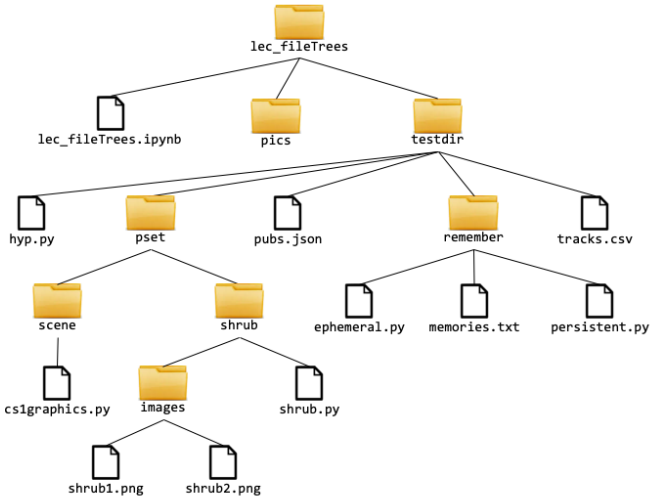
File System Operations and File Tree Traversal



CS111 Computer Programming

Department of Computer Science
Wellesley College

A trip to "The Office"

Folders for organizing files

An empty folder

A folder with one document (file)

Nested folders

A folder with many files

Several folders with several files

File Cabinets

An single-office's file cabinet

An organization's file cabinet

Graphical User Interfaces

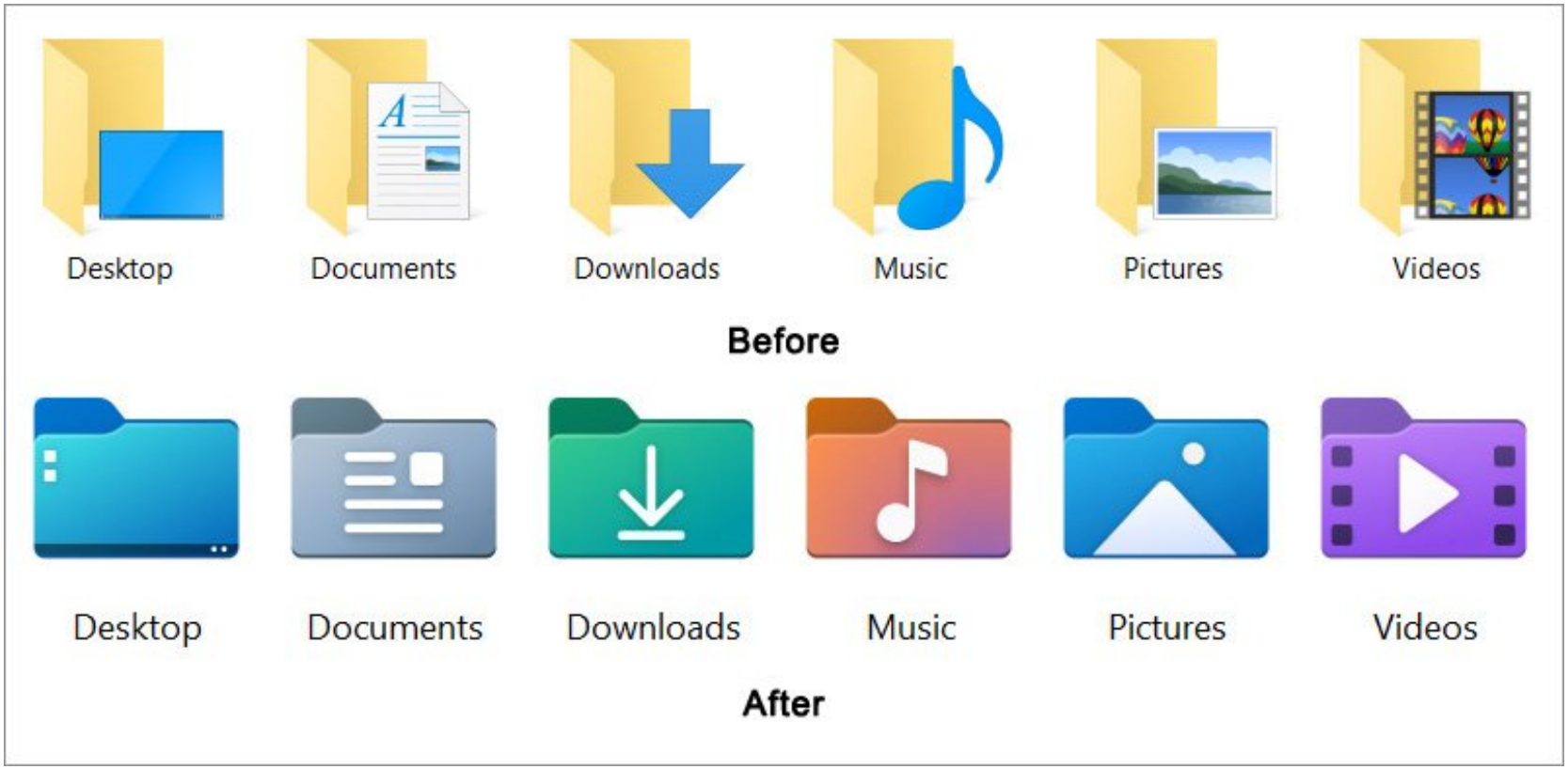
The original Mac OS interface icons, created by Susan Kare.

