{POWER.CODERS}

Intro to the Command Line

Contents

Introduction to the Internet

Key facts

- ~18 billion connected devices in 2017 -> 75 billion in 2025 -> 500 billion in 2030
- 4 exabytes of daily traffic in 2017 -> 463 exabytes in 2025
  (exabyte ≈ 1000^3 GB)
- 82% of traffic video streams

Internet is a fragile place

- Data is lost all the time
- Connections are dropped daily
- Whole countries loose connection

Simple mistakes can have tremendous effects on the internet as a whole.

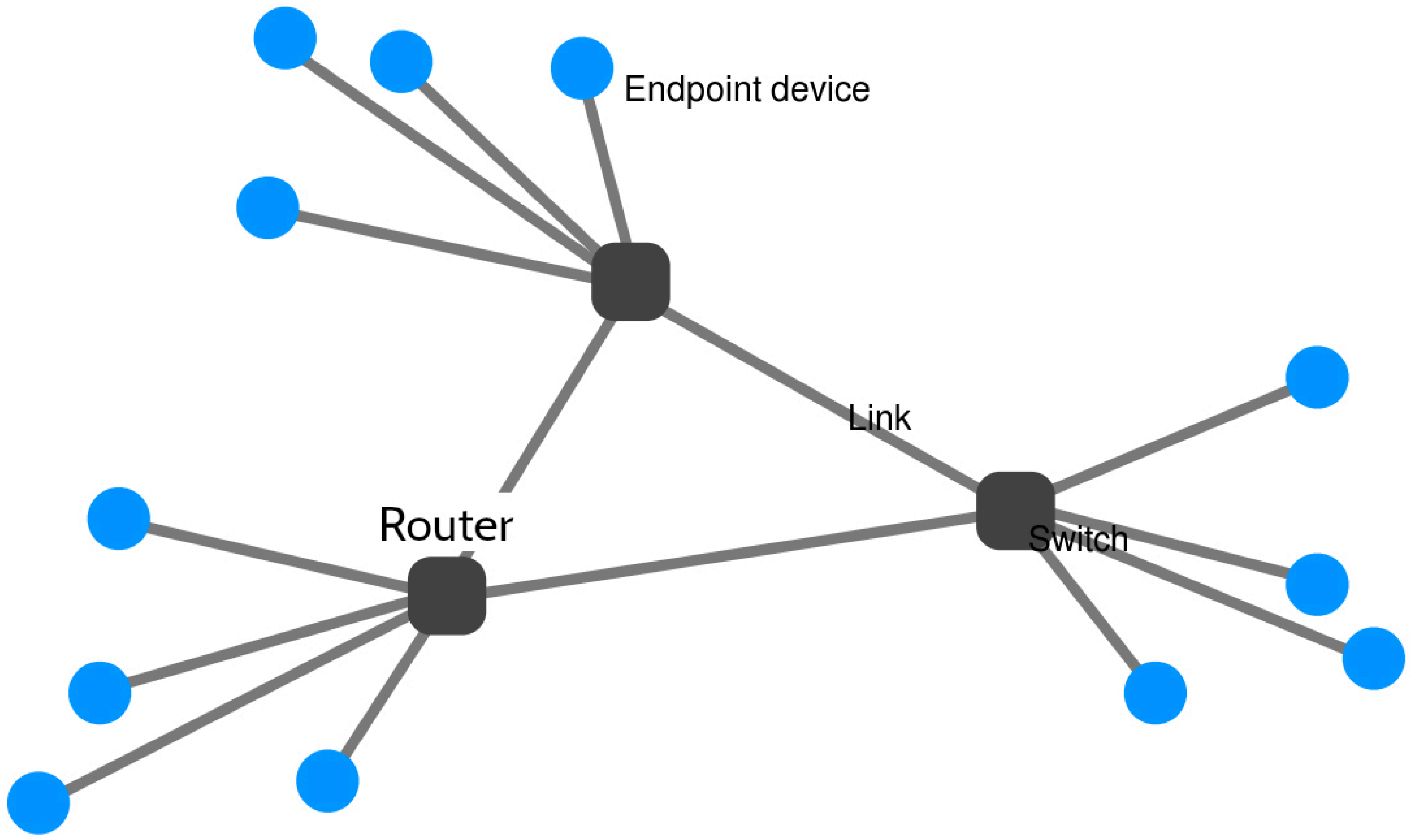
In 2017 one single google engineer made a mistake resulting in a loss of internet for Japan for a couple hours

What is the internet?

It is a network of networks

... and it is HUGE.

What is a network made of?


Endpoint device
Link
Router
Switch

What is a network made of?

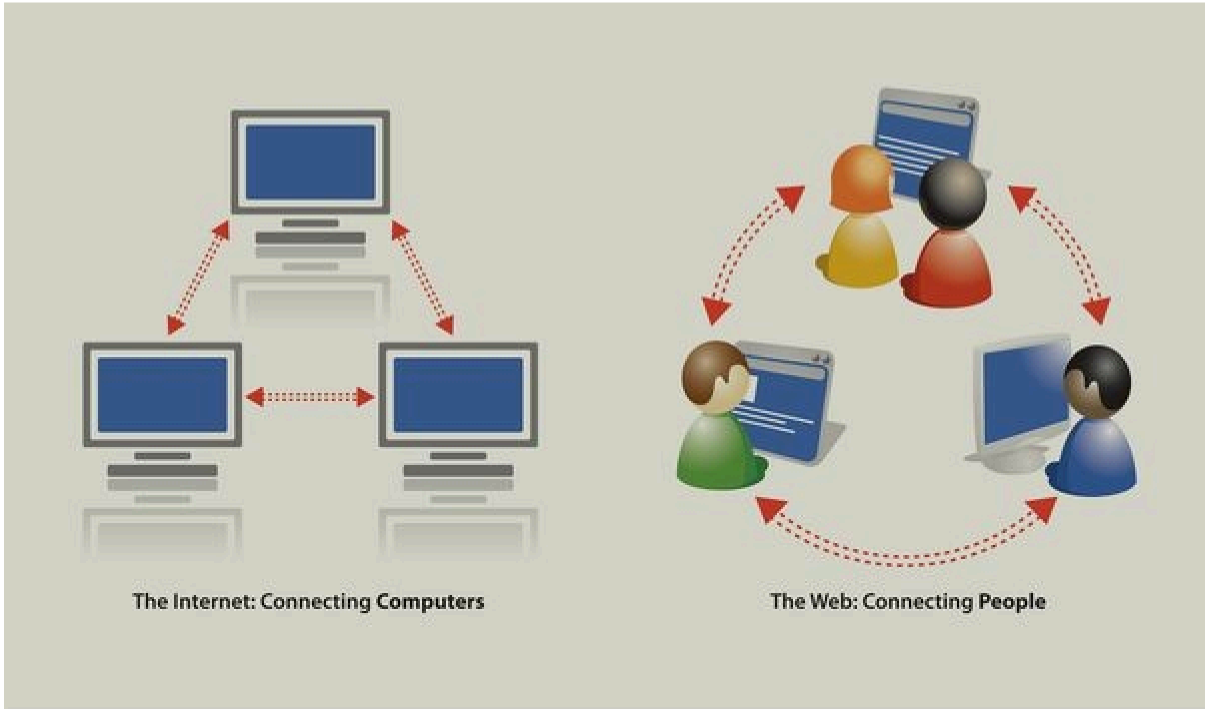
- **Endpoint devices** e.g. computers, mobile phones, medical devices, smart TVs, anything with an internet connection
- **Links** e.g. the air (WiFi), copper cables, fiber cables
  submarinecablemap.com
- **Switches** connect devices within a network
- **Router** connect multiple networks together

Why do we care how the internet works?

When you create websites you should have basic knowledge of the environment you build it for. And you should be aware how important security and performance are.

Browsing the web

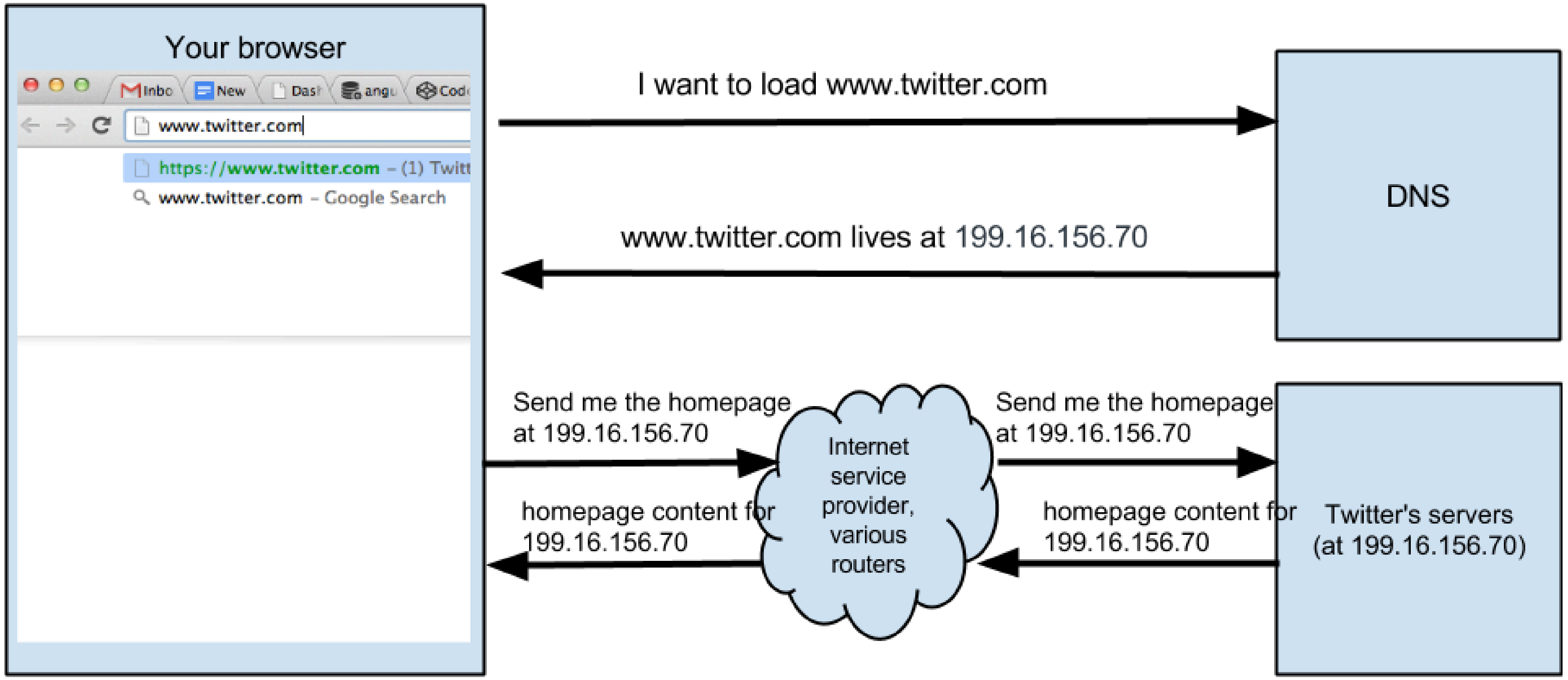
Internet vs Web?


