inc.

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.

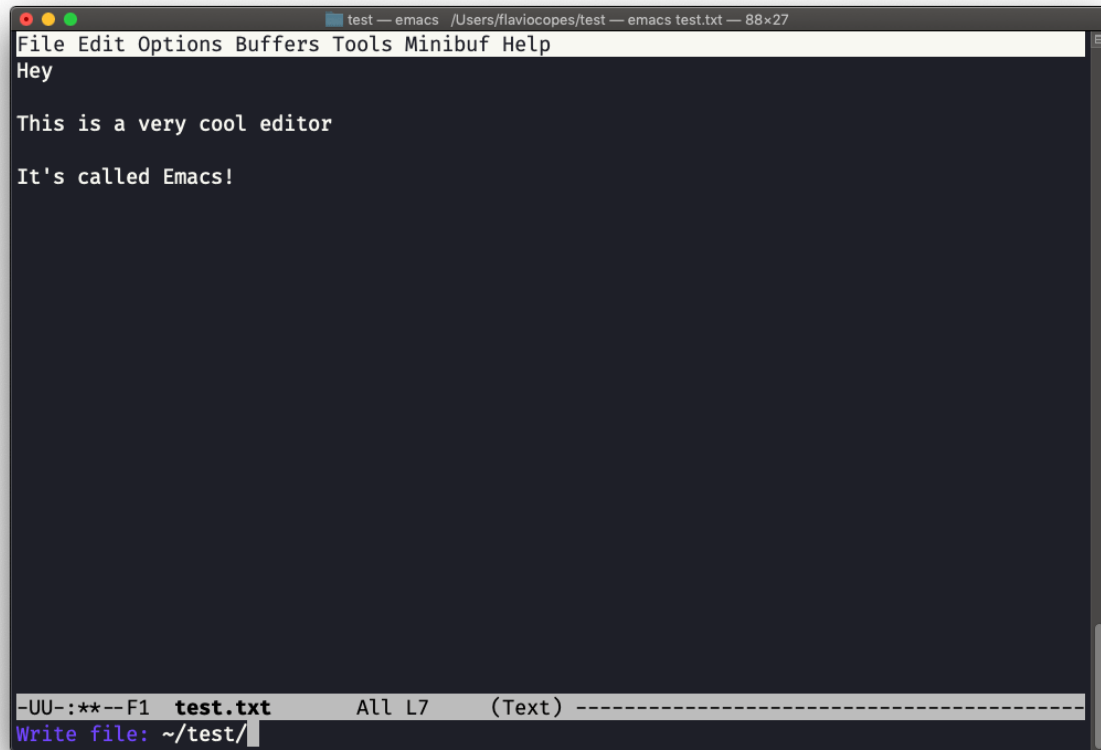
-UUU:%--F1 *GNU Emacs* All L1 (Fundamental) -----
For information about GNU Emacs and the GNU system, type C-h C-a.
```

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)

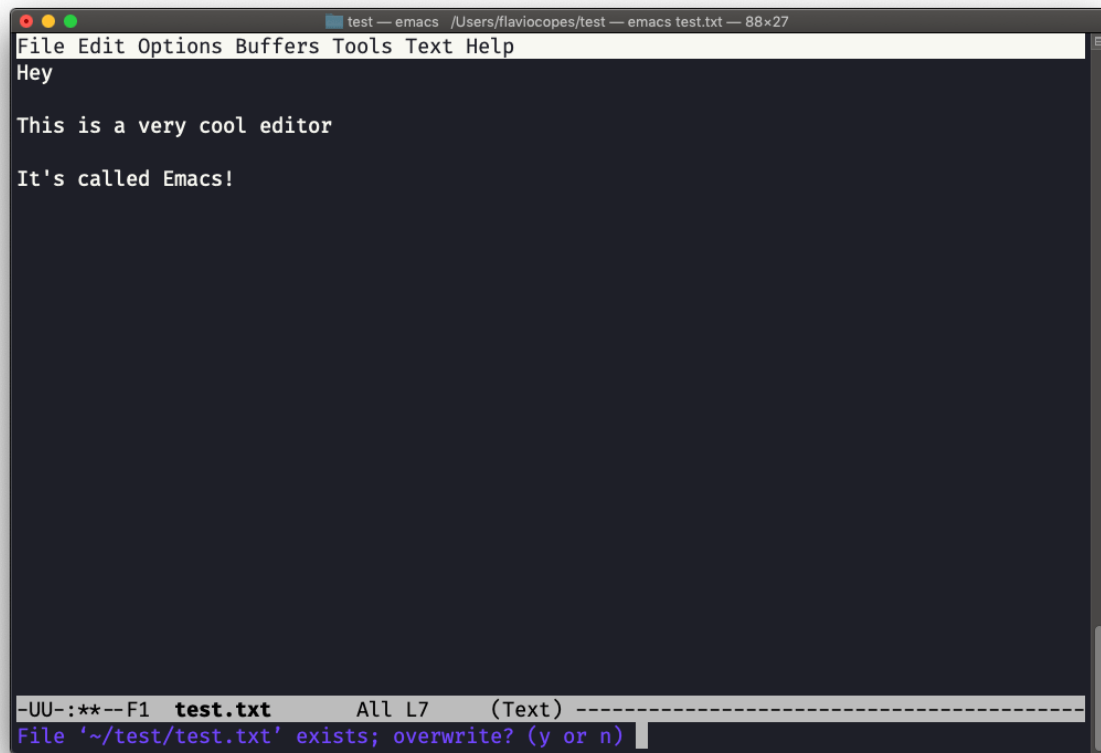
You can also edit an existing file calling `emacs <filename>` :



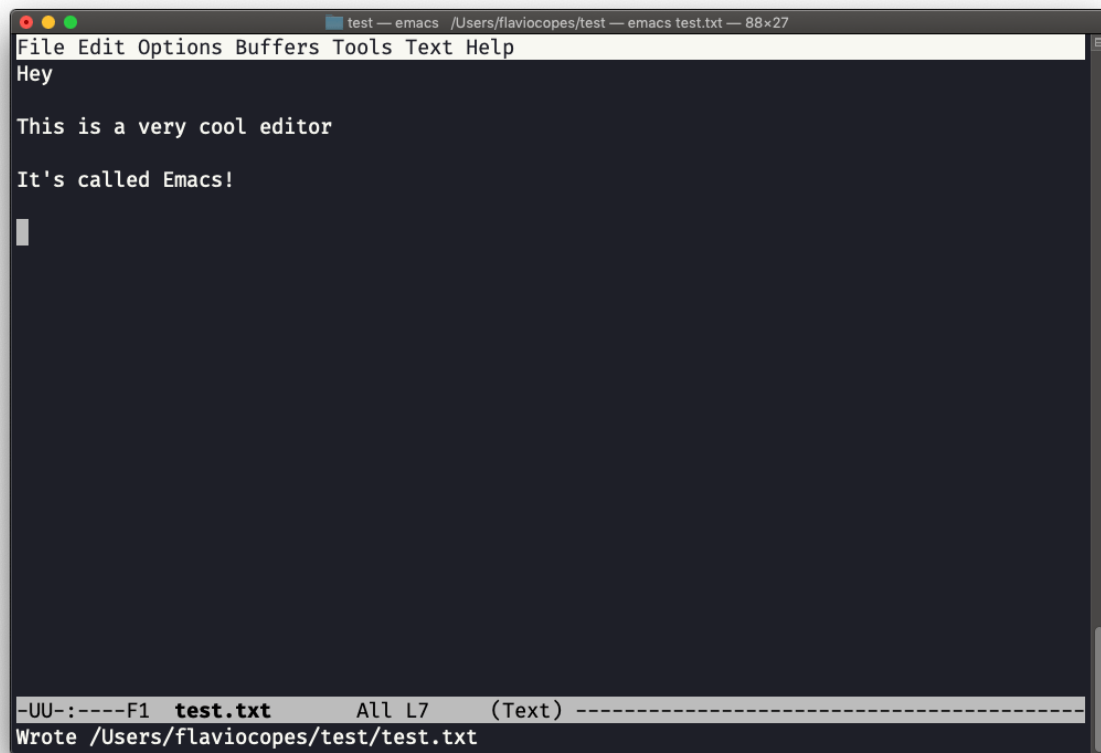
You can start editing and once you are done, press `ctrl-x` followed by `ctrl-w` . You confirm the folder:



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



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



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.

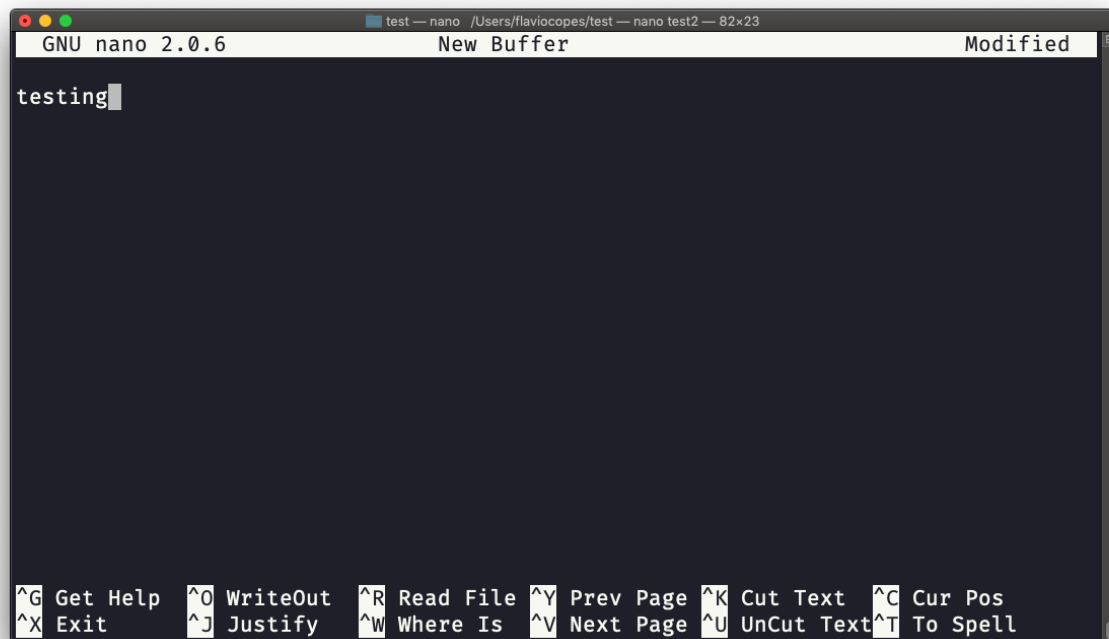
nano

`nano` is a beginner friendly editor.

Run it using `nano <filename> .`

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

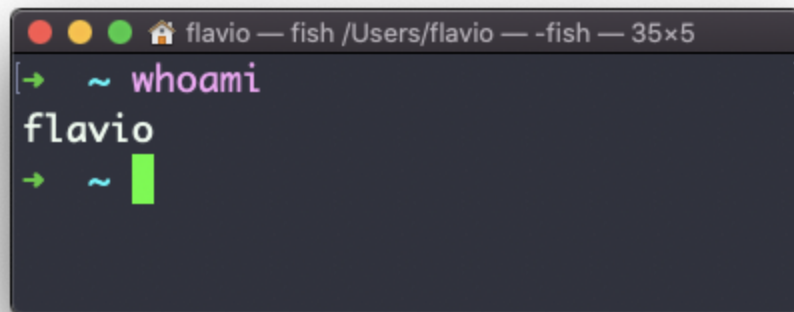
You can quit without editing using `ctrl-x` . If you edited the file buffer, the editor will ask you for confirmation and you can save the edits, or discard them. The help at the bottom shows you the keyboard commands that let you work with the file:



`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 terminal window with a dark background. The title bar shows three colored window control buttons (red, yellow, green) followed by a home icon and the text 'flavio — fish /Users/flavio — -fish — 35x5'. The terminal content shows a green prompt character followed by a blue tilde '~' and the command 'whoami' in purple. The output 'flavio' is printed in white. Below the output, there is another green prompt character followed by a blue tilde '~' and a green cursor block.

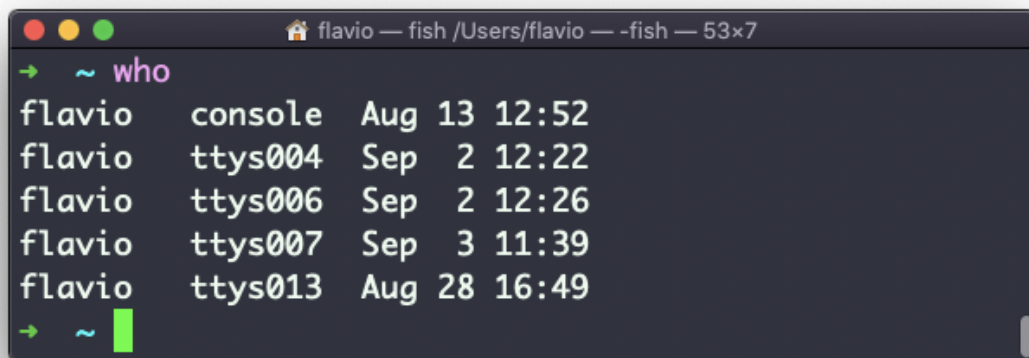
```
flavio — fish /Users/flavio — -fish — 35x5
[→ ~ whoami]
flavio
→ ~ █
```

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 terminal window titled 'flavio — fish /Users/flavio — -fish — 53x7'. The prompt is '~' followed by the command 'who' in pink. The output shows five lines of user login information for the user 'flavio'.

Username	Terminal	Date	Time
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

The prompt is '~' followed by a green cursor bar.

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.

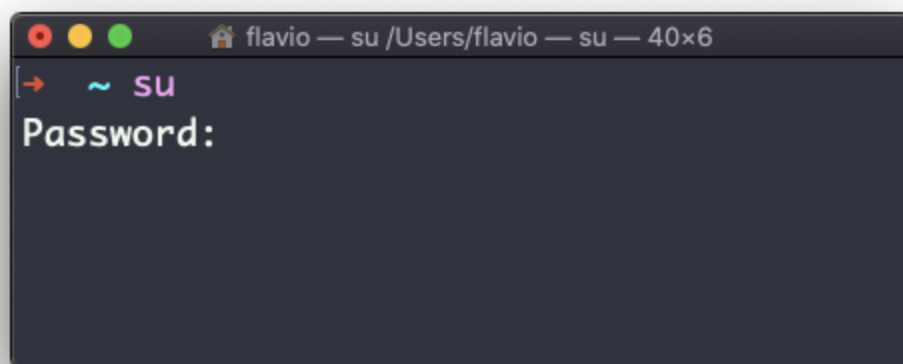
For example you're logged in as root to perform some maintenance, but then you want to switch to a user account.

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:

A terminal window with a dark background. The title bar shows a home icon, the name 'flavio', and the command 'sudo /Users/flavio — bash — 42x6'. The terminal content shows a prompt '→ ~ sudo -i', followed by 'Password:', and then the prompt 'mbp:~ root#'.