Susan Kare

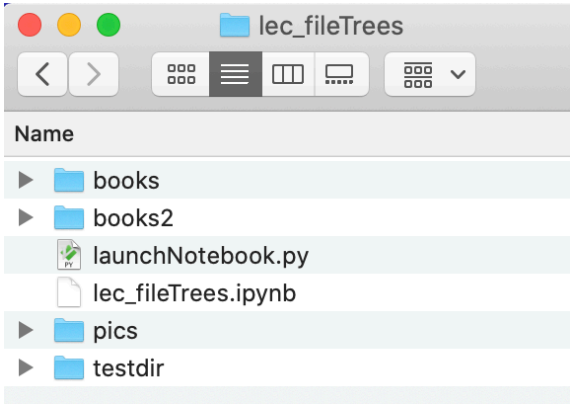
Graphic designer at Apple (1983-1986).

Read about Susan's work in this New Yorker article: https://www.newyorker.com/culture/cultural-comment/the-woman-who-gave-the-macintosh-a-smile

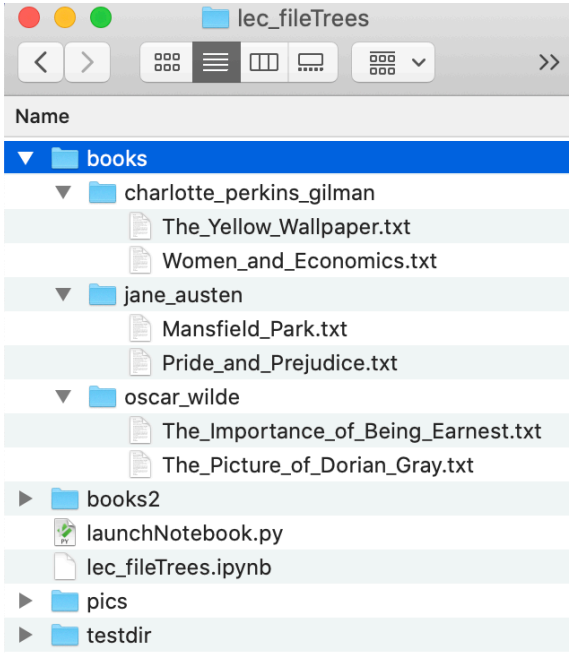
Windows OS Folder Icons (over the years)