The Internet: Connecting Computers
The Web: Connecting People

Internet vs Web?

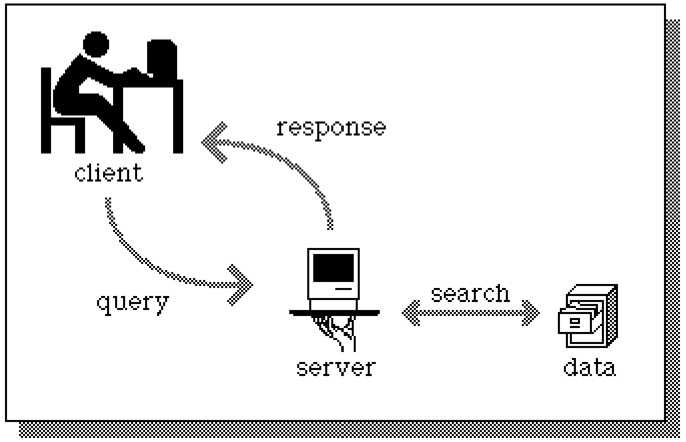
Internet:
Network of networks. Global network of interconnected computers that communicate via **TCP/IP**.

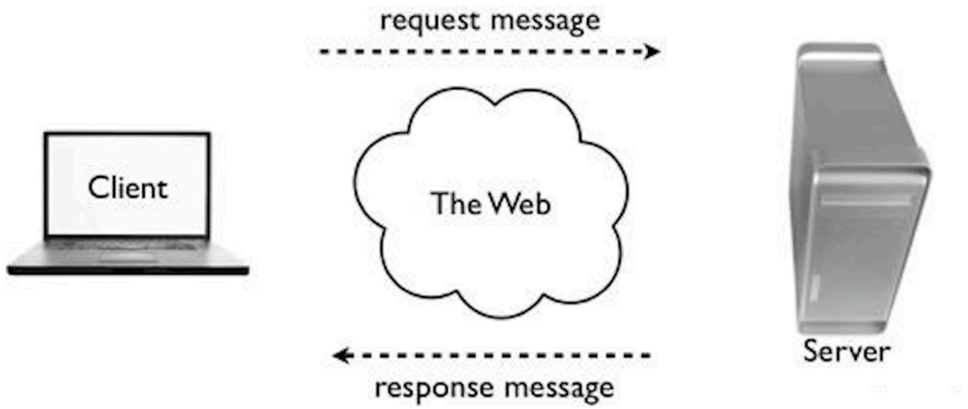
Web:
The world wide web is an information system where documents and other resources are available over the internet. Documents are transfrerred via **HTTP/S**.


Your browser
Inbo
New
Dash
angu
Code
www.twitter.com
https://www.twitter.com – (1) Twitt
www.twitter.com – Google Search
I want to load www.twitter.com
DNS
www.twitter.com lives at 199.16.156.70
Send me the homepage at 199.16.156.70
homepage content for 199.16.156.70
Internet service provider, various routers
Send me the homepage at 199.16.156.70
homepage content for 199.16.156.70
Twitter's servers (at 199.16.156.70)

Clients and Servers

How your computer accesses websites





- Computers communicating with each other with **REQUESTS/QUERIES** and **RESPONSES**
- Computers can be **CLIENTS** or **SERVERS**

Request

or QUERY contains instructions detailing the

- **Protocol**: Which protocol to use to retrieve the content
  `https://`
- **Domain**: The web address of the server to send the request to
  `powercoders.org`
- **Action**: What it wants the server to do
  `GET`
- **Path**: What it wants from the server
  `/volunteer/it-trainer/`

results in an URL: https://powercoders.org/volunteer/it-trainer/

URL PROTOCOL

Which protocol to use depends on what content and result is expected

- **http**: **h**yper**t**ext **t**ransfer **p**rotocol
  Used for websites, transfers html, css, images and text
- **https**: **h**yper**t**ext **t**ransfer **p**rotocol **s**ecure
  Commonly used for websites, with encrpytion
- **ftp**: **f**ile **t**ransfer **p**rotocol
  Used to transfer computer files between client and server
- **mailto**: email protocol
  Triggers an email client and creates a new email
- **tel**: phone protocol
  Triggers an external phone client and creates a new call via voice over IP

Domain

Anatomy of domain names:

subdomain.domain.topleveldomain

- powercoders.org
- www.gmail.com
- calendar.google.com

Domain name system (DNS)

Translates domain names into the IP addresses that allow machines to communicate with one another.

Look up powercoders's IP address by typing into VSC Terminal:

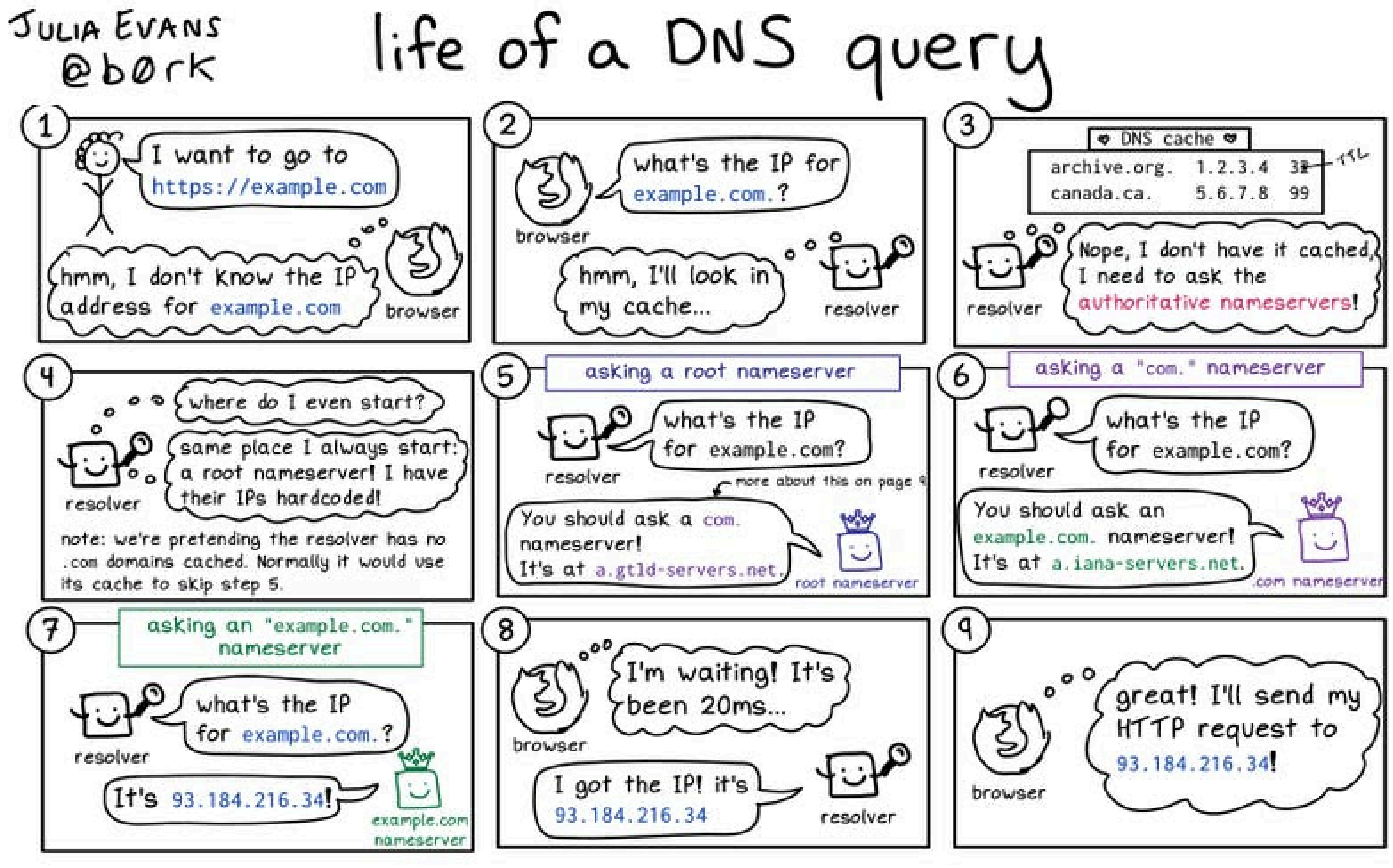
```
nslookup powercoders.org
```

How does it work?

Short recap: Websites are stored on web/hosting servers.

Web servers are often large computers connected to a network.

