

Lecture 1.2 – How Computers Work

Specific Learning Objectives:


1.1.8 – Understand the concept of working directories.

2.1.1 – Understand how file systems are structured and organized.

2.1.2 – Understand how to navigate file systems using a GUI interface.

2.1.3 – Use directories to organize course work.

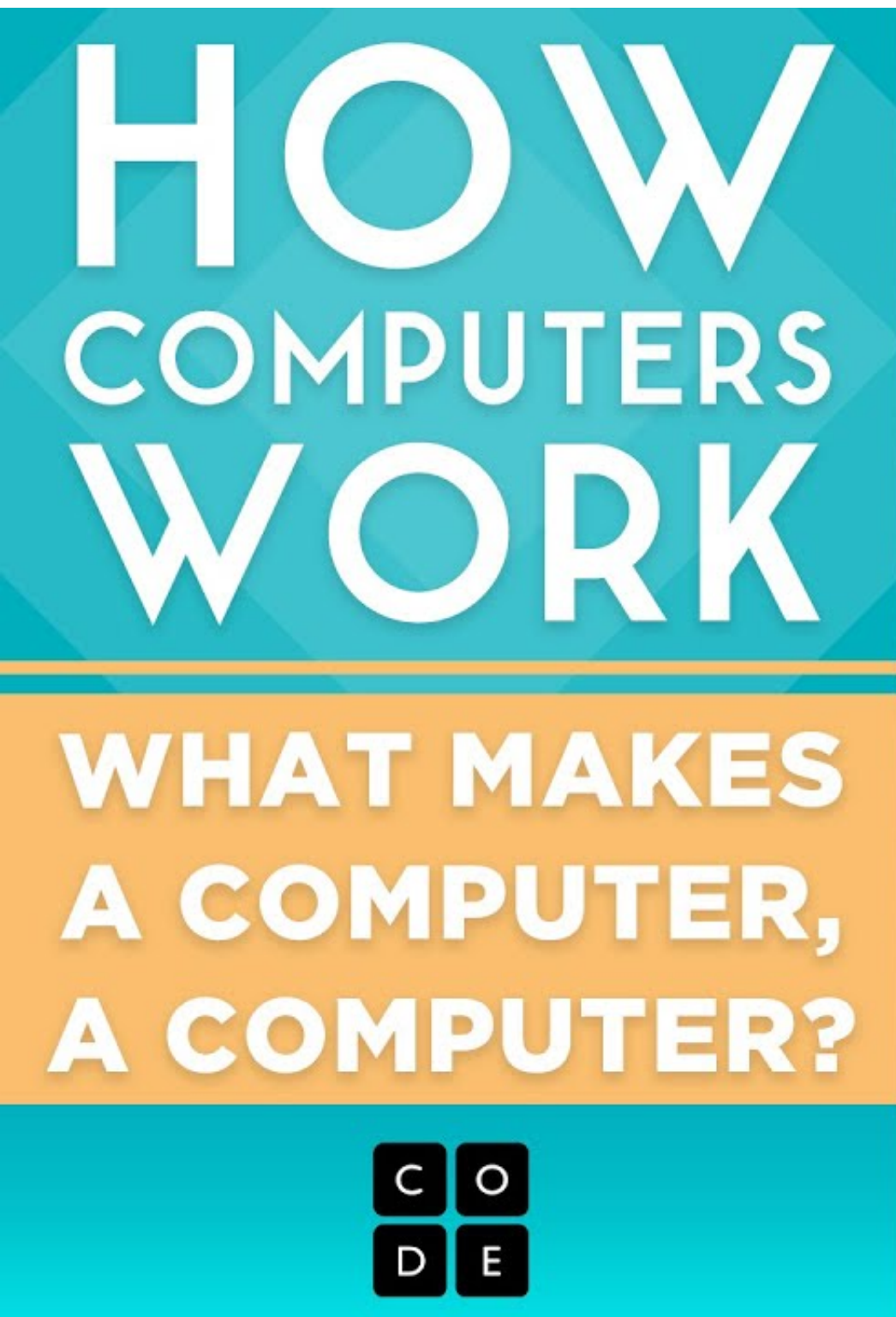
Tips for Flipped Lectures

- Have a notepad and pen handy so you can write down any questions! Anything that seems confusing, you don't totally understand, anything you might be wondering about. **We'll always start the in-class portion with time for questions from lecture material!**
- Be sure to **pause the video**  and work through the Check Your Understanding questions! These are there to help you solidify those concepts. **If you can't do one, ask to go over it at the beginning of the in-class portion!**

Instructions for this Lecture!

Watch the following 5 videos in the lecture notes PDF and then return to the Panopto Video to continue!

Understanding Computers: What is a computer?