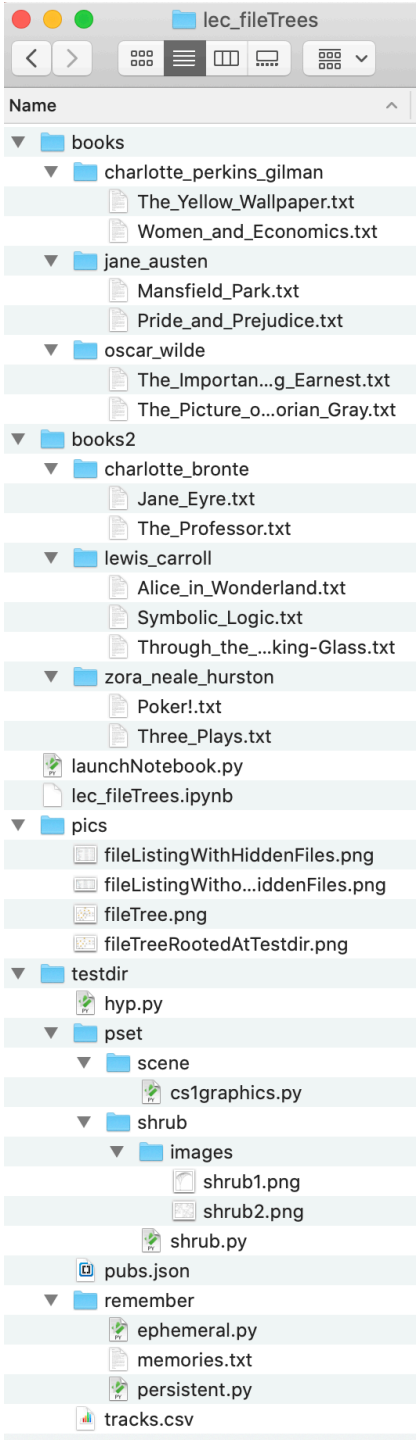
Directory = Folder
Expanded Folder View



Our folder lec_fileTrees



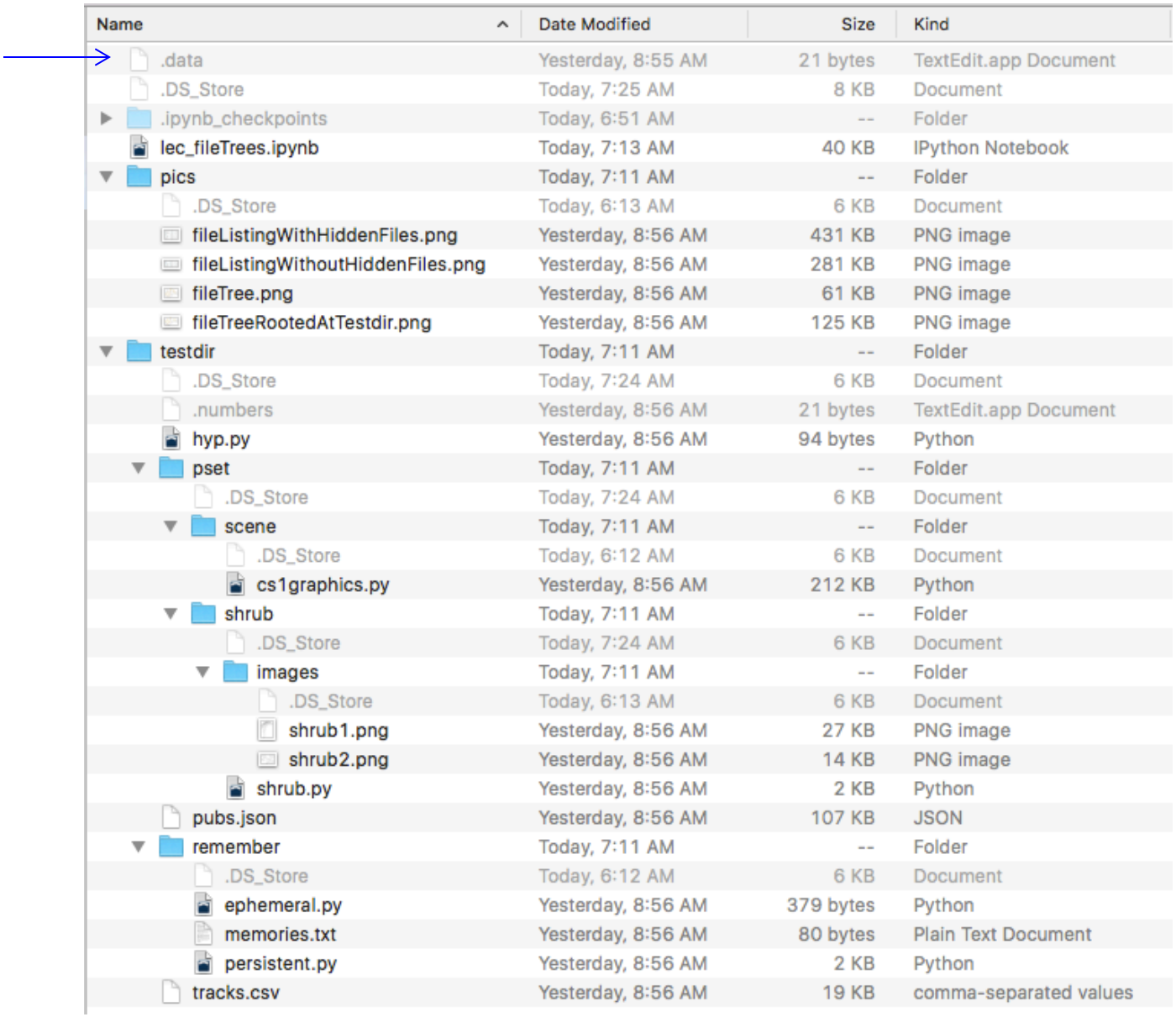
Expanding subfolders in the lec_fileTrees folder.