1. Type a web address (=URL) into the address bar
2. DNS connects you to the hosting server
3. Files are then sent back to your computer for display



JULIA EVANS
@b0rk
life of a DNS query
1
I want to go to https://example.com
hmm, I don't know the IP address for example.com
browser
2
browser
what's the IP for example.com.?
hmm, I'll look in my cache...
resolver
3
♥ DNS cache ♥
archive.org. 1.2.3.4 ~~32~~ ← TTL
canada.ca. 5.6.7.8 99
resolver
Nope, I don't have it cached, I need to ask the authoritative nameservers!
4
where do I even start?
same place I always start: a root nameserver! I have their IPs hardcoded!
resolver
note: we're pretending the resolver has no .com domains cached. Normally it would use its cache to skip step 5.
5
asking a root nameserver
resolver
what's the IP for example.com?
more about this on page 9
You should ask a com. nameserver! It's at a.gtld-servers.net.
root nameserver
6
asking a "com." nameserver
resolver
what's the IP for example.com?
You should ask an example.com. nameserver! It's at a.iana-servers.net.
.com nameserver
7
asking an "example.com." nameserver
resolver
what's the IP for example.com.?
It's 93.184.216.34!
example.com nameserver
8
browser
I'm waiting! It's been 20ms...
I got the IP! it's 93.184.216.34
resolver
9
browser
great! I'll send my HTTP request to 93.184.216.34!

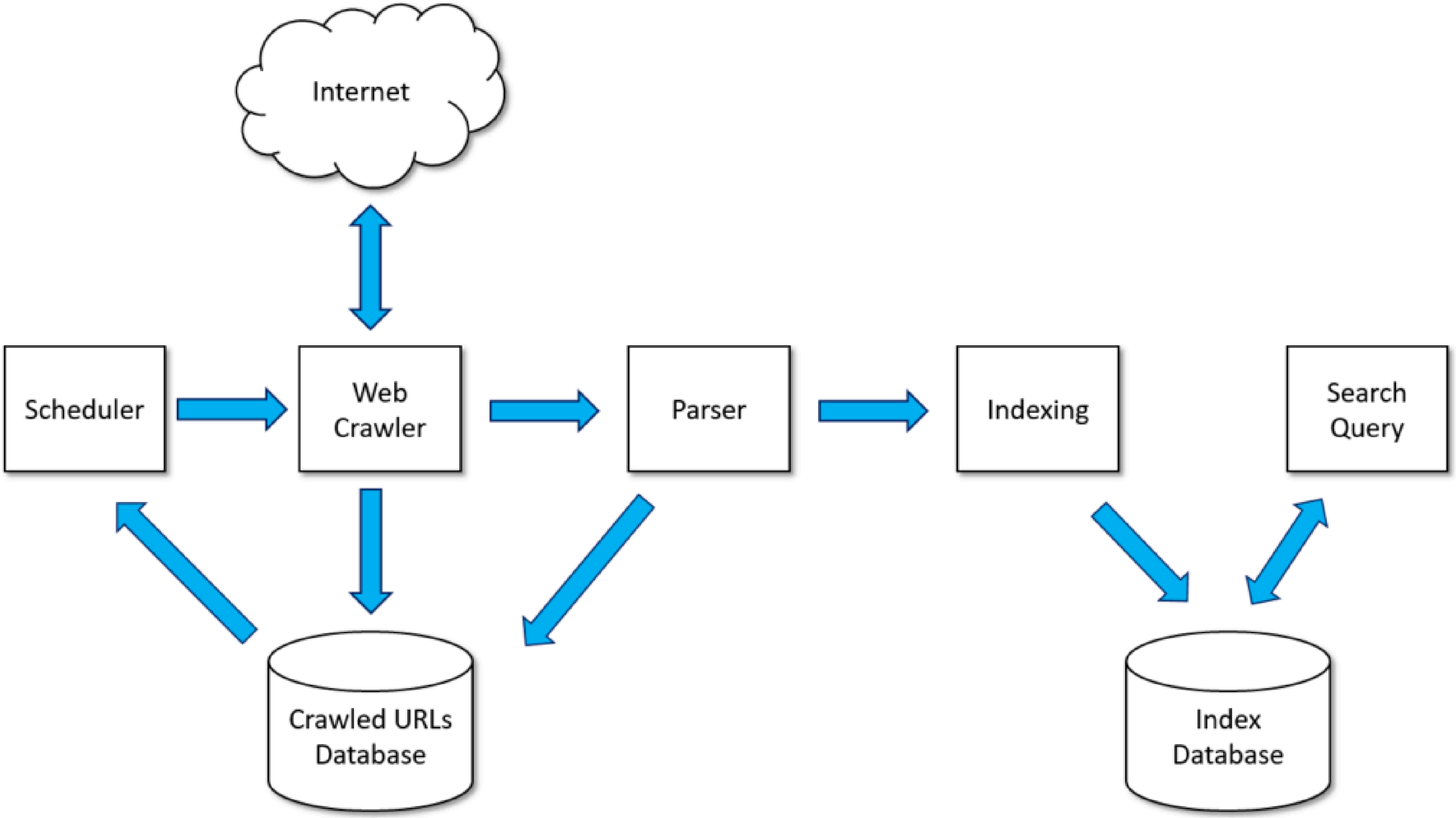
Intro to search engines

How to google

Search engines exist to **discover, understand, and organize** the internet's content in order to offer the **most relevant results to the questions** searchers are asking.

How do search engines work?

- **Crawling**: search engine bots discover new and changed content, always following links.
- **Indexing**: search engines store the found data in huge databases. Once a webpage is indexed, it can be displayed as a search engines result.
- **Ranking**: then the results of a search engine are ordered by relevance to answer the searcher's query.


Internet
Scheduler
Web Crawler
Parser
Indexing
Search Query
Crawled URLs Database
Index Database

How to search

- Search in English more results
- Use more than one word e.g. how to learn programming
- Give context e.g. go programming language
- Be precise e.g. go programming language for absolute beginners
- Use operators e.g. "math operators" javascript -jquery
- Check dates and up-to-dateness
- Use more than one source
- Search also images, scholar or books

Exercise 1

You want to find a co-working space nearby. You need to do some research online first.

Exercise 2

You want to learn Python and you are looking for the course / book / tutorial that fits your needs best.

Command line

From the beginning ...

- `Machine` is the physical computer and hardware (disks, keyboard, etc)
- It runs an `Operating System`, which manages access to everything
- You interact with the OS through the `shell` (user interface)
- You use the shell to tell the operating system which programs to run and it runs them
- The shell is just another program

Two types of Shell

- Graphical (GUI = Graphical User Interface)
- Command line

  aka

  - Terminal
  - Command prompt
  - Console
  - CLI

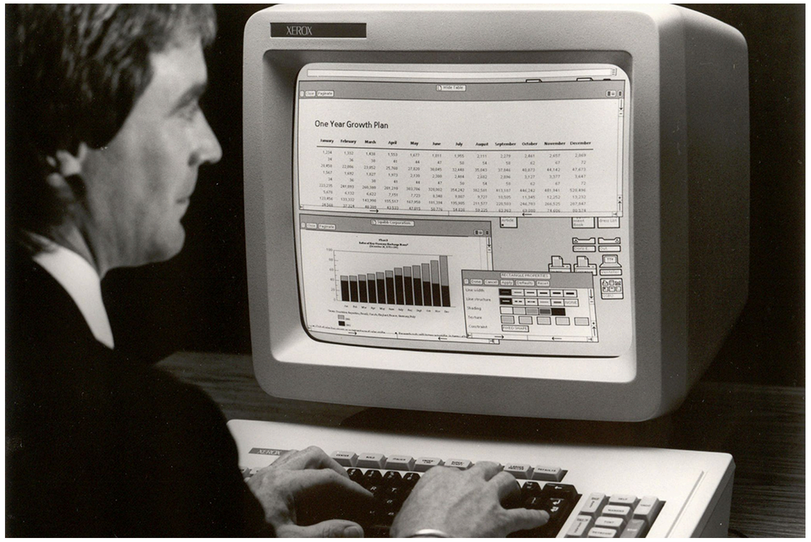
The history of CLI

- In the 1960s CLI was the standard user interface
- CLI was the only way to communicate with the computer
- Wrong commands in the CLI often resulted in deleted data (= bad user experience)

?

GUI (Graphical User Interface)

- 10 years later the computer mouse changed everything
- The interaction with the computer moved to point-and-click, a lot saver for the average user
- Operating systems started to offer a **G**raphical **u**ser **i**nterface



And so when will I use CLI?

In general you might use the command line to...

- Work with files and directories
- Open and close programs
- Manage computer processes
- Perform repetitive tasks
- Handle networking (remember `nslookup`)
- Use version control (like Git)

CLI on Windows vs. Mac

Depending on the operating system different default shells are installed.

Depending on the shell the syntax is different and not every command works everywhere.

- `Bash` (**B**orn **a**gain **sh**ell) is the popular default shell on Linux and macOS.
- Windows uses `PowerShell` and `cmd.exe`, 2 different shells with their own syntax.
- We already installed `zsh` as our preferred shell.