<https://code.org/educate/resources/videos>

Understanding Computers

HOW COMPUTERS WORK

BINARY
&
DATA

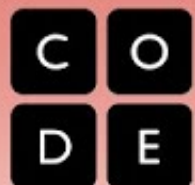


<https://code.org/educate/resources/videos>

Understanding Computers

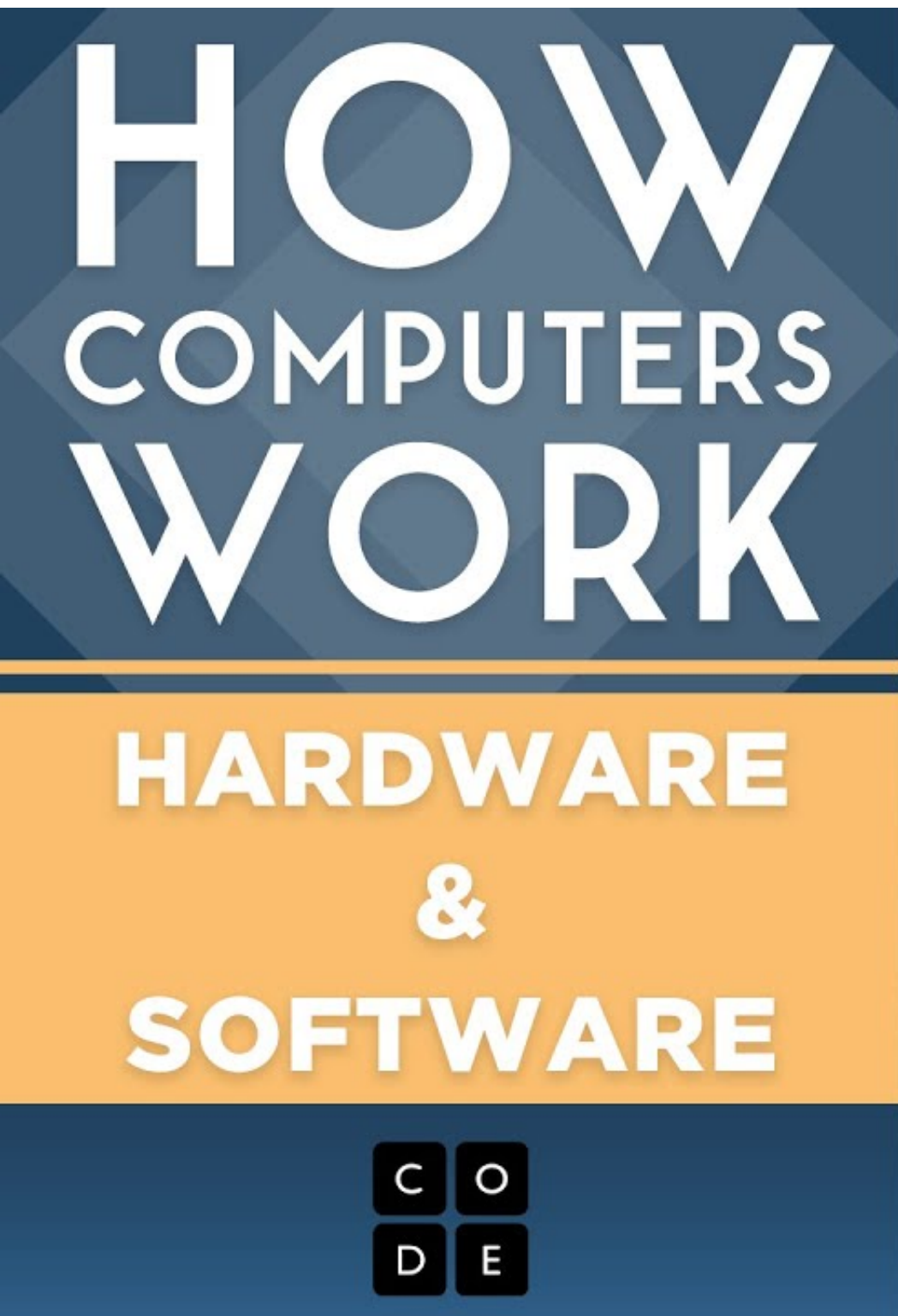
HOW COMPUTERS WORK

CIRCUITS
&
LOGIC



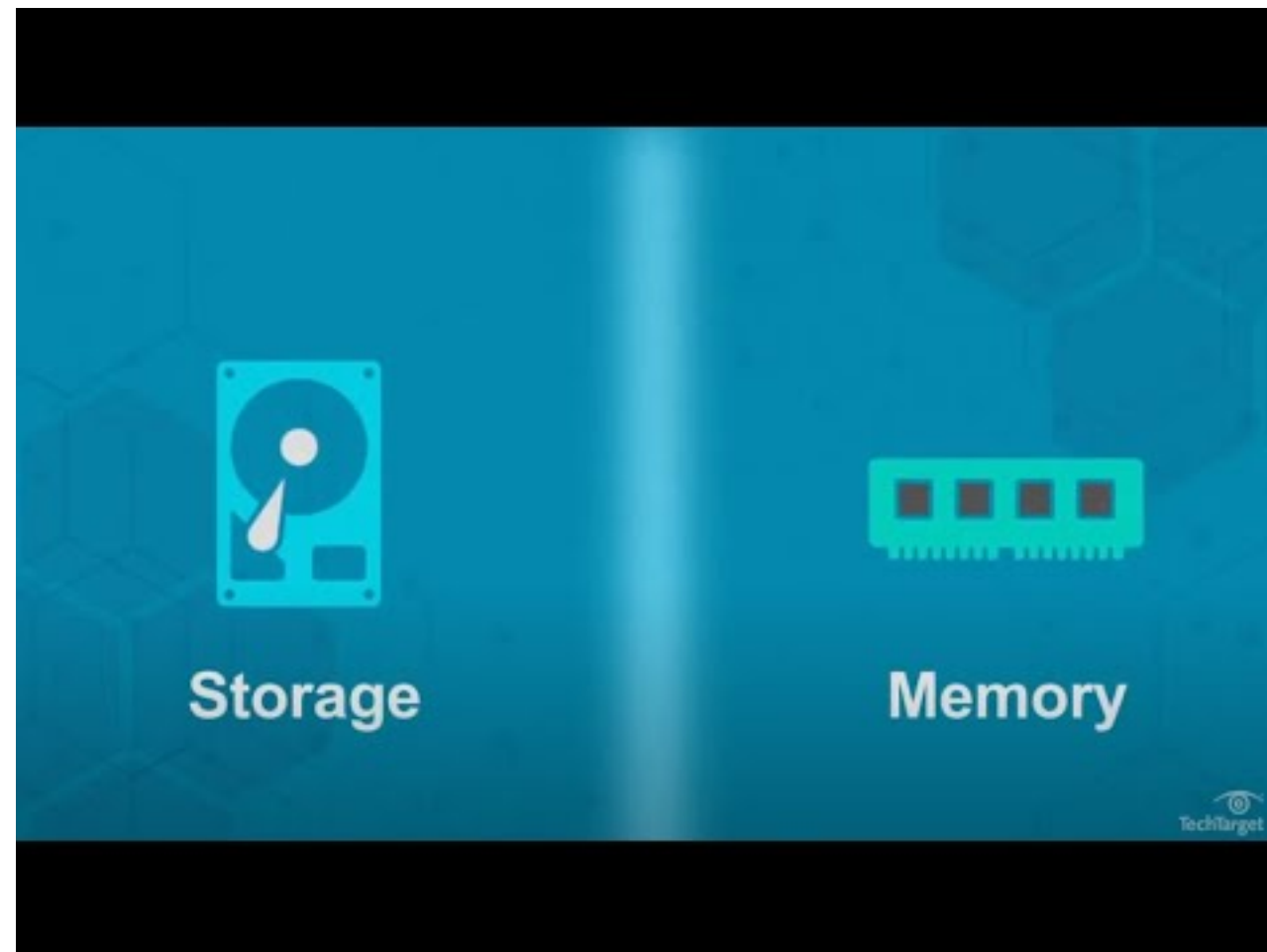
<https://code.org/educate/resources/videos>