```
flavio — sudo /Users/flavio — bash — 42x6  
→ ~ 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

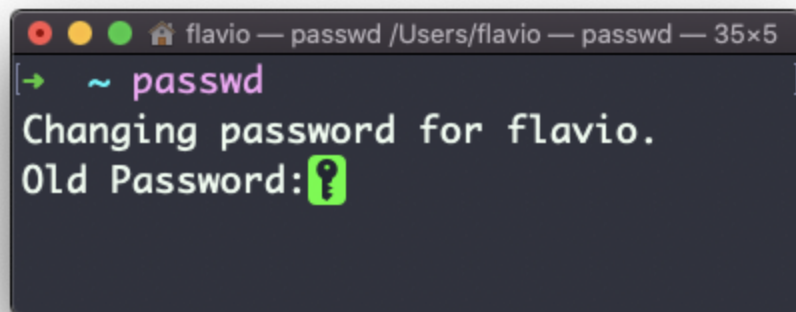
Users in Linux have a password assigned. You can change the password using the `passwd` command.

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>
```

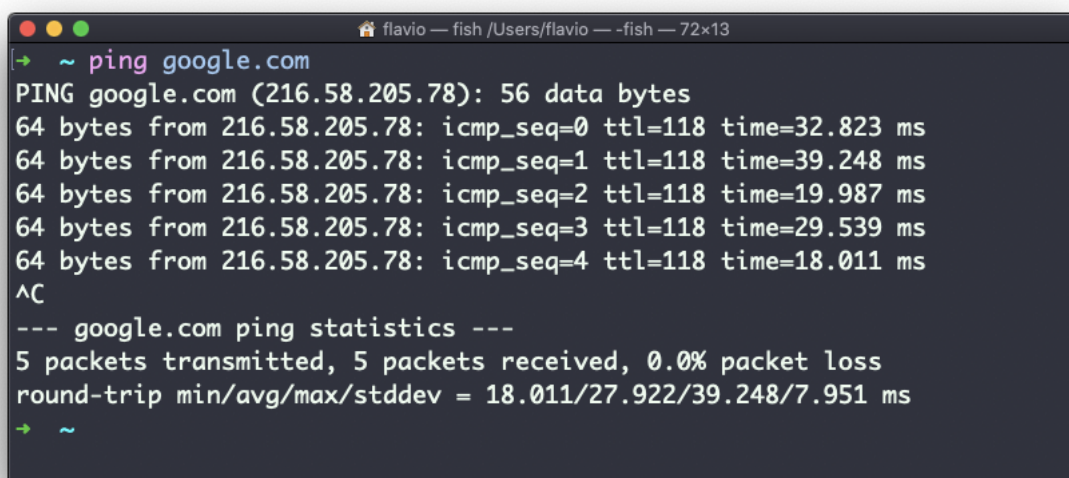
In this case you don't need to enter the old one.

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` :

A terminal window with a dark background and light text. The window title bar shows 'flavio — fish /Users/flavio — -fish — 72x13'. The prompt is '~'. The user has entered 'ping google.com'. The output shows the IP address 216.58.205.78 and five successful ping results with varying times. The user has pressed Ctrl-C, indicated by '^C'. The terminal then shows the statistics for the ping command.