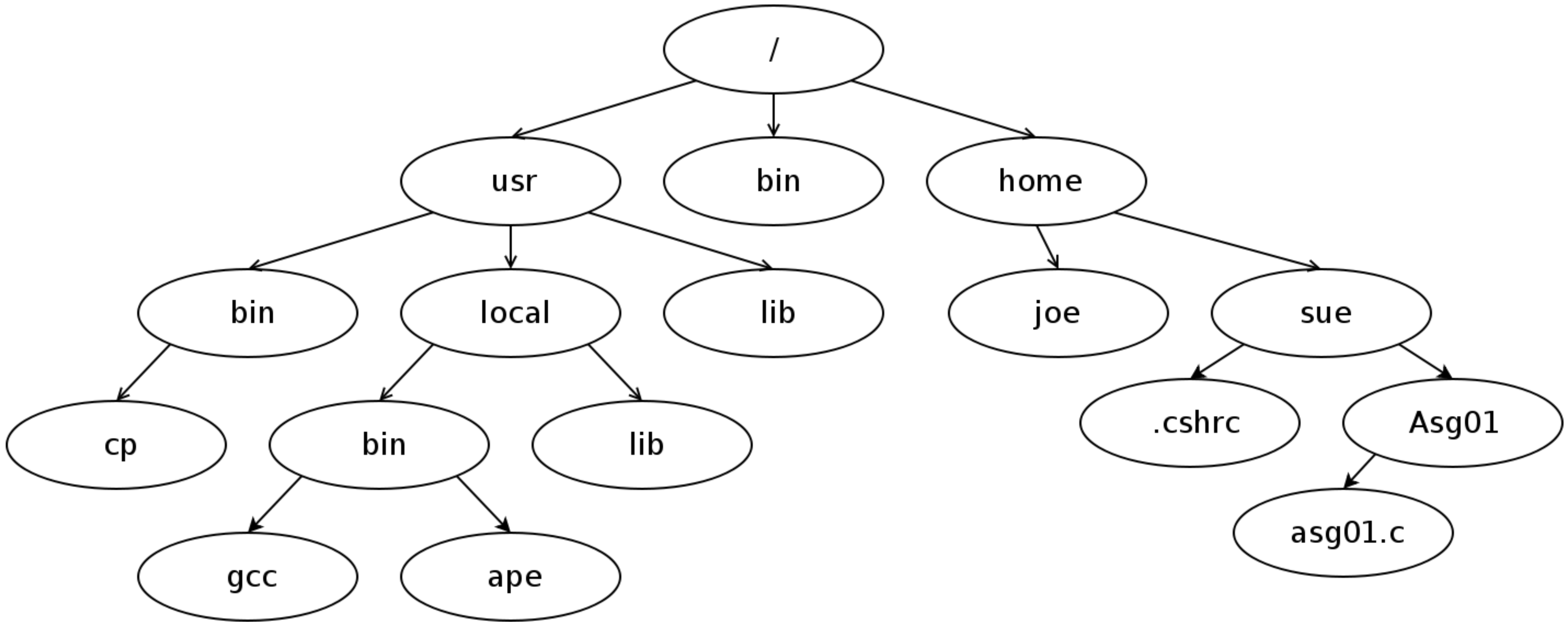
Directories

Also referred to as "folders".

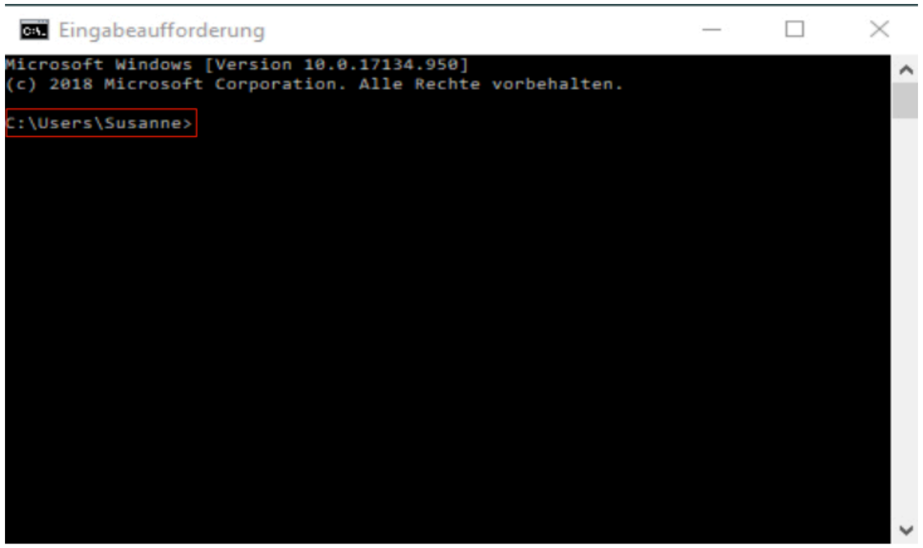
A directory is a container for files, or other directories.

Directory Trees

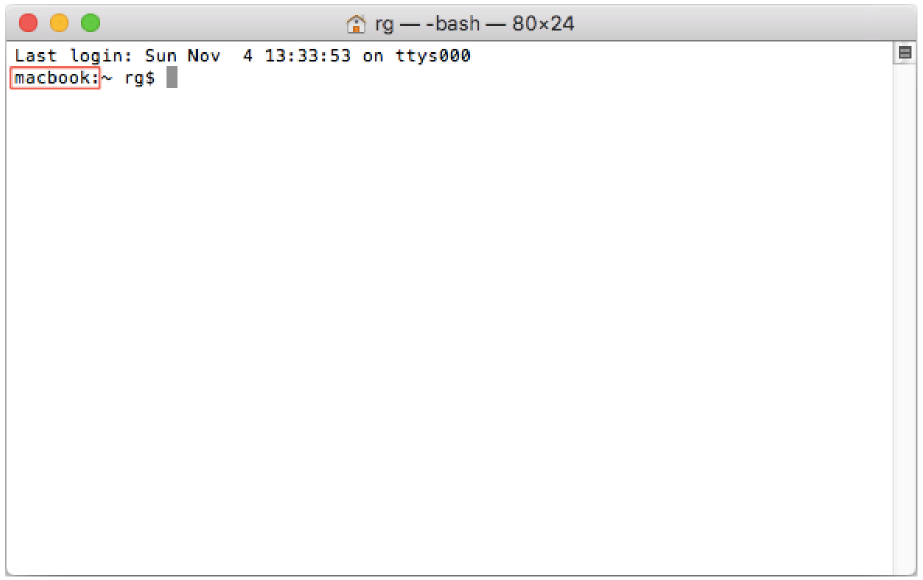
At the very top of the tree is the root folder.



Prompt



```
Microsoft Windows [Version 10.0.17134.950]
(c) 2018 Microsoft Corporation. Alle Rechte vorbehalten.

C:\Users\Susanne>
```



```
Last login: Sun Nov  4 13:33:53 on ttys000
macbook:~ rg$
```

Prompt

Usually shows your username and computer name.

Indicates that the terminal is ready for a command.

Cursor

Indicates your current spot in the terminal.

Shows you where the stuff you type will go.

Commands

- `cd`: change directory
- `ls`: list all the files
- `mkdir`: make directory
- `rmdir`: remove/delete directory
- `touch`: create a file
- `rm`: remove a file
- `pwd`: find out the file path of current directory you are in, from the root

Commands & Arguments

Many commands take one or more **arguments**, which come after the command, and give detail about what the command should do.

For example, `echo` takes an argument representing the text to be repeated.

```
$ echo "This is an argument."
```

Shortcuts

- Current Directory: `.`
- Parent Directory: `..`
- Home Directory: `~`
- Previous Directory: `-`

Bonus: Drag a folder into the terminal to show its path.

(Only works in Visual Studio Code in Windows.)

Tab Completion

Tab completion autocompletes commands and filenames.

- Pressing **tab** once, autocompletes a unique instance.
- If there's more than one possible completion, pressing **tab** twice gives you all the options available.

Tutorials

- Windows: 1 hour playlist of tutorial videos
- OS X: Learn the command line
- Both: Introduction to the CLI

Try it yourself!

Try It: Your First Commands

1. Open your terminal.
2. Type `echo hello` into your terminal and press **enter**.
3. Type `pwd` into your terminal and press **enter**.
4. Type `clear` into your terminal and press **enter**.

If you are stuck somewhere, try `Ctrl + C` to get back to your entry cursor.

`clear`

The `clear` command clears the contents of the terminal and issues a prompt.

This is good for removing previous output that is unnecessary to the task at hand.

Feel free to use this whenever things get too cluttered.

Working with Directories

The Current Directory

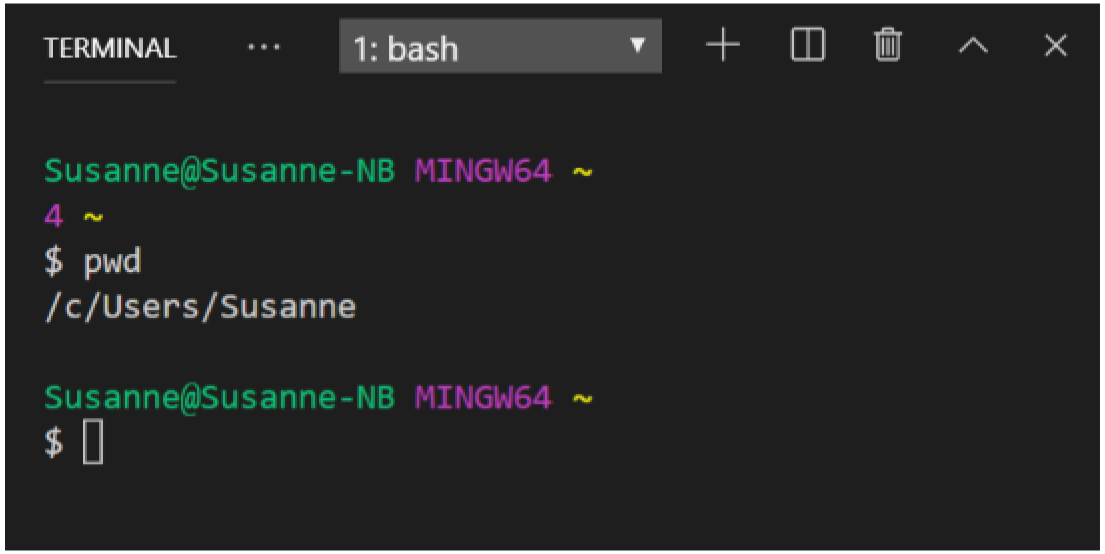
`pwd`

(Print Working Directory)

Type it whenever you want to see what directory (folder) you're in.

pwd

(Print Working Directory)



```
Susanne@Susanne-NB MINGW64 ~
4 ~
$ pwd
/c/Users/Susanne

Susanne@Susanne-NB MINGW64 ~
$ 
```