Understanding Computers: Hardware and Software



<https://code.org/educate/resources/videos>

Understanding Computers: Memory versus Storage



https://www.youtube.com/watch?v=H_M--weEzpA

Check Your Understanding

What are the four things that all computers have in common?

a) input, output, VR, processing

c) hardware, software, circuits, logic

b) input, output, processing, storage

d) CPU, hard drives, memory, buses

Correct answer

Recapping the Videos

- A **computer** is a device that takes input and storage, performs processing, and produces output.
- Computers operate on binary systems (0's and 1's) to create and store information in a variety of forms.
- Computers use basic circuits and logic to perform a variety of calculations in binary.
- No one uses binary to talk to computers because special software converts back and forth between computer binary language and human-readable coding languages (like R), called **compilers**.
- Computers possess both **hardware** (the physical devices and circuits) and **software** (programs, logic) that tells the hardware what to do.
 - Hardware includes the central processing unit, storage, memory, connections, and input and output devices.
 - Software includes the operating system which coordinates all programs running on the computer, as well as CPU, storage, and memory usage.

What does this mean for you?

- When we talk about programming a computer, we have to be mindful of what's going on under the hood to be effective!
- What you should think about:
 - **Inputs and Outputs** – What information are you giving to the computer and what would you like the output to look like?
 - **Languages and Circuits** – Ultimately computers only understand TRUE and FALSE binaries, so how can you create instructions that can tell the computer exactly what steps it needs to do to perform the calculations you want?
 - **Storage and Memory** – Be mindful of what is in storage (saved on your hard drive) versus what is in memory! Information only moves from storage to memory when you tell it to!

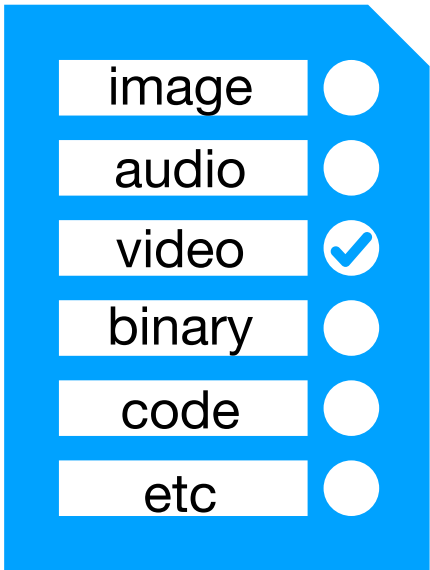
Filesystems: How computers handle storage

- *Purpose:* Provides a non-volatile storage and organization of information

- *Parts:*

- Namespace (rules for naming things)
- Metadata structure (info about files)
- Application Program Interface (API)
- Security (Permissions, which users are allowed to access, run, change files)

Files



- Operating system (aka the kernel 🌽) interacts with virtual filesystem, which organizes drivers (🚗 software which talks to hardware)

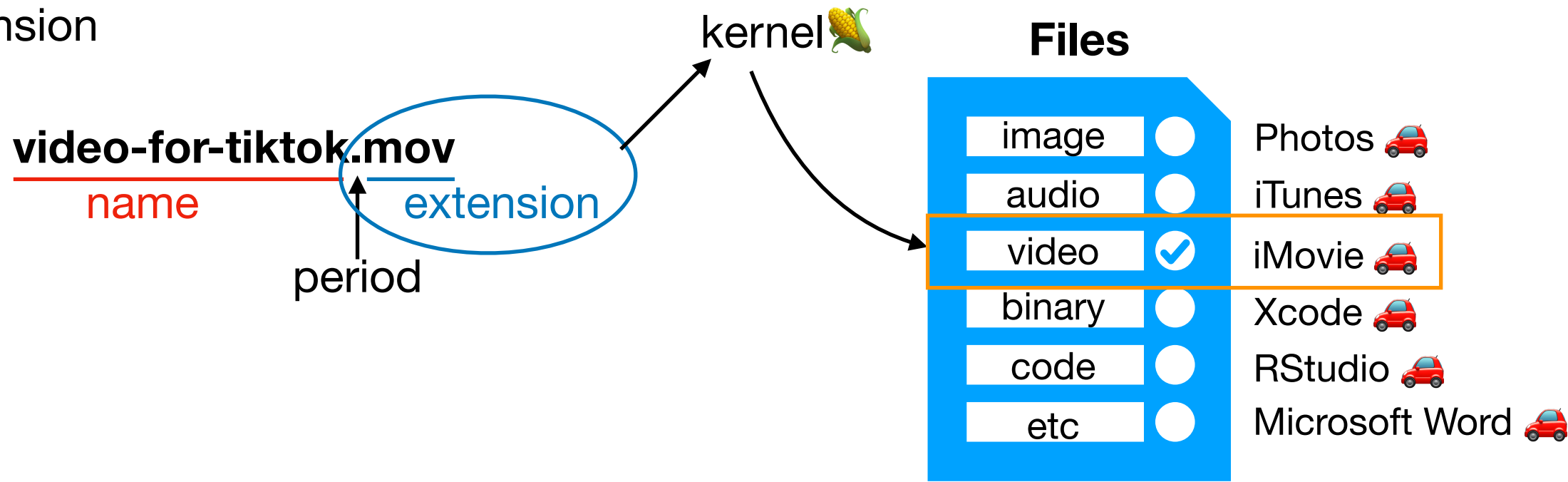
Permissions	Info on files							File names
-rw-r--r--@ tf	1	waldrop	staff	11799	Dec 13	2016		Bosque-IBAMR-Install-clang.r
-rw-r--r--@ xt	1	waldrop	staff	9199	Dec 13	2016		Bosque-IBAMR-Install_Notes.t
-rw-r--r--@	1	waldrop	staff	12445	Dec 21	2016		IBAMR-Bridges.rtf
-rw-r--r--@	1	waldrop	staff	10876	Jun 19	2017		IBAMR-Bridges2_gcc.rtf
-rw-r--r--@	1	waldrop	staff	16603	Apr 10	16:50		IBAMR-Bridges2_intel.rtf
-rw-r--r--@	1	waldrop	staff	14782	Apr 12	17:45		IBAMR-Bridges3.rtf
-rw-r--r--@	1	waldrop	staff	10630	Sep 15	2018		IBAMR2016_Dogwood.rtf
-rw-r--r--@ f	1	waldrop	staff	143916	Oct 3	2016		IBAMR_Install_August_2016.pd