```
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
~
```

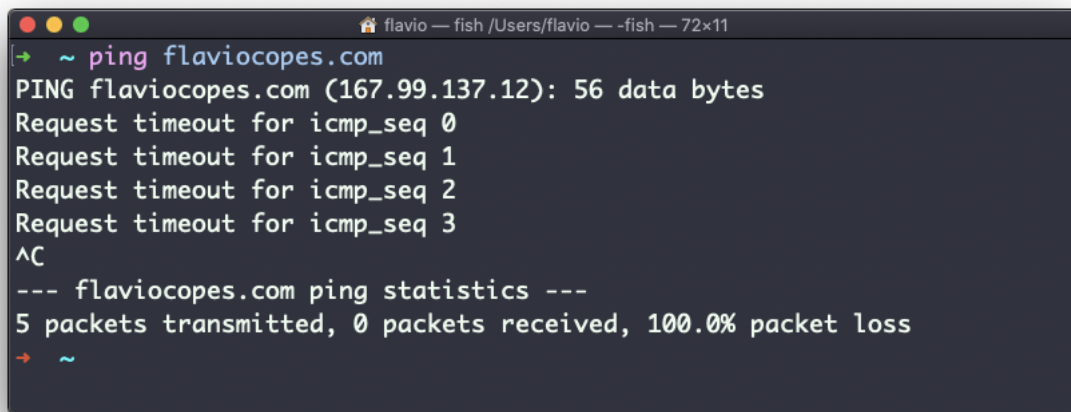
The command sends a request to the server, and the server returns a response.

`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:

A terminal window with a dark background and light text. The window title bar shows 'flavio — fish /Users/flavio — -fish — 72x11'. The prompt is '~'. The user has entered 'ping flaviocopes.com'. The output shows 'PING flaviocopes.com (167.99.137.12): 56 data bytes' followed by four 'Request timeout for icmp_seq 0' through 'icmp_seq 3'. The user has pressed Ctrl-C, indicated by '^C'. The terminal then shows '--- flaviocopes.com ping statistics ---' and '5 packets transmitted, 0 packets received, 100.0% packet loss'. The prompt is '~'.

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
```

```
flavio — fish /Users/flavio — -fish — 86x17
~ 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.

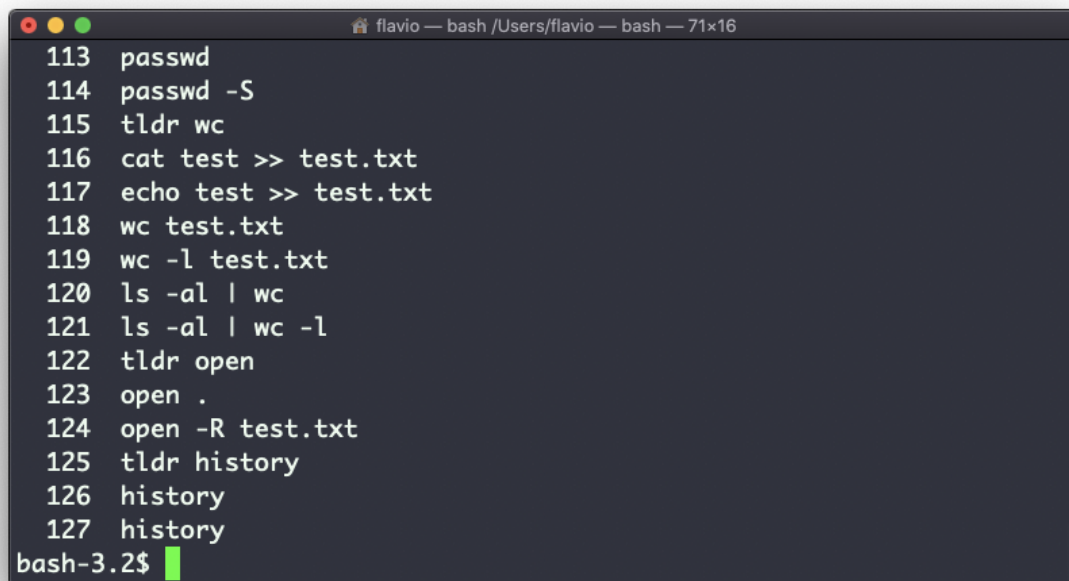
history

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 terminal window with a dark background and light text. The title bar at the top reads 'flavio — bash /Users/flavio — bash — 71x16'. The terminal displays a list of 15 commands, each preceded by a line number from 113 to 127. The commands are: passwd, passwd -S, tldr wc, cat test >> test.txt, echo test >> test.txt, wc test.txt, wc -l test.txt, ls -al | wc, ls -al | wc -l, tldr open, open ., open -R test.txt, tldr history, history, and history. The prompt 'bash-3.2\$' is visible at the bottom, followed by a green cursor bar.

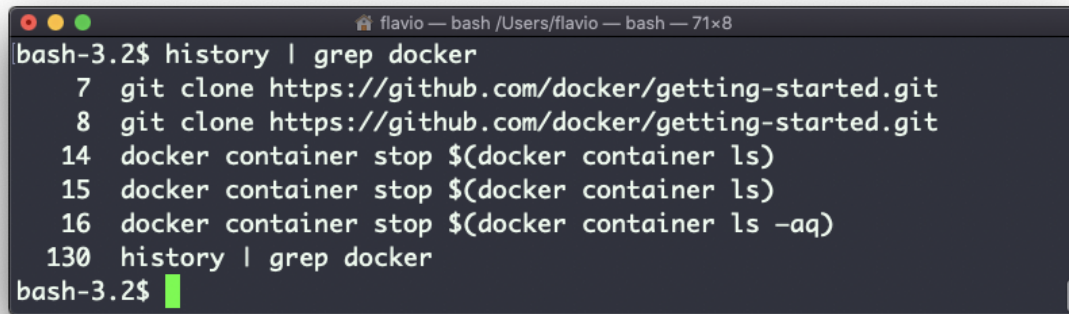
```
113 passwd
114 passwd -S
115 tldr wc
116 cat test >> test.txt
117 echo test >> test.txt
118 wc test.txt
119 wc -l test.txt
120 ls -al | wc
121 ls -al | wc -l
122 tldr open
123 open .
124 open -R test.txt
125 tldr history
126 history
127 history
bash-3.2$
```

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 terminal window titled 'flavio — bash /Users/flavio — bash — 71x8' showing the output of the command 'history | grep docker'. The output lists several commands from the history, including 'git clone' and 'docker container stop', with line numbers 7, 8, 14, 15, 16, and 130. The prompt 'bash-3.2\$' is visible at the bottom.