Paths

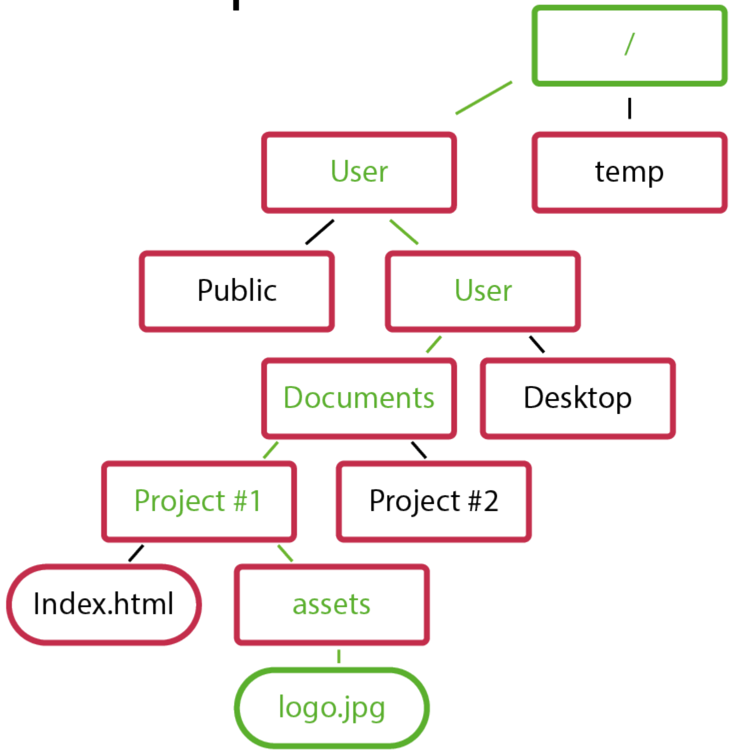
Nested files and directories can be referenced using **paths**.

Each directory or file is separated by a forward slash `/`

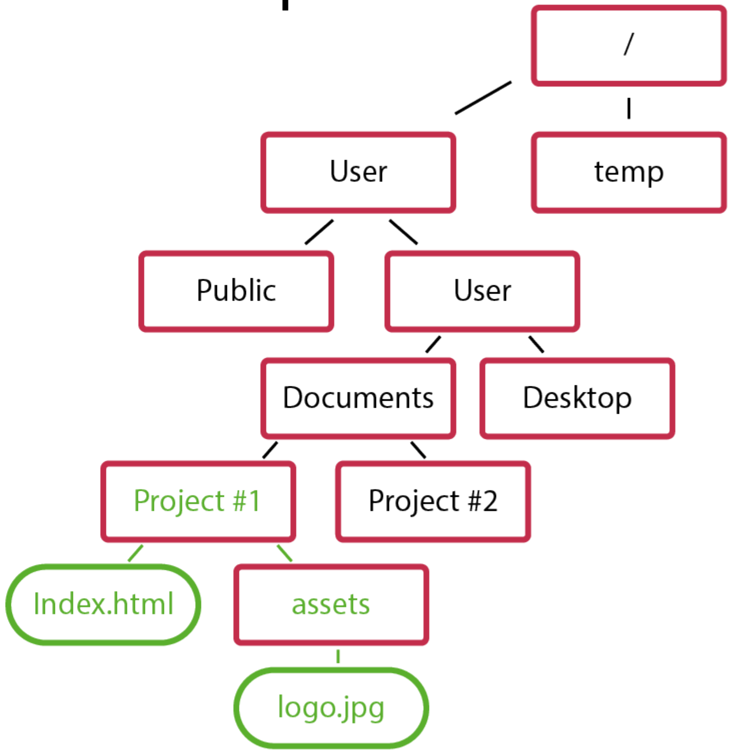
There are two kinds of paths:

- Relative: `Desktop/the_project/overview.txt`
- Absolute: `/Users/Susanne/Desktop/logo.png`

Absolute-path



Relative-path



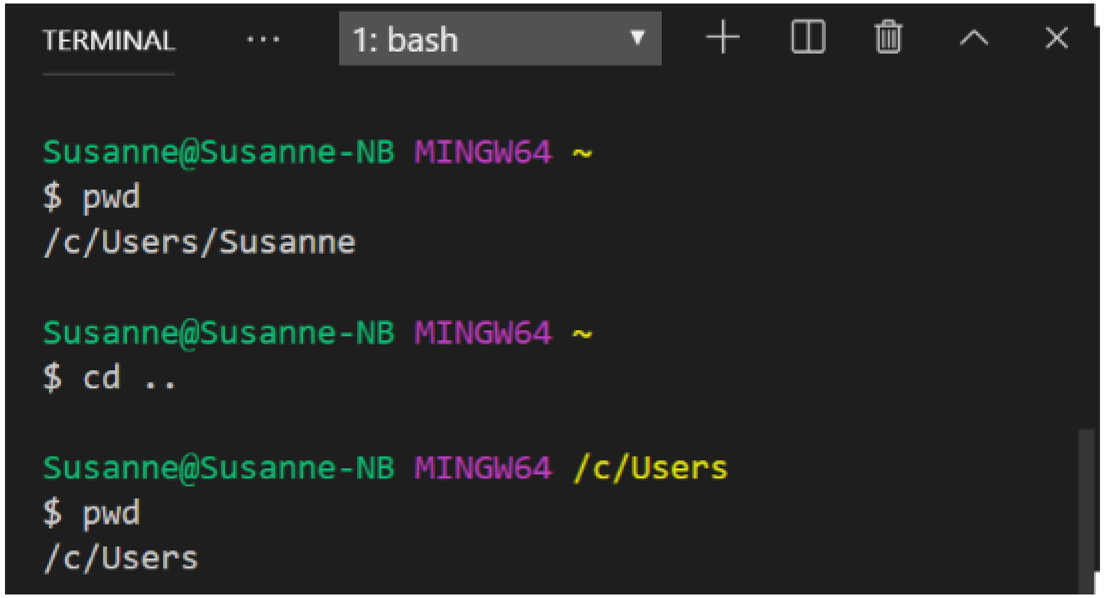
`cd`

The `cd` command changes the current working directory.

It expects a file path as an argument.

If no file path is given, it assumes your home directory by default.

cd



```
Susanne@Susanne-NB MINGW64 ~
$ pwd
/c/Users/Susanne

Susanne@Susanne-NB MINGW64 ~
$ cd ..

Susanne@Susanne-NB MINGW64 /c/Users
$ pwd
/c/Users
```

Shortcuts

- Current Directory: `.`
- Parent Directory: `..`
- Home Directory: `~`
- Previous Directory: `-`

Bonus: Drag a folder into the terminal to show its path.

(Only works in Visual Studio Code in Windows.)

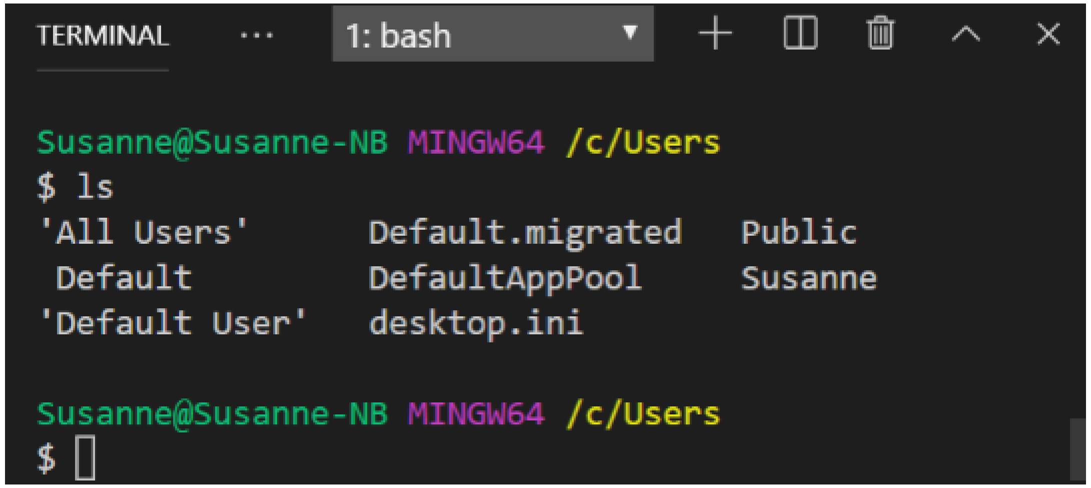
List

The `ls` command lists the contents of a directory.

It expects a file path as an argument.

If no file path is given, it assumes the current directory by default.

`ls`



```
Susanne@Susanne-NB MINGW64 /c/Users
$ ls
'All Users'       Default.migrated   Public
 Default          DefaultAppPool     Susanne
'Default User'    desktop.ini

Susanne@Susanne-NB MINGW64 /c/Users
$ 
```

Flags

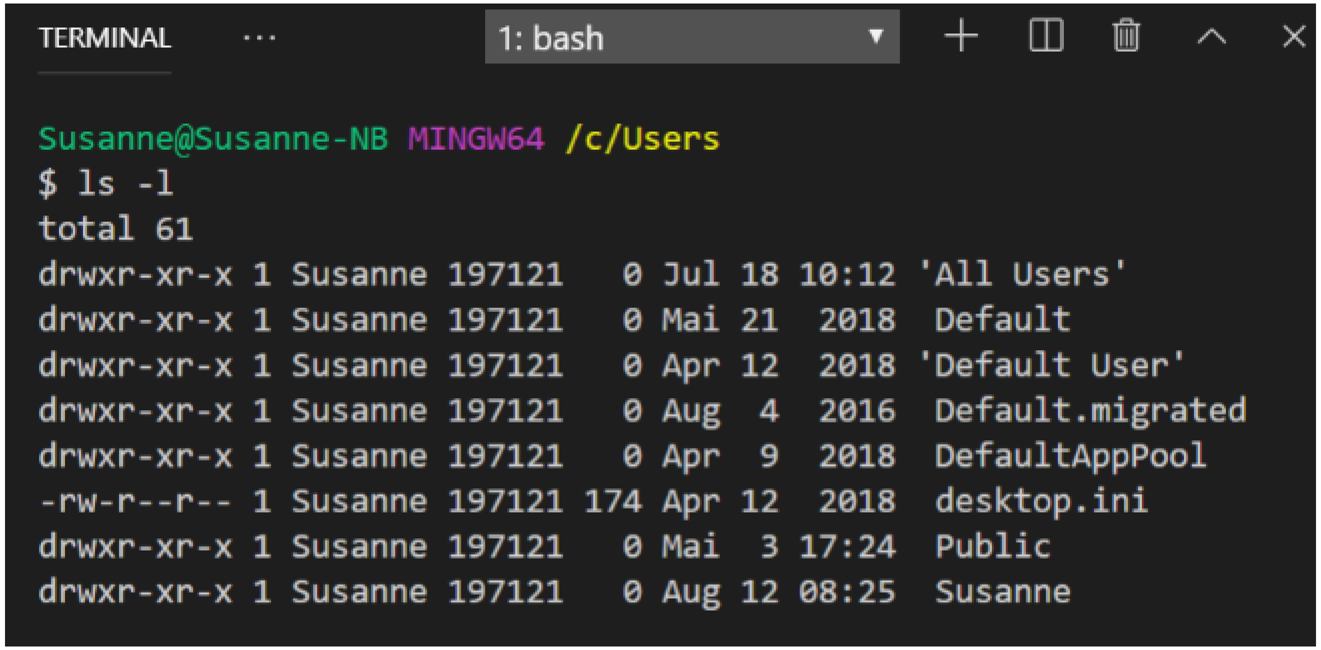
The `ls` command accepts several option flags.