Concepts in this slide:
Files in a computer are organized in nested folders.

Sample Directory: Folder View Showing Dot Files

Concepts in this slide: Some files, known as dot files, are "hidden".



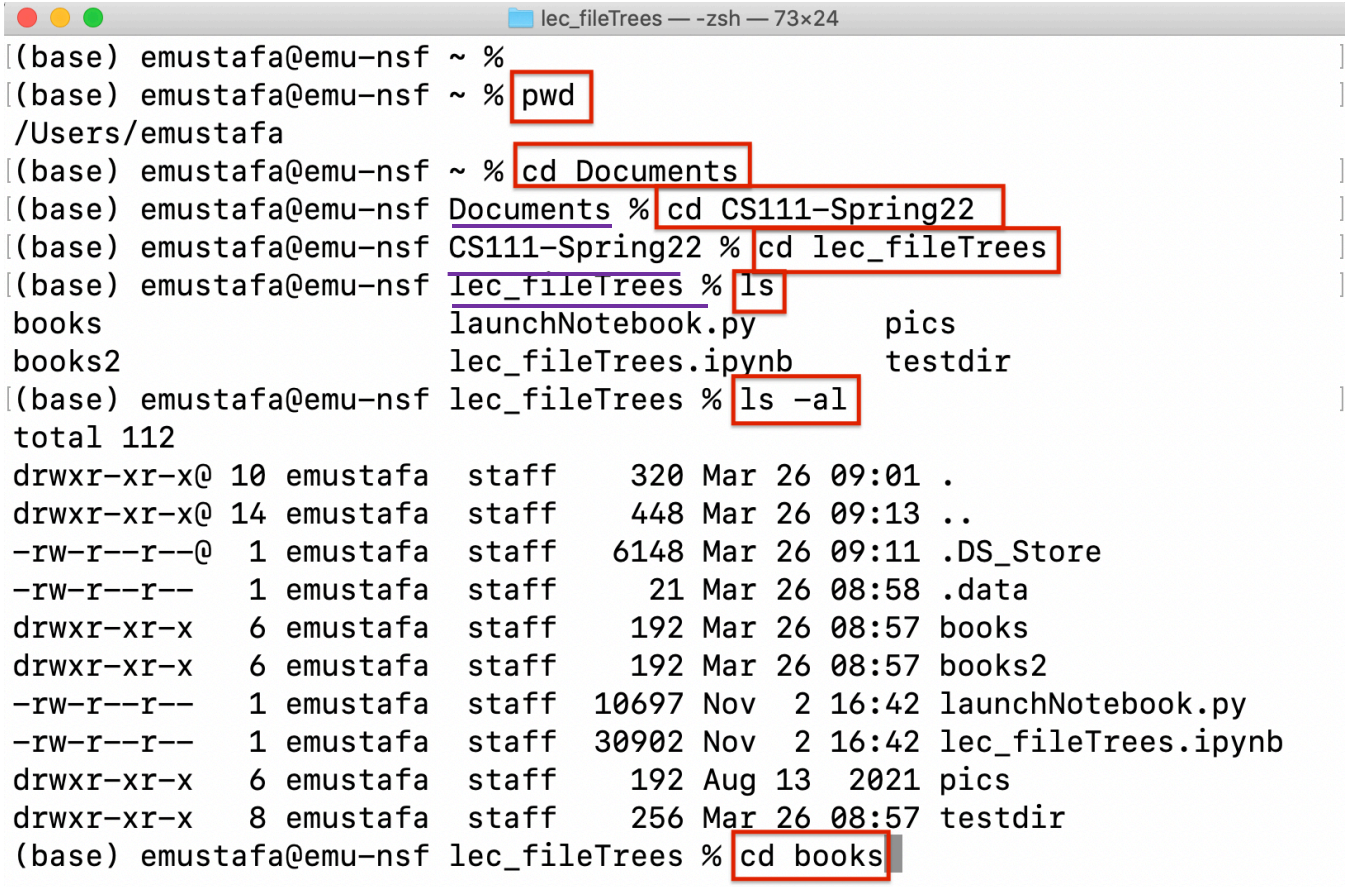
Name	Date Modified	Size	Kind
.data	Yesterday, 8:55 AM	21 bytes	TextEdit.app Document
.DS_Store	Today, 7:25 AM	8 KB	Document
.ipynb_checkpoints	Today, 6:51 AM	--	Folder
lec_fileTrees.ipynb	Today, 7:13 AM	40 KB	IPython Notebook
pics	Today, 7:11 AM	--	Folder
.DS_Store	Today, 6:13 AM	6 KB	Document
fileListingWithHiddenFiles.png	Yesterday, 8:56 AM	431 KB	PNG image
fileListingWithoutHiddenFiles.png	Yesterday, 8:56 AM	281 KB	PNG image
fileTree.png	Yesterday, 8:56 AM	61 KB	PNG image
fileTreeRootedAtTestdir.png	Yesterday, 8:56 AM	125 KB	PNG image
testdir	Today, 7:11 AM	--	Folder
.DS_Store	Today, 7:24 AM	6 KB	Document