Files: How Computers Organize Info

- Purpose: Files provide a unit of saved information.

- Parts of Filename:

- Name
- period
- Extension



```
-rw-r--r--@ 1 waldrop staff 12445 Dec 21 2016 IBAMR-Bridges.rtf
-rw-r--r--@ 1 waldrop staff 10876 Jun 19 2017 IBAMR-Bridges2_gcc.rtf
-rw-r--r--@ 1 waldrop staff 16603 Apr 10 16:50 IBAMR-Bridges2_intel.rtf
-rw-r--r--@ 1 waldrop staff 14782 Apr 12 17:45 IBAMR-Bridges3.rtf
-rw-r--r--@ 1 waldrop staff 10630 Sep 15 2018 IBAMR2016_Dogwood.rtf
-rw-r--r--@ 1 waldrop staff 143916 Oct 3 2016 IBAMR_Install_August_2016.pdf
drwxr-xr-x@ 9 waldrop staff 288 Aug 20 2019 IBAMR_install_v2016
-rw-r--r--@ 1 waldrop staff 14207 Jun 15 2017 Shannons_IBAMR_Install_Notes_Mac.rtf
```

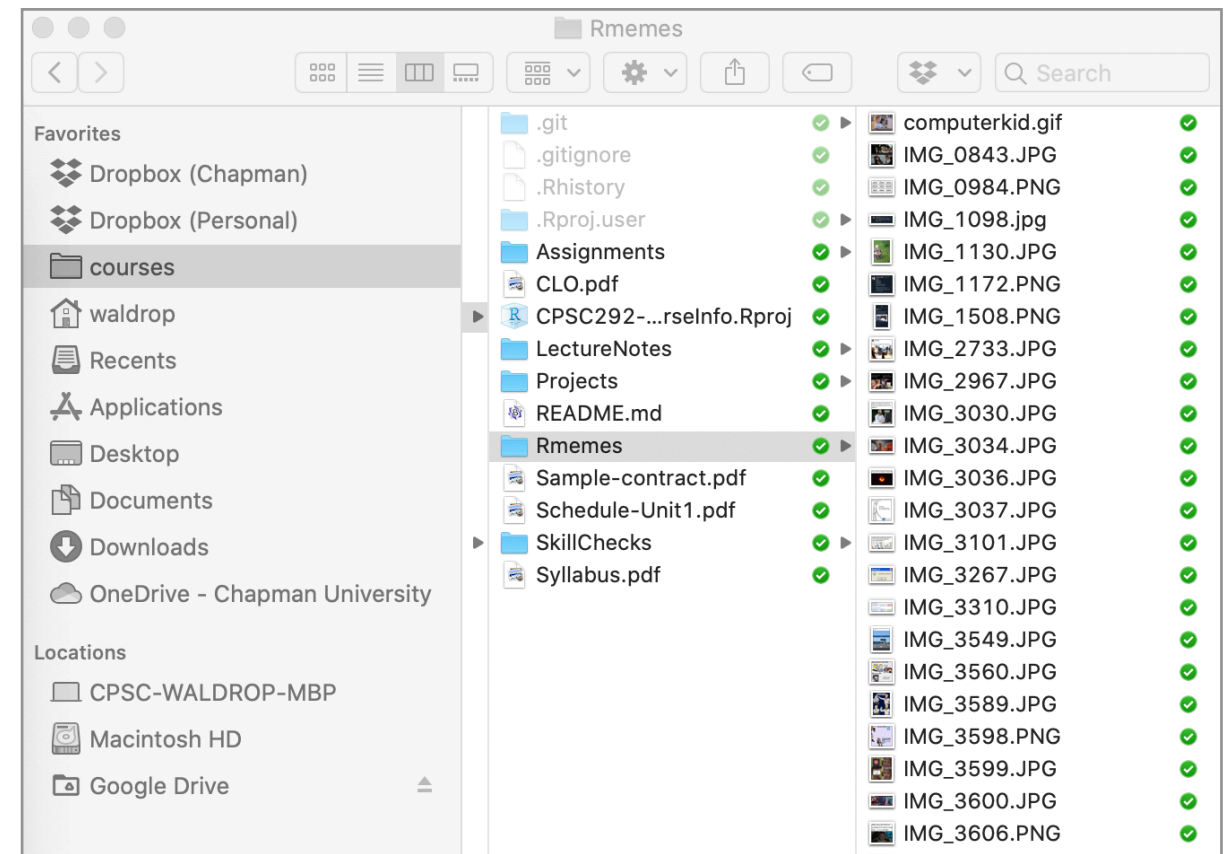
Navigating Filesystems

- **Shells** 🐚: special programs help you/the kernel 🌽 navigate and interact with the filesystem.
 - **Command-line shells** – BASH, zsh, and MS Powershell are command-line shells. You navigate by entering specific commands to navigate and interact with items in the filesystem.
 - **Graphical User Interface (GUI) shells** – Finder, Windows Explorer, and Pantheon are GUI shells which you navigate by clicking graphics.