A **flag** is a special argument that is used to set an option for the command.

These are commonly a hyphen followed by a single character (e.g. `-g`)

`ls -l`

Setting the `-l` flag on the `ls` command causes it to provide more verbose (long) output.



```
Susanne@Susanne-NB MINGW64 /c/Users
$ ls -l
total 61
drwxr-xr-x 1 Susanne 197121   0 Jul 18 10:12 'All Users'
drwxr-xr-x 1 Susanne 197121   0 Mai 21  2018  Default
drwxr-xr-x 1 Susanne 197121   0 Apr 12  2018 'Default User'
drwxr-xr-x 1 Susanne 197121   0 Aug  4  2016  Default.migrated
drwxr-xr-x 1 Susanne 197121   0 Apr  9  2018  DefaultAppPool
-rw-r--r-- 1 Susanne 197121 174 Apr 12  2018  desktop.ini
drwxr-xr-x 1 Susanne 197121   0 Mai  3 17:24  Public
drwxr-xr-x 1 Susanne 197121   0 Aug 12 08:25  Susanne
```

Hidden Files

Filenames that begin with a period are hidden from normal output.

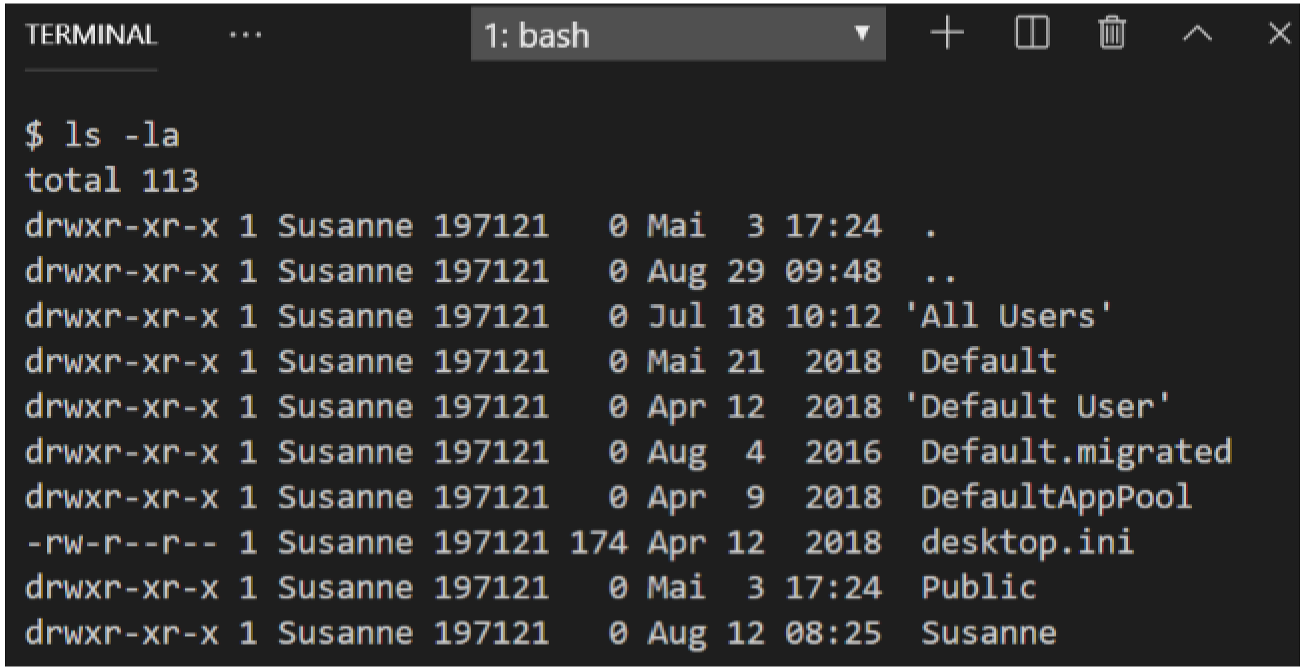
e.g. ".bashrc"

Use the `ls` command with the `-a` flag to see hidden files in addition to the usual output.

Type `ls -la` into your terminal.

Use the `-h` flag to get human readable file sizes.

`ls -la`



```
$ ls -la
total 113
drwxr-xr-x 1 Susanne 197121   0 Mai  3 17:24  .
drwxr-xr-x 1 Susanne 197121   0 Aug 29 09:48  ..
drwxr-xr-x 1 Susanne 197121   0 Jul 18 10:12 'All Users'
drwxr-xr-x 1 Susanne 197121   0 Mai 21  2018  Default
drwxr-xr-x 1 Susanne 197121   0 Apr 12  2018 'Default User'
drwxr-xr-x 1 Susanne 197121   0 Aug  4  2016  Default.migrated
drwxr-xr-x 1 Susanne 197121   0 Apr  9  2018  DefaultAppPool
-rw-r--r-- 1 Susanne 197121 174 Apr 12  2018  desktop.ini
drwxr-xr-x 1 Susanne 197121   0 Mai  3 17:24  Public
drwxr-xr-x 1 Susanne 197121   0 Aug 12 08:25  Susanne
```

Try It Yourself

Play with the `cd` and `ls` commands.
Be sure to incorporate:

- relative and absolute file path
- the `.` shortcut
- the `..` shortcut
- the `~` shortcut
- `cd` without an argument

Use `pwd` to check your location periodically.

Use Tab completion to autocomplete commands and filenames.

Make a Directory

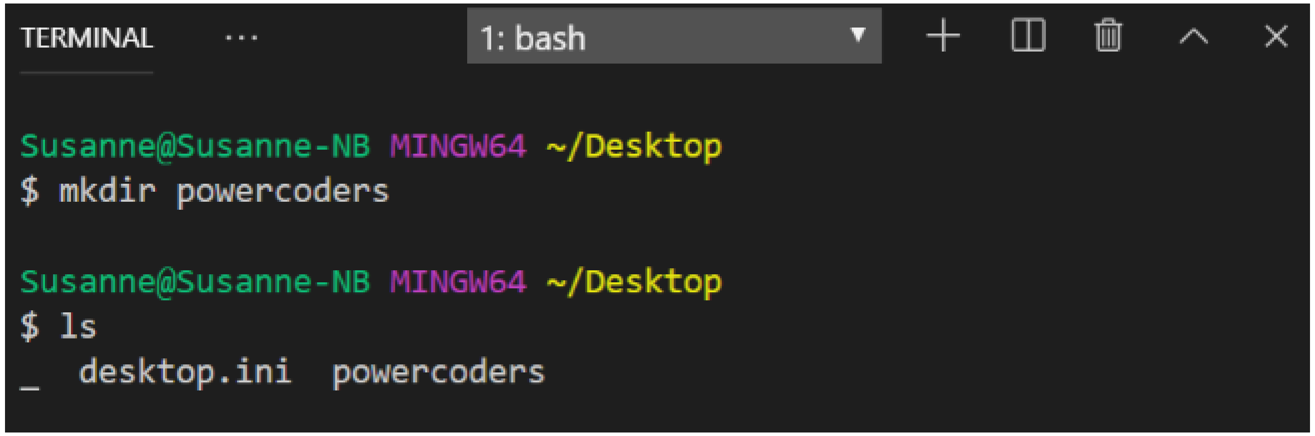
Use `mkdir` to create a new empty directory.

Pass the path of the directory name as the first argument.

If the base of the path doesn't already exist, the command will fail.