.numbers	Yesterday, 8:56 AM	21 bytes	TextEdit.app Document
hyp.py	Yesterday, 8:56 AM	94 bytes	Python
pset	Today, 7:11 AM	--	Folder
.DS_Store	Today, 7:24 AM	6 KB	Document
scene	Today, 7:11 AM	--	Folder
.DS_Store	Today, 6:12 AM	6 KB	Document
cs1graphics.py	Yesterday, 8:56 AM	212 KB	Python
shrub	Today, 7:11 AM	--	Folder
.DS_Store	Today, 7:24 AM	6 KB	Document
images	Today, 7:11 AM	--	Folder
.DS_Store	Today, 6:13 AM	6 KB	Document
shrub1.png	Yesterday, 8:56 AM	27 KB	PNG image
shrub2.png	Yesterday, 8:56 AM	14 KB	PNG image
shrub.py	Yesterday, 8:56 AM	2 KB	Python
pubs.json	Yesterday, 8:56 AM	107 KB	JSON
remember	Today, 7:11 AM	--	Folder
.DS_Store	Today, 6:12 AM	6 KB	Document
ephemeral.py	Yesterday, 8:56 AM	379 bytes	Python
memories.txt	Yesterday, 8:56 AM	80 bytes	Plain Text Document
persistent.py	Yesterday, 8:56 AM	2 KB	Python
tracks.csv	Yesterday, 8:56 AM	19 KB	comma-separated values