```
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

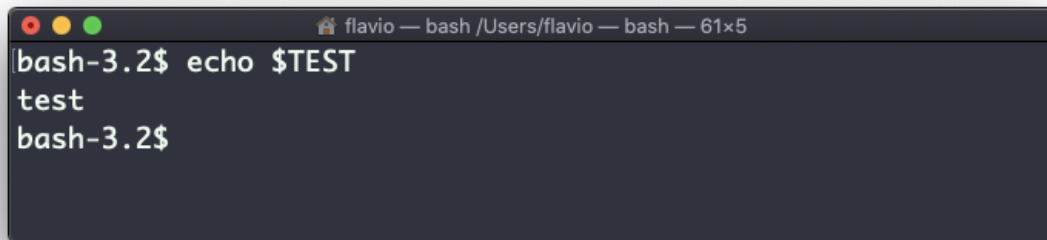
The `export` command is used to export variables to child processes.

What does this mean?

Suppose you have a variable `TEST` defined in this way:

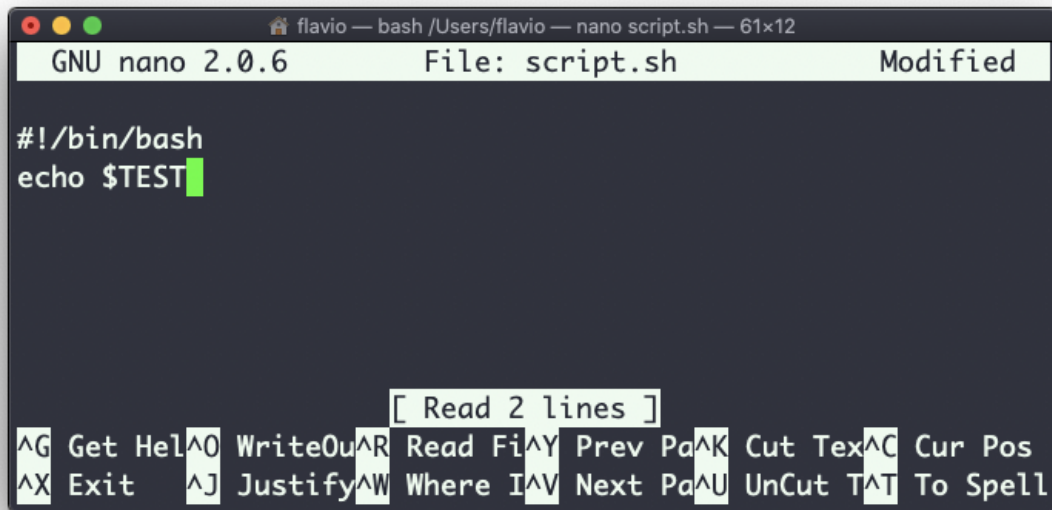
```
TEST="test"
```

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

A terminal window with a dark background and light text. The title bar at the top shows a home icon, the name 'flavio', and the path 'bash /Users/flavio — bash — 61x5'. The terminal content shows three lines: 'bash-3.2\$ echo \$TEST', 'test', and 'bash-3.2\$'.

```
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 Write Out ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit     ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^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.

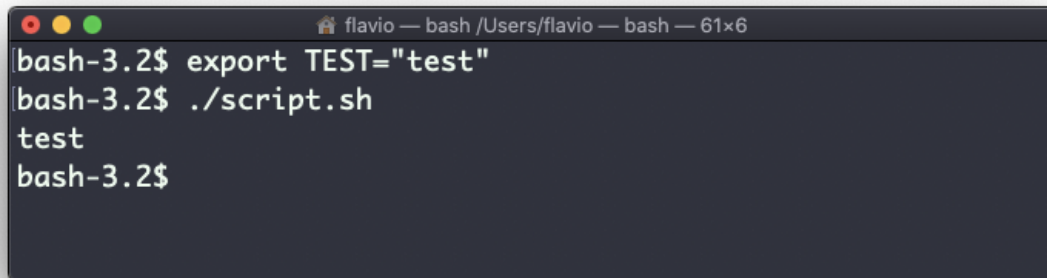
To make the variable available there we need to define `TEST` not in this way:

```
TEST="test"
```

but in this way:

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


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

A terminal window with a dark background and light text. The window title bar shows 'flavio — bash /Users/flavio — bash — 61x6'. The terminal content shows a sequence of commands and their output: 'bash-3.2\$ export TEST="test"', 'bash-3.2\$./script.sh', 'test', and '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

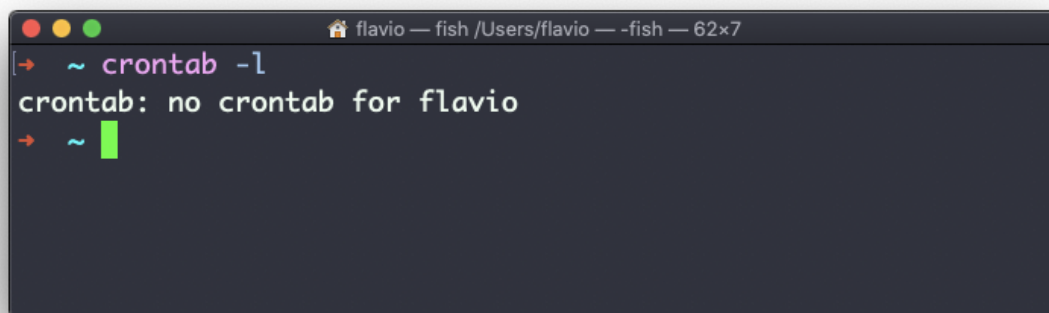
Cron jobs are jobs that are scheduled to run at specific intervals. You might have a command perform something every hour, or every day, or every 2 weeks. Or on weekends. They are very powerful, especially on servers to perform maintenance and automations.

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 terminal window with a dark background and light text. The title bar shows 'flavio — fish /Users/flavio — -fish — 62x7'. The prompt is '~' followed by a green cursor. The command 'crontab -l' is entered. The output is 'crontab: no crontab for flavio'. The prompt is '~' followed by a green cursor.

```
flavio — fish /Users/flavio — -fish — 62x7
[~] ~ crontab -l
crontab: no crontab for flavio
[~] ~
```

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 website in a web browser. The page has a title "Crontab Generator" and a navigation bar. Below the title, there is a blue banner with a tip: "Get frustrated with Cron on your server? Try our [Webcron Service](#)." The main content area explains how to use the generator and provides instructions for Method 1 (online cron job service) and Method 2 (Cron available in Unix/Linux systems). It then prompts the user to "Complete the following form to generate a crontab line". The form consists of five sections: Minutes, Hours, Days, Months, and Weekday. Each section has radio buttons for different intervals and a dropdown menu for specific values. The "Command To Execute" field is at the bottom, with a text area for the command and a "Command Examples" section showing an example command: `/usr/bin/php /home/username/public_html/cron.php`.

Crontab Generator

Get frustrated with Cron on your server? Try our [Webcron Service](#).

If you want to periodically perform a task (e.g. sending E-mails, 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.

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.

Complete the following form to generate a crontab line

Ctrl-click (or command-click on the Mac) to select multiple entries

Minutes

- ☒ Every Minute
- ☐ Even Minutes
- ☐ Odd Minutes
- ☐ Every 5 Minutes
- ☐ Every 15 Minutes
- ☐ Every 30 Minutes

0 1 2 3 4 5 6 7 8 9

Hours

- ☒ Every Hour
- ☐ Even Hours
- ☐ Odd Hours
- ☐ Every 6 Hours
- ☐ Every 12 Hours

Midnight 1am 2am 3am 4am 5am 6am 7am 8am 9am

Days

- ☒ Every Day
- ☐ Even Days
- ☐ Odd Days
- ☐ Every 5 Days
- ☐ Every 10 Days
- ☐ Every Half Month

1 2 3 4 5 6 7 8 9 10

Months

- ☒ Every Month
- ☐ Even Months
- ☐ Odd Months
- ☐ Every 4 Months
- ☐ Every Half Year

Jan Feb Mar Apr May Jun Jul Aug Sep Oct

Weekday

- ☒ Every Weekday
- ☐ Monday-Friday
- ☐ Weekend Days

Sun Mon Tue Wed Thu Fri Sat

Command To Execute

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:

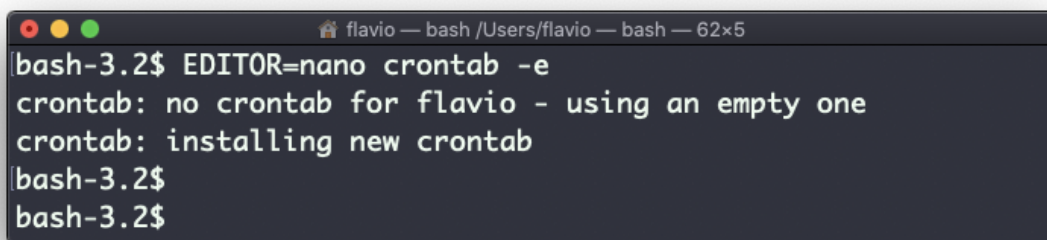
```
* */12 * * * /Users/flavio/test.sh >/dev/null 2>&1
```

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:

A terminal window titled 'flavio — bash /Users/flavio — bash — 62x5' showing the execution of 'EDITOR=nano crontab -e'. The output shows 'crontab: no crontab for flavio - using an empty one' and 'crontab: installing new crontab'. The prompt 'bash-3.2\$' is shown twice.

```
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
```

A terminal window with a dark background and light text. The title bar at the top shows a home icon, the name 'flavio', and the path 'bash /Users/flavio' followed by 'bash' and '61x8'. The terminal content shows a prompt 'bash-3.2\$' followed by the command 'crontab -l'. The output is a single line: '* */12 * * * /Users/flavio/test.sh >/dev/null 2>&1'. Below this, the prompt 'bash-3.2\$' is shown again with a green cursor bar.