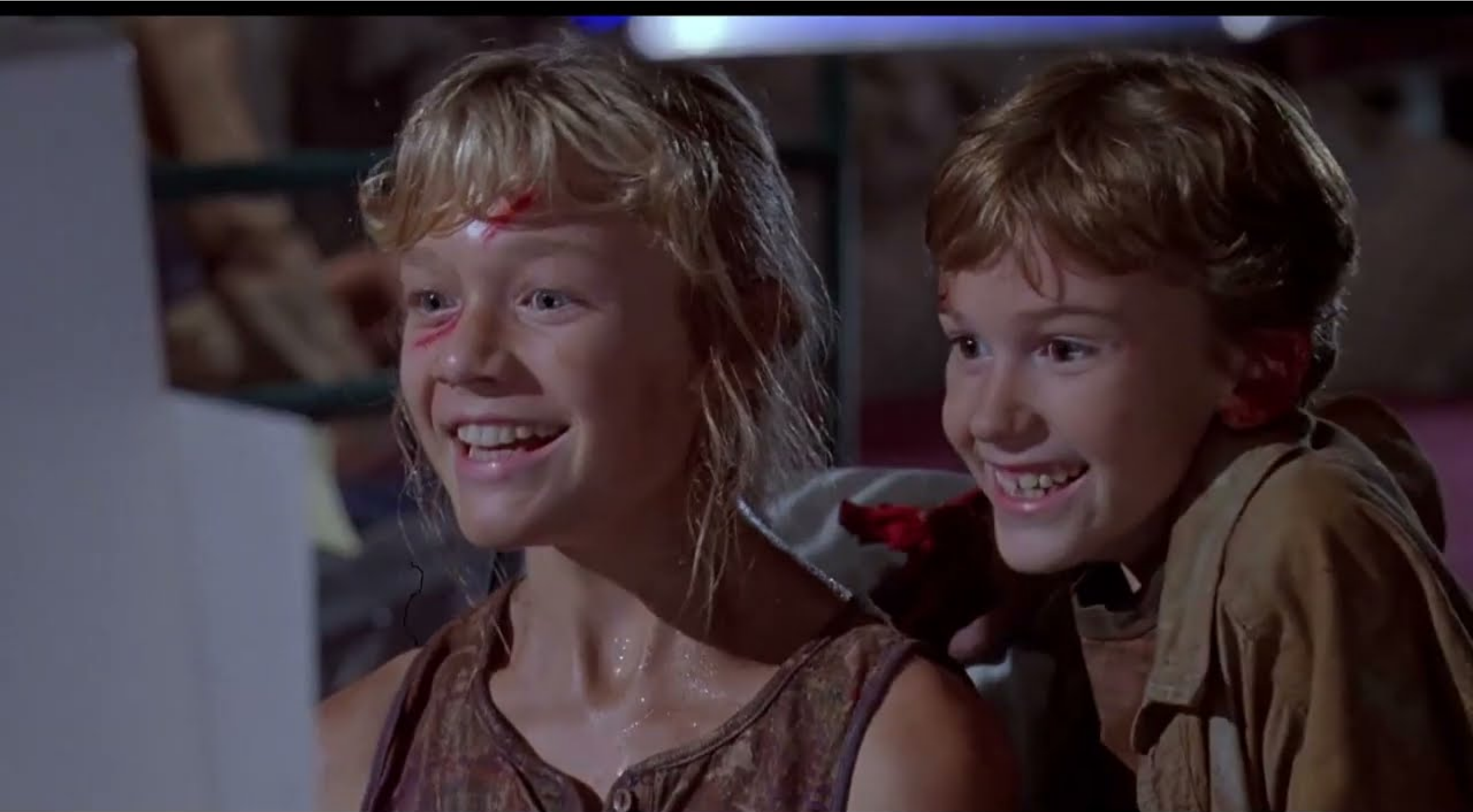
BASH (Linux, Mac OS)

```
Rmemes — -bash — 68x29
CPSC-WALDROP-MBP:CPSC292-CourseInfo waldrop$ ls
Assignments                               Rmemes
CLO.pdf                                  Sample-contract.pdf
CPSC292-CourseInfo.Rproj                 Schedule-Unit1.pdf
LectureNotes                           SkillChecks
Projects                               Syllabus.pdf
README.md
CPSC-WALDROP-MBP:CPSC292-CourseInfo waldrop$ cd Rmemes/
CPSC-WALDROP-MBP:Rmemes waldrop$ ls
IMG_0843.JPG  IMG_2733.JPG  IMG_3101.JPG  IMG_3598.PNG  IMG_
3632.JPG
IMG_0984.PNG  IMG_2967.JPG  IMG_3267.JPG  IMG_3599.JPG  comp
uterkid.gif
IMG_1098.jpg  IMG_3030.JPG  IMG_3310.JPG  IMG_3600.JPG  rmem
e.png
IMG_1130.JPG  IMG_3034.JPG  IMG_3549.JPG  IMG_3606.PNG
IMG_1172.PNG  IMG_3036.JPG  IMG_3560.JPG  IMG_3607.PNG
IMG_1508.PNG  IMG_3037.JPG  IMG_3589.JPG  IMG_3630.jpg
CPSC-WALDROP-MBP:Rmemes waldrop$ git add IMG_1130.JPG computerkid.gi
f IMG_0843.JPG
CPSC-WALDROP-MBP:Rmemes waldrop$ ls
IMG_0843.JPG  IMG_2967.JPG  IMG_3310.JPG  IMG_3606.PNG
IMG_0984.PNG  IMG_3030.JPG  IMG_3549.JPG  IMG_3607.PNG
IMG_1098.jpg  IMG_3034.JPG  IMG_3560.JPG  IMG_3630.jpg
IMG_1130.JPG  IMG_3036.JPG  IMG_3589.JPG  IMG_3632.JPG
IMG_1172.PNG  IMG_3037.JPG  IMG_3598.PNG  computerkid.gif
IMG_1508.PNG  IMG_3101.JPG  IMG_3599.JPG  rmeme.png
IMG_2733.JPG  IMG_3267.JPG  IMG_3600.JPG
CPSC-WALDROP-MBP:Rmemes waldrop$
```