To Notice

Hidden files/folders start with the dot character, e.g., .data.

Operating Systems (OS) Commands: Navigating around

Concepts in this slide: Before GUIs there was the command line for text commands.



This window is the Mac app "Terminal".

It only accepts text commands in the command line.

The shown commands (in red):

`pwd`

`cd`

`ls`

`ls -al`

As a result of the `cd` command, we get to move inside that folder, indicated by the name on the left of %

OS commands

Here is what the previously shown OS commands mean:

`pwd` – display the name of the parent working directory
`cd` – change directory (to the provided argument)
`ls` – list the content of the current directory
`ls -al` – list all content of the current directory one line at at time, with extra info
`mkdir` – make a new directory
`more` – view the content of a text file

Some of these commands take arguments, as shown in the previous slide.

After the last command, `cd books`, we can check with `pwd` the absolute path in which we have arrived (see screenshot below):

```
(base) emustafa@emu-nsf lec_fileTrees % cd books
(base) emustafa@emu-nsf books % pwd
/Users/emustafa/Documents/CS111-Spring22/lec_fileTrees/books
```

Where do you live? Absolute vs Relative

To: Wendy Wellesley

Unit 1025

21 Wellesley College Rd
Wellesley MA 02481 -0210

[absolute address]

Cazenove Hall (Caz), 3rd floor

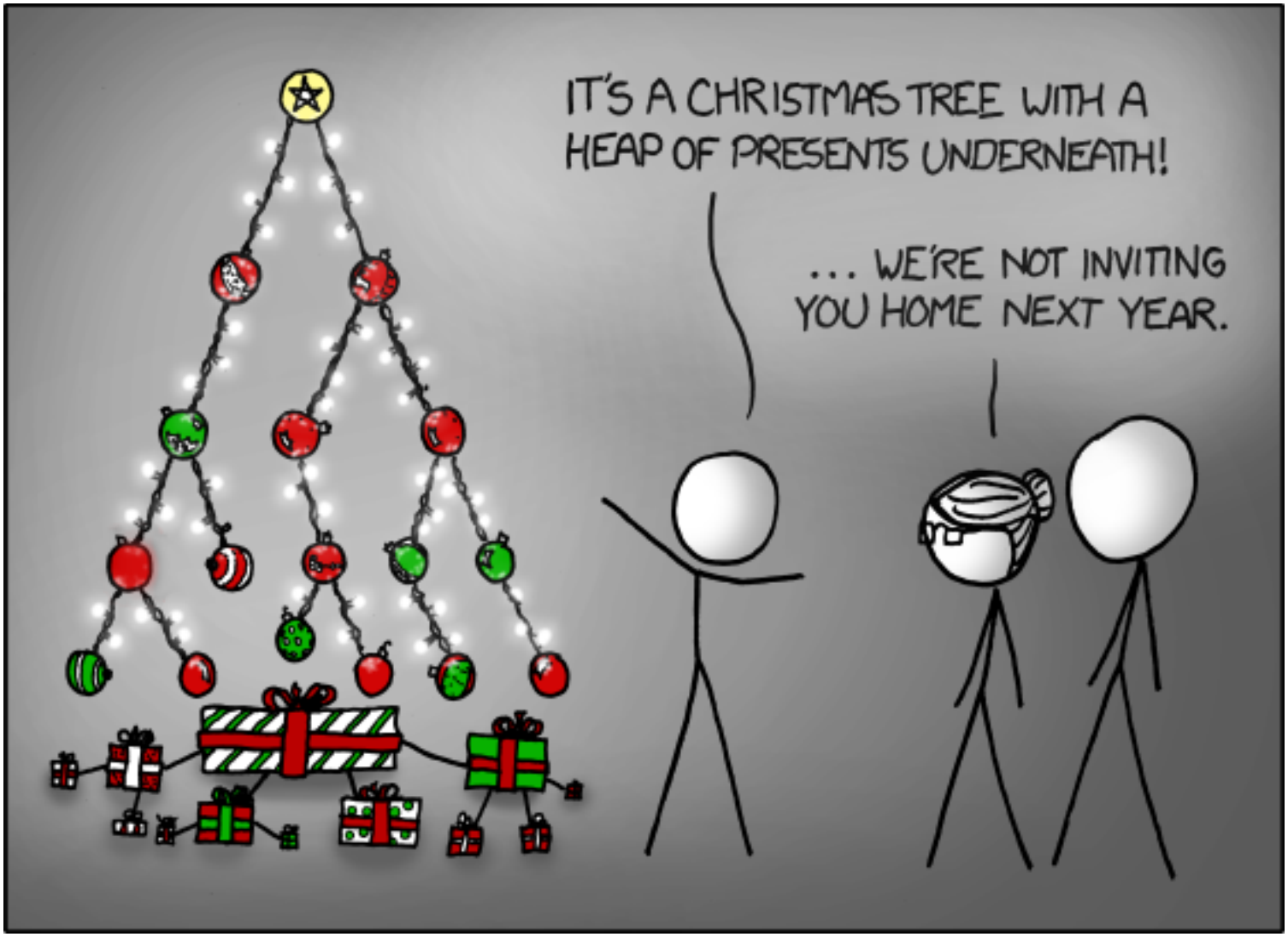
[relative address]

relative path

```
(base) emustafa@emu-nsf lec_fileTrees % cd books
(base) emustafa@emu-nsf books % pwd
/Users/emustafa/Documents/CS111-Spring22/lec_fileTrees/books
```