```
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:

```
flavio — bash /Users/flavio — nano • crontab — 61x8
GNU nano 2.0.6 File: /tmp/crontab.j0t2KZjmTC Modified

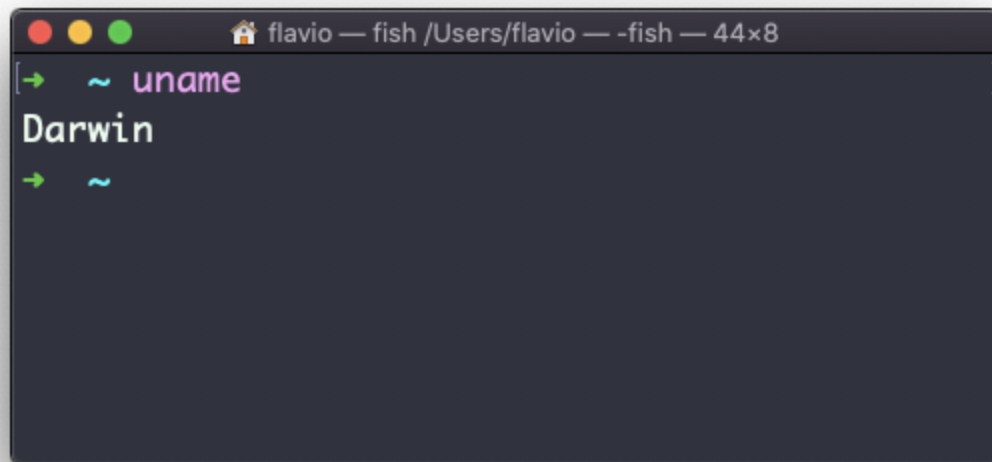
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
Y Yes
N No ^C Cancel
```

```
flavio — bash /Users/flavio — bash — 61x8
bash-3.2$ EDITOR=nano crontab -e
crontab: installing new crontab
bash-3.2$ crontab -l

bash-3.2$
```

uname

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

A terminal window with a dark background and light-colored text. The window title bar shows a home icon, the name 'flavio', and the path 'fish /Users/flavio'. The terminal content shows a prompt '→ ~' followed by the command 'uname' in pink. The output 'Darwin' is displayed in white. Below the output, another prompt '→ ~' is visible.

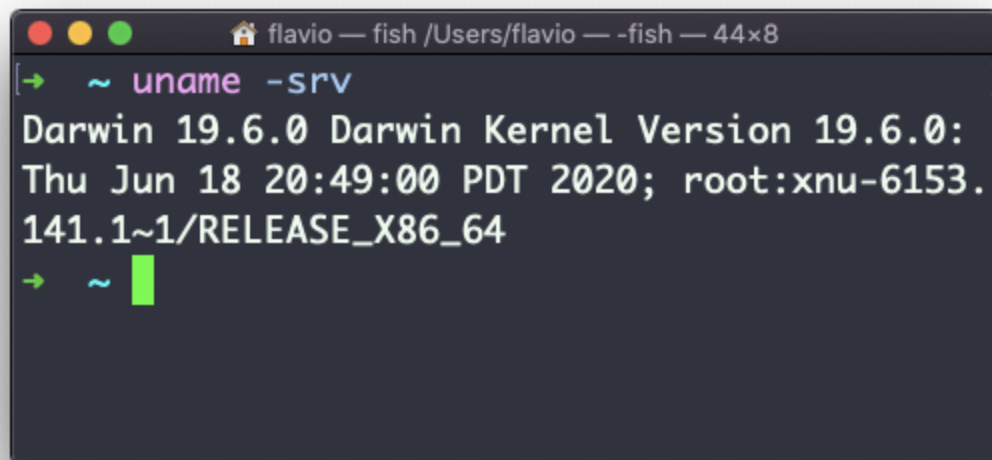
```
flavio — fish /Users/flavio — -fish — 44x8  
→ ~ uname  
Darwin  
→ ~
```

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):

A terminal window with a dark background and light-colored text. The window title bar shows a home icon, the name 'flavio', and the path 'fish /Users/flavio'. The prompt is '~'. The command 'uname -mp' has been entered and executed, resulting in the output 'x86_64 i386'. The prompt is now '~' followed by a green cursor.

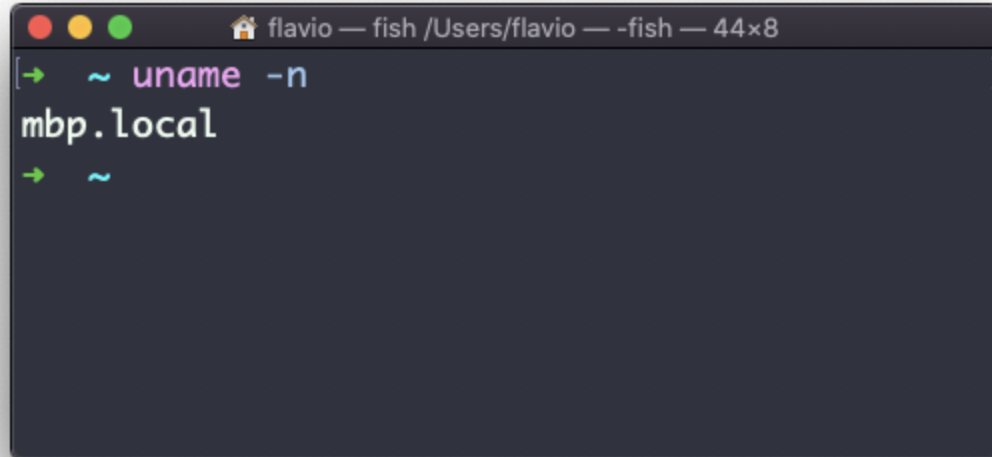
```
flavio — fish /Users/flavio — -fish — 44x8
→ ~ uname -mp
x86_64 i386
→ ~
```

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

A terminal window with a dark background and light-colored text. The window title bar shows a home icon, the name 'flavio', and the path 'fish /Users/flavio'. The prompt is '~'. The command 'uname -srv' has been entered and executed, resulting in 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 prompt is now '~' followed by a green cursor.