Finder (Mac OS)



Why bother understanding how filesystems work?

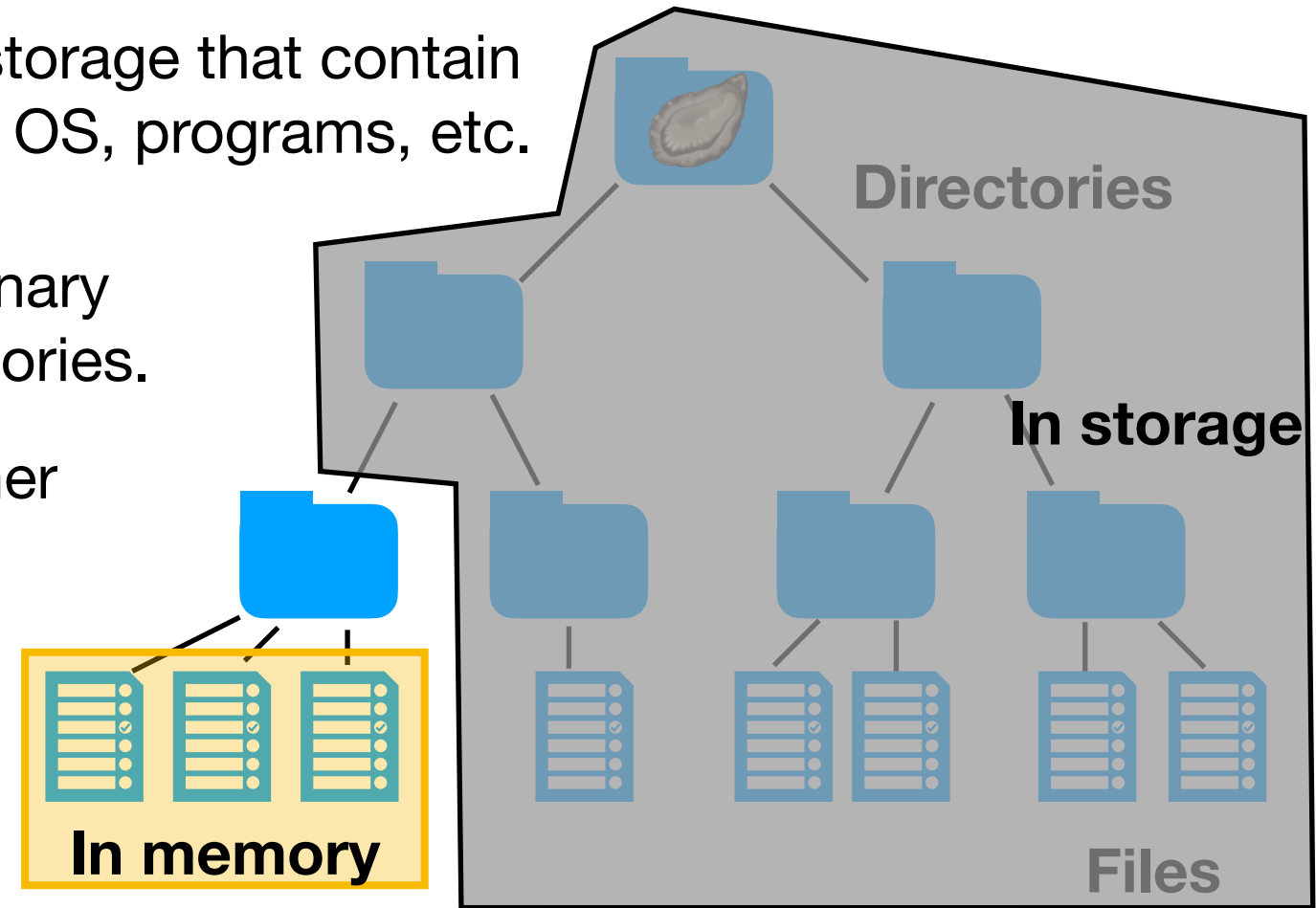


Jurassic Park - A UNIX system

Working Directories: how filesystems handle memory!

- **Directories:** subdivisions of filesystem storage that contain files. Directories are created by the user, OS, programs, etc.

- Directories can contain items like binary files, computer code, or other directories.
- Because directories can contain other directories, they have a *hierarchical structure*.