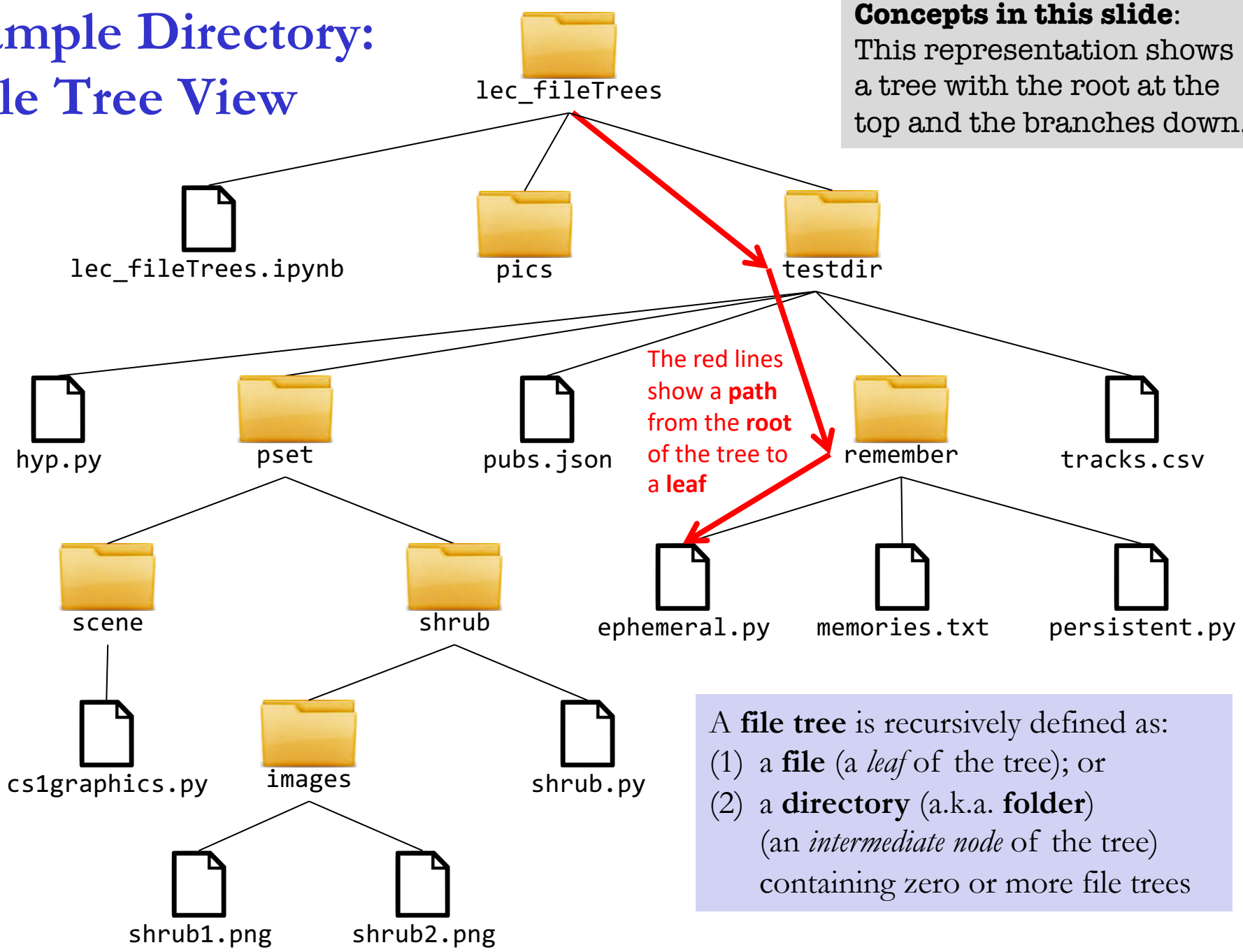
absolute path

Trees – a data structure in CS



Sample Directory: File Tree View

Concepts in this slide: This representation shows a tree with the root at the top and the branches down.



A **file tree** is recursively defined as:
(1) a **file** (a *leaf* of the tree); or
(2) a **directory** (a.k.a. **folder**) (an *intermediate node* of the tree) containing zero or more file trees

File System Operations: `os.getcwd`

Concepts in this slide: The Python module **os** has all functionalities needed to operate with files and folders.

Via the **os** module (os = operating system), Python provides a way to manipulate the directories and files in a file system. To use these features, we first need to import the **os** module:

```
import os
```

The **os.getcwd** function returns the **current working directory** as a string. This is the directory that the Python program is currently "connected" to. All **relative** file names will be interpreted **relative** to this directory.

```
In [1]: import os

In [2]: os.getcwd()
Out[2]: '/Users/wendy/Downloads/lec_fileTrees'
```

components of a **file path** are separated by /

To Notice

The function **getcwd** returns an **absolute** path, containing all directory names in the path to the current one. A path name that is not absolute is known as **relative**.

File System Operations: `os.listdir`

The **`os.listdir`** function returns a list of all files/directories in the argument directory.