Use the `-p` flag to create the full path if non-existent.

mkdir



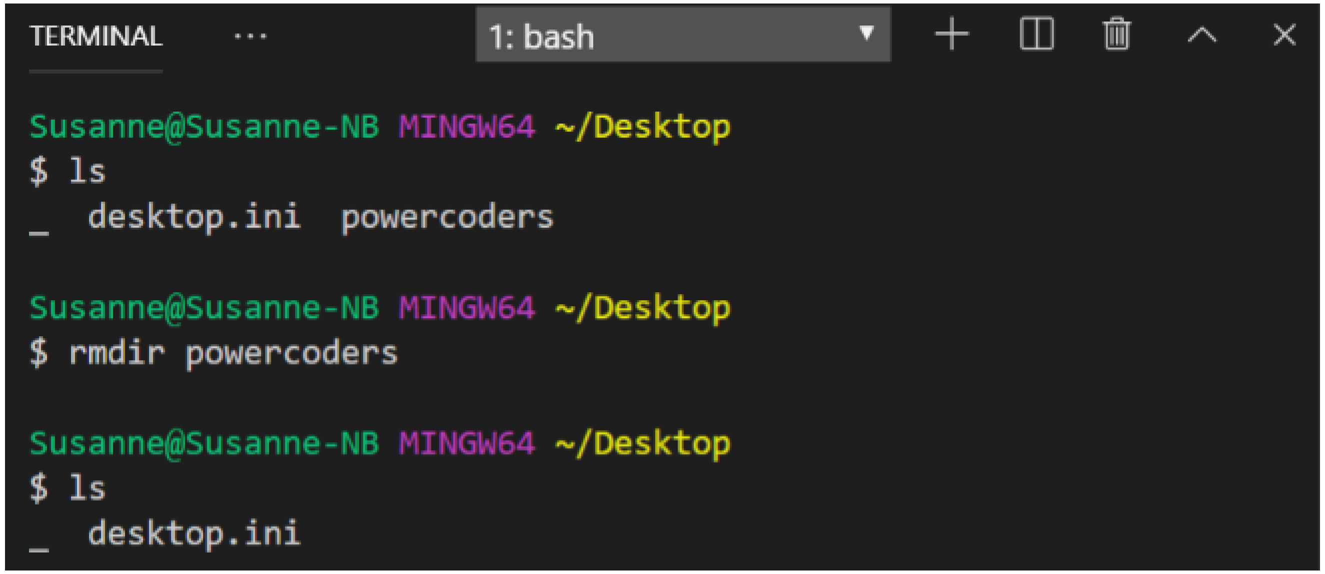
```
Susanne@Susanne-NB MINGW64 ~/Desktop
$ mkdir powercoders

Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini  powercoders
```

Remove a Directory

Use `rmdir` to remove an empty directory.

Use `rm -r` to remove a non-empty directory.

`rmdir`

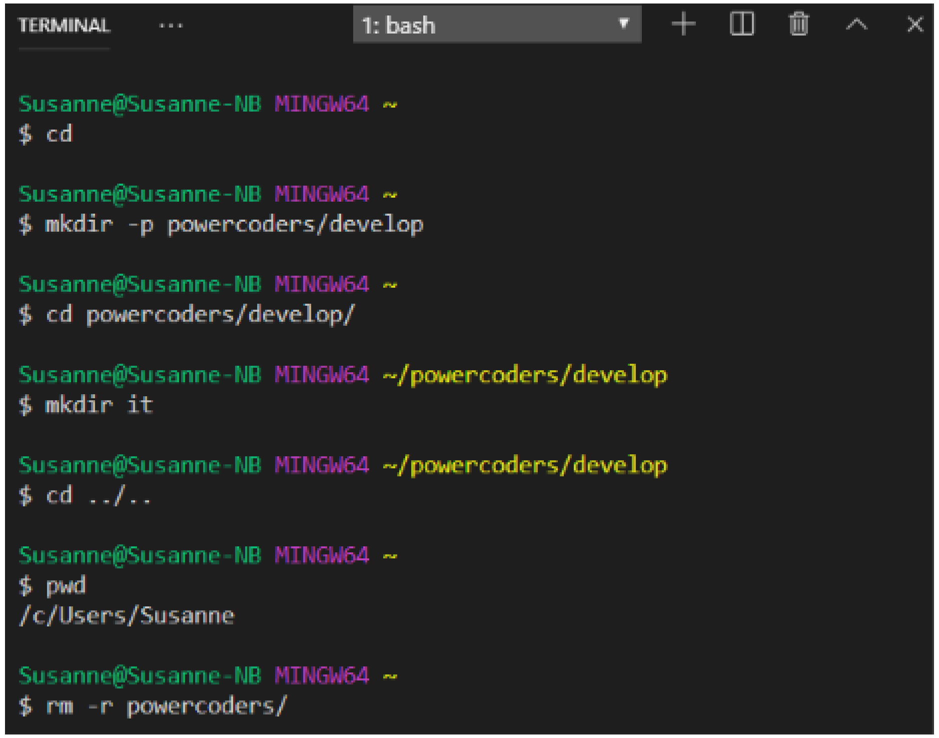


```
Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini  powercoders

Susanne@Susanne-NB MINGW64 ~/Desktop
$ rmdir powercoders

Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini
```

Try It Yourself

1. `cd` to your home directory.
2. Create the **powercoders/develop** directory path.
3. Navigate into the **powercoders/develop** directory.
4. Create the **it** directory.
5. Navigate up two directories.
6. Use the `pwd` command to verify you are home.
7. Remove the **powercoders/develop/it** path.

Try It Yourself



```
Susanne@Susanne-NB MINGW64 ~
$ cd

Susanne@Susanne-NB MINGW64 ~
$ mkdir -p powercoders/develop

Susanne@Susanne-NB MINGW64 ~
$ cd powercoders/develop/

Susanne@Susanne-NB MINGW64 ~/powercoders/develop
$ mkdir it

Susanne@Susanne-NB MINGW64 ~/powercoders/develop
$ cd ../..

Susanne@Susanne-NB MINGW64 ~
$ pwd
/c/Users/Susanne

Susanne@Susanne-NB MINGW64 ~
$ rm -r powercoders/
```

Working with Files

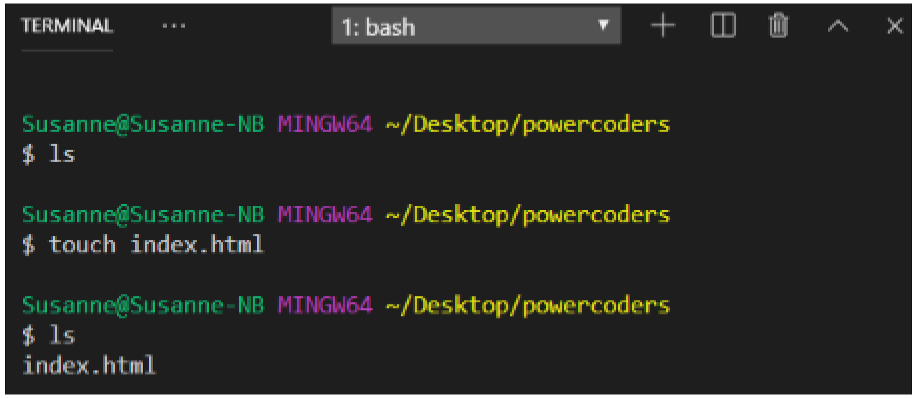
Create a File

Use `touch` to create a new file.

The `touch` command expects the name of your new file as an argument.

`touch`

(create a file)



```
Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ ls

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ touch index.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ ls
index.html
```

Copy a File

Use `cp` to copy a file.

The `cp` command takes two arguments:

- 1st argument = the "origin" file
- 2nd argument = the "destination" file

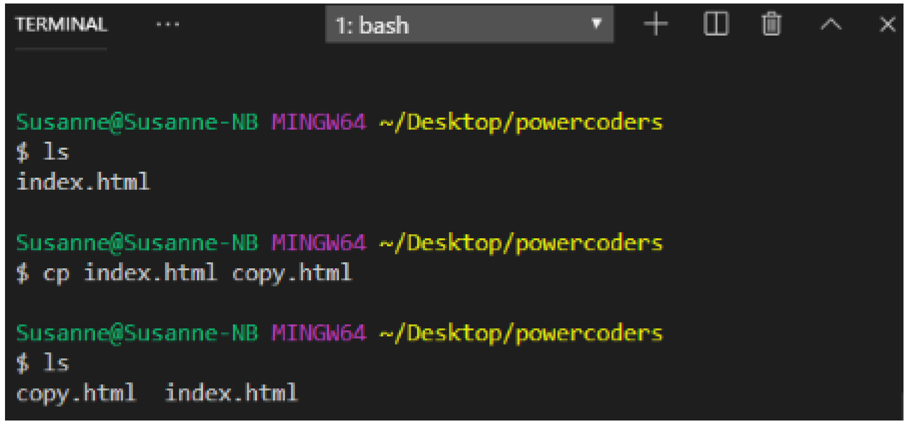
```
$ cp resume.txt resume-copy.txt
```

Use `cp -R` to copy a whole directory and all files in it.

cp

(copy a file)

```
cp origin destination
```

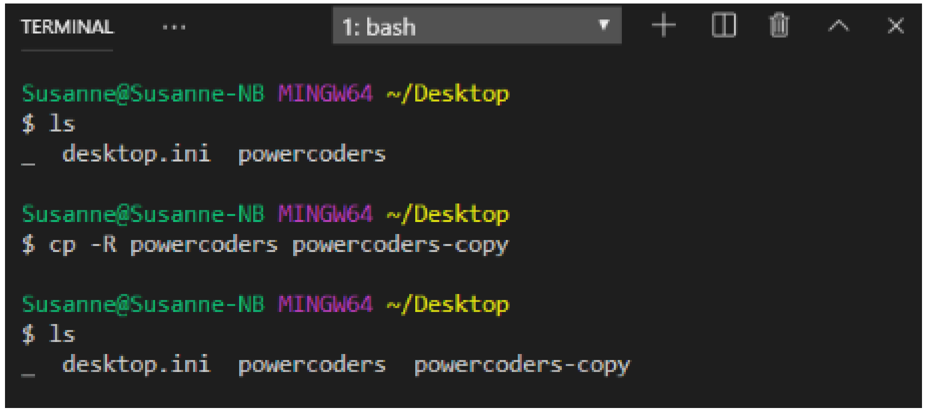


```
Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ ls
index.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ cp index.html copy.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ ls
copy.html  index.html
```

`cp -R`

(copy a whole directory)

```
cp -R origin destination
```



```
Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini  powercoders

Susanne@Susanne-NB MINGW64 ~/Desktop
$ cp -R powercoders powercoders-copy

Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini  powercoders  powercoders-copy
```

Moving (or Renaming) a File/Directory

Use `mv` to move a file or directory.