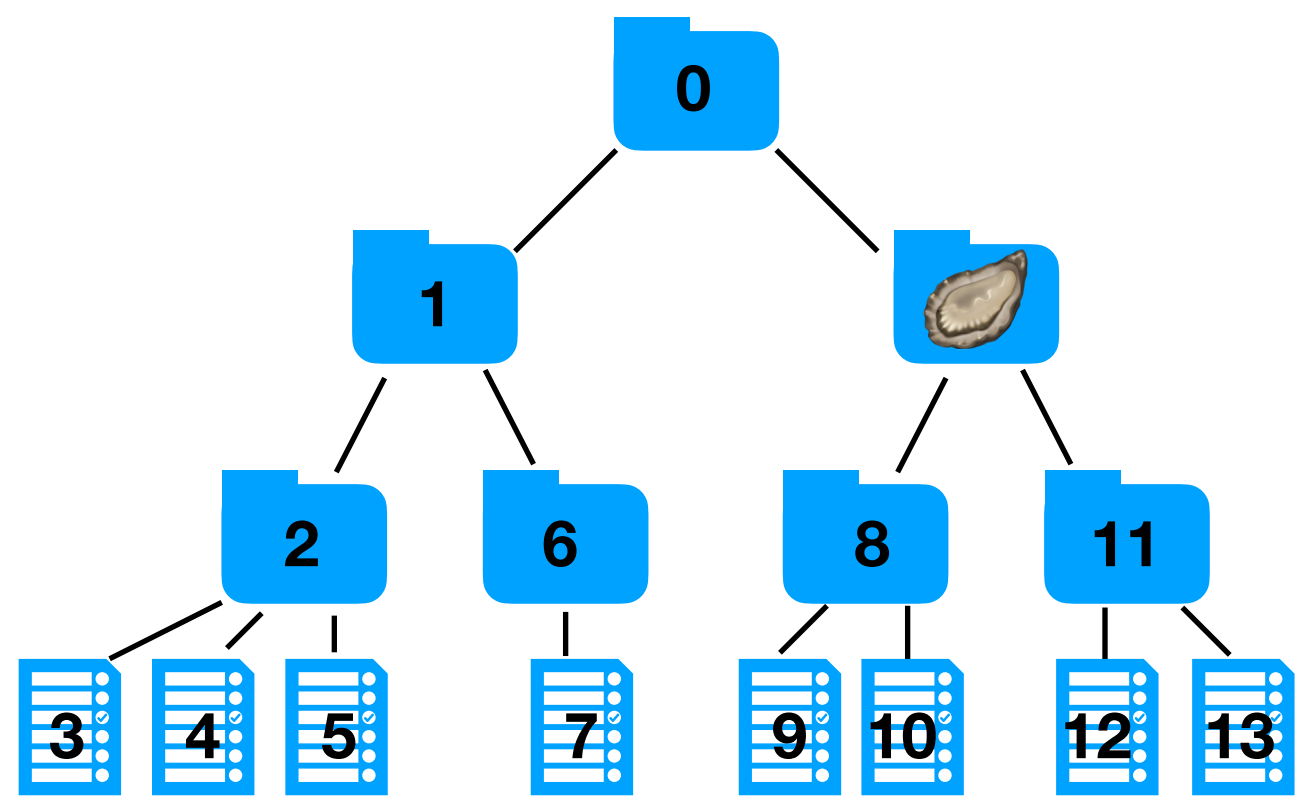


- **Working Directories:** are the current location of the shell 🐚 within filesystem storage.
 - When you “enter” a directory, the shell loads into memory the **metadata** about the items within it like the size, date last accessed, permissions, etc.
 - The shell only has information on the items within the working directory! It doesn’t know anything about items in other directories!

**Remember
where you are
(or your
working
directory)!**

Check Your Understanding

If the shell's working directory were in this folder, what items would it see (load metadata for)?



a) 0, 1, 2, 6

c) 8, 11 **Correct answer**

b) 8, 9, 10, 11, 12, 13

d) 0 through 13

Finding the location of an item

- Each item has a location based on its position in the filesystem hierarchy, described by which directories it occupies (in order!)

- **Root directory:** a computer's highest-level directory, this is a `/` in Unix-based OS and `C:\` in Windows.

Location of file 3: `/1/2/`

Location of folder 11: `/14/`

- **Home directory:** a specific user's root directory. Shortcut in command-line Bash is `$HOME` or `~`

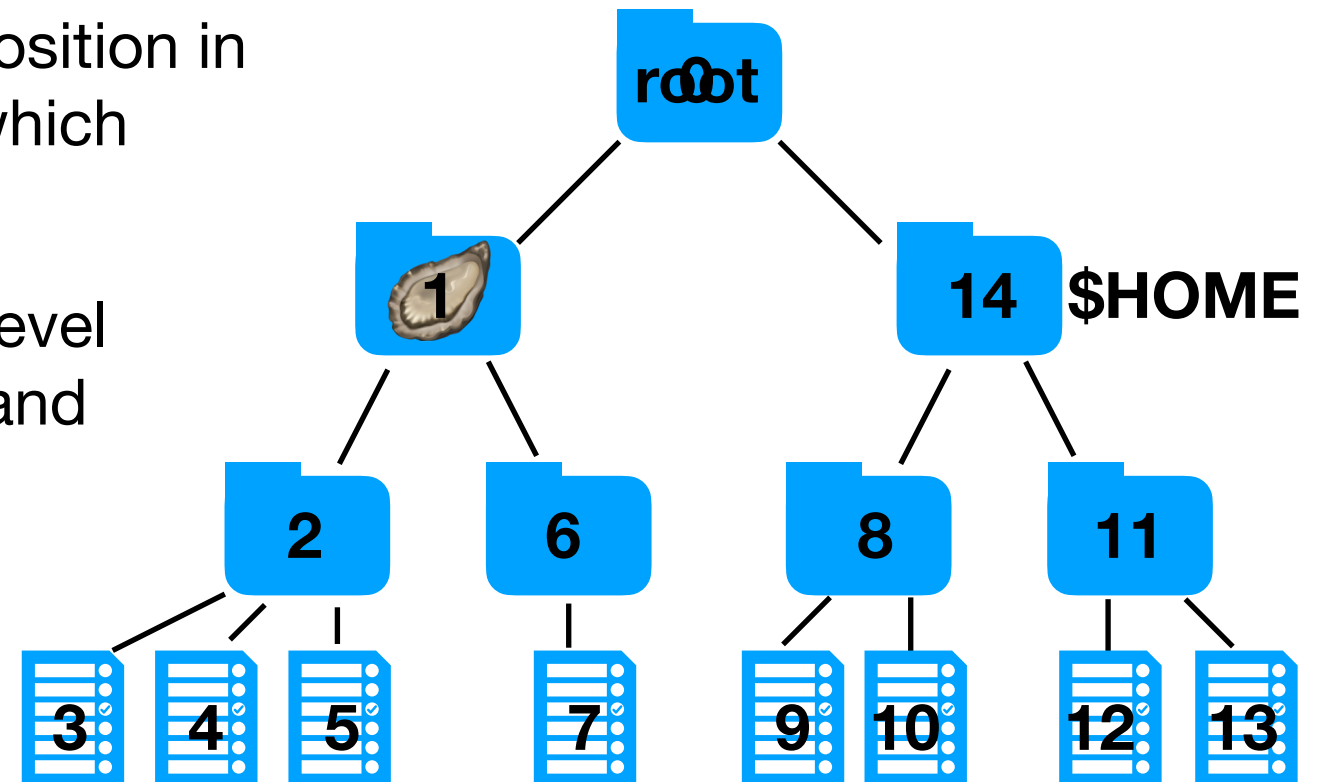
Location of file 12: `/14/11/` OR `$HOME/11/`