`os.listdir` shows "dot files" that are often hidden on Macs

```
In [3]: os.listdir(os.getcwd())
Out[3]: ['.DS_Store', '.data', '.ipynb_checkpoints', 'lec_fileTrees.ipynb',

'pics', 'testdir']
```

`'.'` is a synonym for the current directory

```
In [4]: os.listdir('.')
Out[4]: ['.DS_Store', '.data', .ipynb_checkpoints', 'lec_fileTrees.ipynb',
'pics', 'testdir']

In [5]: os.listdir('testdir')
Out[5]: ['.DS_Store', '.numbers', 'hyp.py', 'pset', 'pubs.json', 'remember',
'tracks.csv']

In [6]: os.listdir('testdir/remember')
Out[6]: ['.DS_Store', 'ephemeral.py', 'memories.txt', 'persistent.py']

In [7]: os.listdir('testdir/pset')
Out[7]: ['.DS_Store', 'scene', 'shrub']

In [8]: os.listdir('testdir/pset/shrub')
Out[8]: ['.DS_Store', 'images', 'shrub.py']

In [9]: os.listdir('testdir/pset/shrub/images')
Out[9]: ['.DS_Store', 'shrub1.png', 'shrub2.png']
```

components of a **file path** are separated by /

`'.DS_store'` is a data file for a folder in macOS

To Notice

We used **relative** pathnames in lines 4 to 9. These are relative with respect to the current directory in which we are in.

File System Operations: `os.path.exists`

The **`os.path.exists`** function determines whether the given name denotes a file/directory in the filesystem. It returns a Boolean value.

```
In [10]: os.path.exists('testdir/remember/memories.txt')
Out[10]: True

In [11]: os.path.exists('testdir/remember/catPlaysPiano.png')
Out[11]: False

In [12]: os.path.exists('testdir/remember')
Out[12]: True

In [13]: os.path.exists('remember/memories.txt')
Out[13]: False # this is not a path from working directory

In [14]: os.path.exists('memories.txt')
Out[14]: False # this is not a path from working directory
```

File System Ops: `os.path.isfile` & `os.path.isdir`

`os.path.isfile` and **`os.path.isdir`** determine whether the given name is a file or directory, respectively. If the file does not exist, these return **`False`**.

```
In [15]: os.path.isdir('testdir/remember')
Out[15]: True

In [16]: os.path.isfile('testdir/remember')
Out[16]: False

In [17]: os.path.isdir('testdir/remember/memories.txt')
Out[17]: False

In [18]: os.path.isfile('testdir/remember/memories.txt')
Out[18]: True

In [19]: os.path.isdir('memories.txt')
Out[19]: False

In [20]: os.path.isfile('memories.txt')
Out[20]: False
```

These return **`False`** because we did not provide the relative path to the file. If no path is given, Python looks for it in the current working directory.

File System Ops: `os.path.join` & `os.path.basename`

`os.path.join` is a clearer and less error-prone way of joining directories and a filename into a path than concatenating strings with **`'/'`**

```
In [21]: os.path.join('testdir', 'remember')
Out[21]: 'testdir/remember'

In [22]: os.path.join('testdir', 'remember', 'memories.txt')
Out[22]: 'testdir/remember/memories.txt'
```

`os.path.basename` returns the last component of a file path.

```
In [23]: os.path.basename('testdir/remember/memories.txt')
Out[23]: 'memories.txt'

In [24]: os.path.basename('testdir/remember')
Out[24]: 'remember'

In [25]: os.path.basename('testdir/remember/')
Out[25]: ''
```

File System Operations: `path.getsize`

The **`os.path.getsize`** function returns the size of the file (in bytes). For text files, this is the number of characters.

```
In [26]: os.path.getsize('testdir/remember/memories.txt')
Out[26]: 80

In [27]: os.path.getsize('testdir/remember/persistent.py')
Out[27]: 1634

In [28]: os.path.getsize('testdir/pset/shrub/images/shrub1.png')
Out[28]: 27248

In [29]: os.path.getsize('testdir/pset/shrub/images')
Out[29]: 136
```

The size of a directory is related to the "meta information" the directory holds for subdirectories and files. It is **not** the sum total of the sizes of the contained files.

File System Operations: A summary

Concepts in this slide: All functions from the **os** module that we encountered in this lecture.

Function Name	Description
os.getcwd	Get current working directory (shows its full name)
os.listdir	List directory (list the names of files and subfolders within it)
os.chdir	Change directory to the provided argument.
os.path.exists	Returns true if the provided argument exists as a file or directory.
os.path.isfile	Returns true if the provided argument corresponds to a file.
os.path.isdir	Returns true if the provided argument corresponds to a directory.
os.path.join	Join any number of path components into a path name
os.path.basename	Returns the last component of a file or directory path
os.path.getsize	Returns an integer value, the size in bytes of a file or directory.

There are many other file system operations. See the documentation at https://docs.python.org/3/library/os.html and https://docs.python.org/3/library/os.path.html