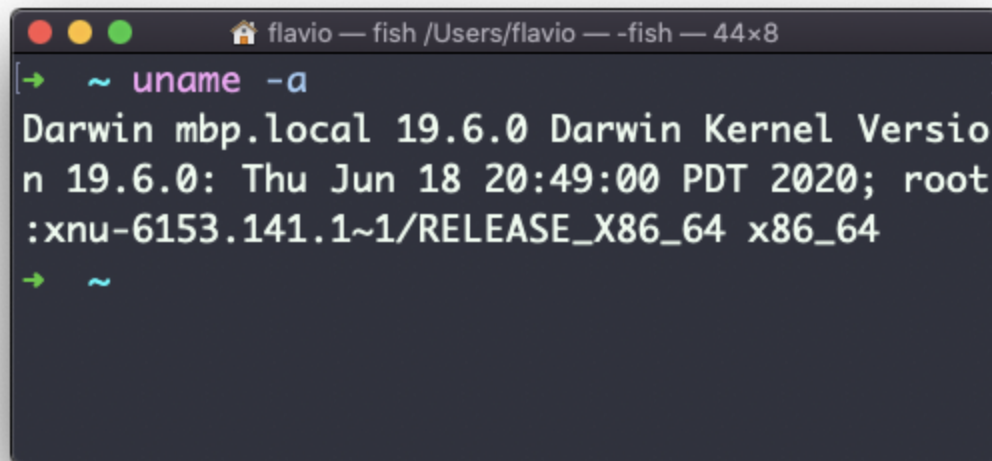
```
flavio — fish /Users/flavio — -fish — 44x8
→ ~ uname -srv
Darwin 19.6.0 Darwin Kernel Version 19.6.0:
Thu Jun 18 20:49:00 PDT 2020; root:xnu-6153.
141.1~1/RELEASE_X86_64
→ ~
```

The `n` option prints the node network name:

A terminal window titled 'flavio — fish /Users/flavio — -fish — 44x8'. The prompt is '~'. The command 'uname -n' is entered and executed, resulting in the output 'mbp.local'. The prompt returns to '~'.

```
[→ ~] uname -n
mbp.local
[→ ~]
```

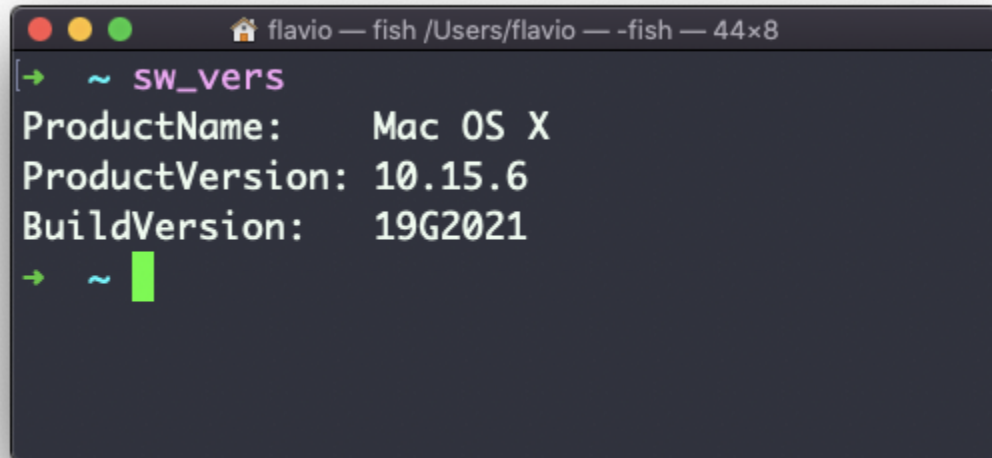
The `a` option prints all the information available:

A terminal window titled 'flavio — fish /Users/flavio — -fish — 44x8'. The prompt is '~'. The command 'uname -a' is entered and executed, resulting in the output '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'. The prompt returns to '~'.

```
[→ ~] 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
```

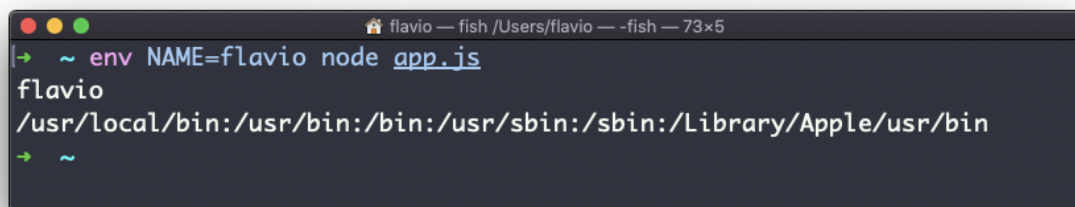
You can pass an env variable:

```
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 terminal window with a dark background and light text. The title bar shows 'flavio — fish /Users/flavio — -fish — 73x5'. The prompt is '~'. The command entered is 'env NAME=flavio node app.js'. The output shows 'flavio' on the first line and the PATH environment variable on the second line: '/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin'. The prompt is '~'.

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.

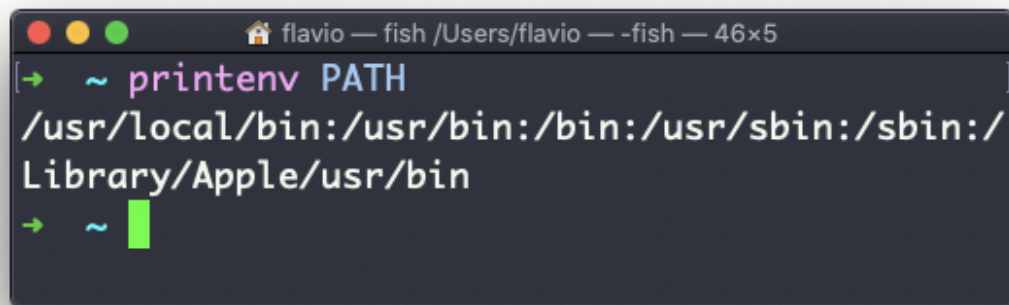
You can print them all to the terminal using the `printenv` command. The output will be something like this:

```
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
```

A terminal window with a dark background and light text. The title bar at the top shows three colored window control buttons (red, yellow, green) on the left, followed by a home icon and the text "flavio — fish /Users/flavio — -fish — 46x5". The terminal content shows a command prompt "→ ~" followed by the command "printenv PATH" in a light blue font. The output of the command is displayed on the next line: "/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/Apple/usr/bin". Below the output, another command prompt "→ ~" is shown with a green cursor block.

```
flavio — fish /Users/flavio — -fish — 46x5  
→ ~ printenv PATH  
/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/  
Library/Apple/usr/bin  
→ ~ █
```


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