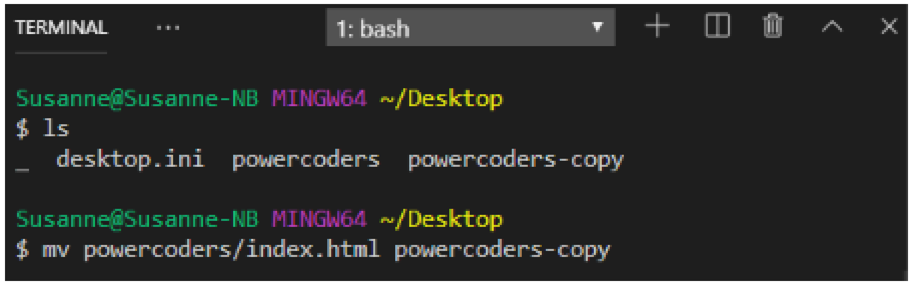
The `mv` command takes two arguments:

- 1st argument = the "origin"
- 2nd argument = the "destination"

If the destination is a filename, the file will be renamed.

Move a File/Directory

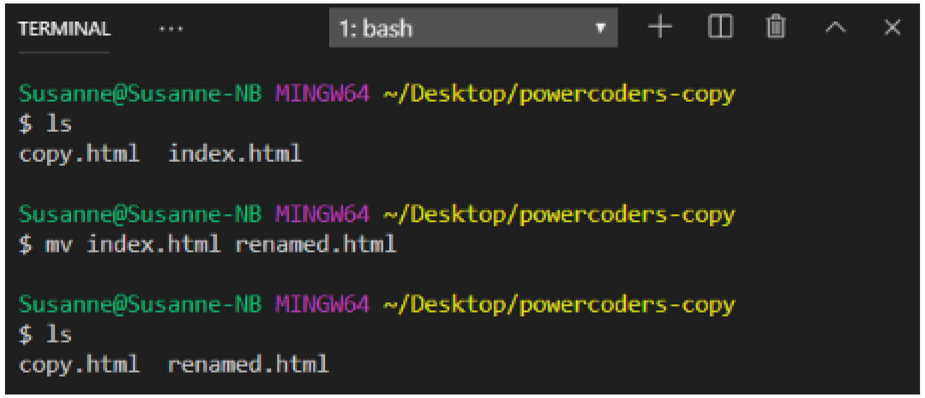
```
mv origin destination
```



```
Susanne@Susanne-NB MINGW64 ~/Desktop
$ ls
_  desktop.ini  powercoders  powercoders-copy

Susanne@Susanne-NB MINGW64 ~/Desktop
$ mv powercoders/index.html powercoders-copy
```

Rename a File/Directory

```
mv origin destination(filename)
```



```
Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ ls
copy.html  index.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ mv index.html renamed.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ ls
copy.html  renamed.html
```

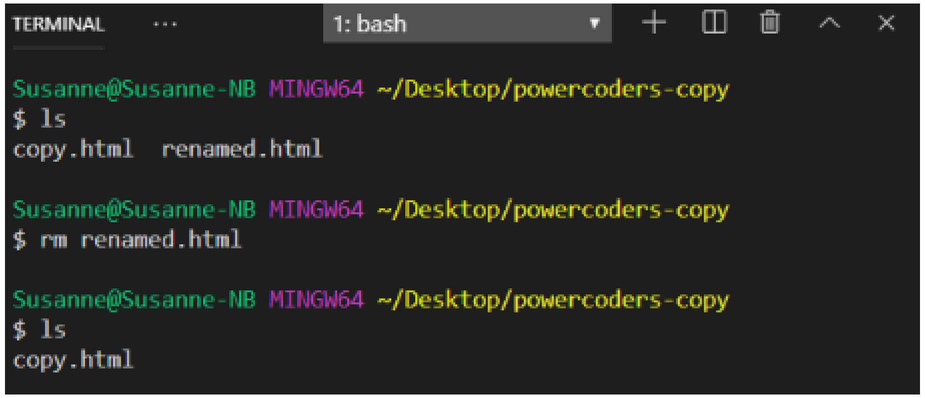
Remove a File

Use `rm` to remove a file.

The `rm` command takes the name of the file you are removing as an argument.

`rm`

(remove a file)



```
Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ ls
copy.html  renamed.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ rm renamed.html

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders-copy
$ ls
copy.html
```

Try It Yourself

1. Create a folder called **cli**.
2. Make that folder your current working directory.
3. Create two files: **file1.txt**, **file2.txt**.
4. Copy **file1.txt** and call the copy **file3.txt**.
5. Create a directory called **folder1**.
6. Move **file1.txt** into **folder1**.
7. List the contents of **folder1** without going into it.
8. Rename **file1.txt** to **myfile.txt**.
9. Remove the directory **folder1**, including the file inside.

Read a File

Use `cat` to output the contents of a file to the console.

Use `more` to step through the contents of a file one screen at a time.

Use `less` to step backwards or forwards.

Use `q` to get out of the `less`.

Open a File/Directory

Use `open` to open a file or directory in its default app—the equivalent of double-clicking it.

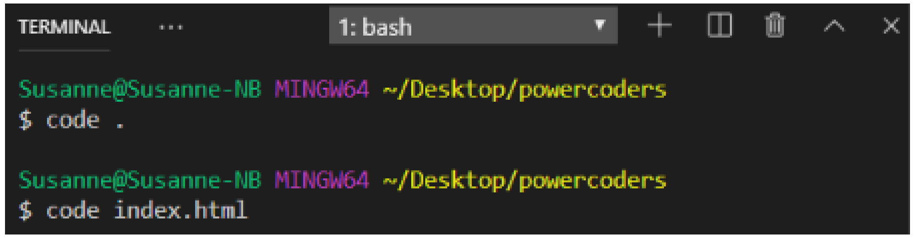
(Sadly, this does not work in Windows. 😞)

Pass the path of the file or directory name as the argument.

Open a File/Directory

Use `code .` to open the current directory in VSC.

Use `code` plus filename to open a specific file of the current dirctory in Visual Studio Code (VSC).



```
Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ code .

Susanne@Susanne-NB MINGW64 ~/Desktop/powercoders
$ code index.html
```

Edit a File

You can use various editors built into bash, including `vi` and `nano`.

Enter the editor command and the file path:

```
$ nano myfile.txt
```

Or on a Mac, you can open with any desktop app:

```
open -a TextEdit myfile.txt
```

Or with the default editor:

```
$ open -t myfile.txt
```

Try It Yourself

1. Navigate to the **powercoders** directory you made before.
2. Use `vi` or `nano` to add a few sentences to **file2.txt**, then exit and save.
3. Mac users, read the new contents of **file2.txt** in your terminal.
4. Everyone, try using `code` to open **file2.txt** in Visual Studio Code.

Working with Commands

Command Line Movement

- **ctrl-a**: jump to beginning of line
- **alt-f**: jump forward a word
- **alt-b**: jump back a word
- **alt-d**: delete word
- **alt-t**: transpose two words

More Command Line Movement

- The ← and → arrow keys let you edit within a command
- The ↑ and ↓ arrow keys let you select previous commands
- `tab` auto-completes filenames and directories

```
$ cd ~/pr[TAB]ojects/ac[TAB]medesign/doc[TAB]umentation/
```

Command Line History

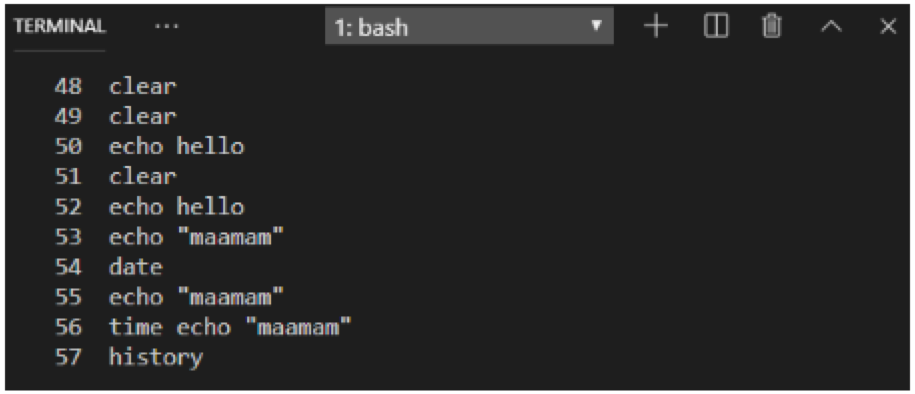
Use the `history` command to see a list of all your previous commands.

Each command will be listed next to a line number.

A few history-related commands:

- **!!**: Latest command
- **!54**: Command by line number
- **!code**: Command matching a string

`history`



```
   48  clear
   49  clear
   50  echo hello
   51  clear
   52  echo hello
   53  echo "maamam"
   54  date
   55  echo "maamam"
   56  time echo "maamam"
   57  history
```

Try It Yourself

1. Use your `up` and `down` arrows to locate a past command with one or more arguments.
2. Move your cursor to the beginning of the line.
3. Move your cursor from word to word to the end of the line.
4. Change one of the arguments and run it.
5. Run the `date` command.
6. Re-run the command from step 4 using `!`.
7. Time the execution of your original command by running `time !!`.

Troubleshooting

What can go wrong?

- Mis-spell a command: `aaaaaaaa` ('a' x 8)
- `cd` in to a directory that does not exist
- `cd ...`
- `cd .`
- `cd` `filename`
- `rmdir aaaaaaaa`

Where's the prompt?!

Different processes have different ways of exiting back to the prompt. If you're stuck, try one of these:

- **ctrl + c**
- **ctrl + x**
- `q`
- `:q`
- **esc** key, then `:q`

`command not found`

If you receive a `command not found` error message, check for typos!

Otherwise, you may need to install the software that uses the command.

Try searching online for:

> how to install [command-name-here] on [Mac/Windows/Linux]

Cheatsheet

Action	Windows	OS X
Print working directory	`cd`	`pwd`
List directory contents	`dir`	`ls`
Change to a subdirectory	`cd` `dir`	`cd` `dir`
Go up a directory	`cd ..`	`cd ..`
Create a directory	`mkdir` `dir`	`mkdir` `dir`
Delete a directory	`rmdir` `dir`	`rmdir` `dir`

... and many more on following cheat sheet

FURTHER MATERIAL

- CLI Challenge
- Networking in detail
- BGP visualized