- **Working directory:** shortcut is `.`. If you don't include the root or home shortcut, the shell will look in your working directory!

Location of file 3: `.`

Location of file 7: `../6/`

Two dots indicates the directory one above your current directory!

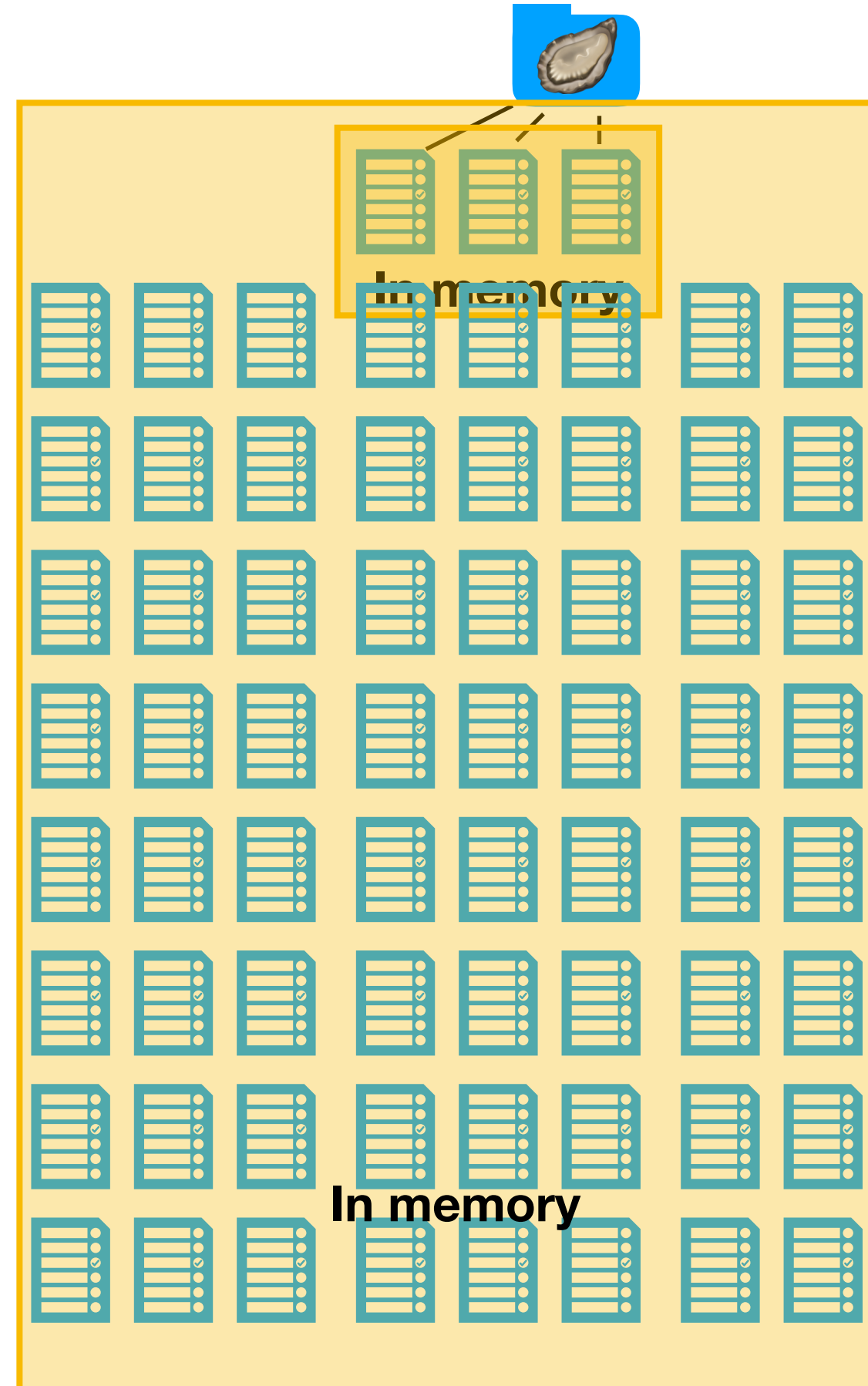


Check Your Understanding

- 1) Write down the location for file 7 from root.
- 2) Write down the location for file 7 if your working directory is 8.

Why bother using directories to organize files?

- Only metadata of files in the working directory is loaded into memory, but what if that directory has a LOT OF FILES??
- By having too many files in one directory/folder, you clutter up your memory with all sorts of stuff you don't need.
- It's also super hard to find stuff, or remember which versions are which, what's related to what, etc.
- **Do yourself a massive favor and organize your files into separate directories!!!!!!**



DON'T WORK IN YOUR DOWNLOADS FOLDER.



Action Items

- 1. Complete assignments 1.2 and 1.3 (due a week from today).**
- 2. Review Computer Games for the next class! (No video lecture.)**