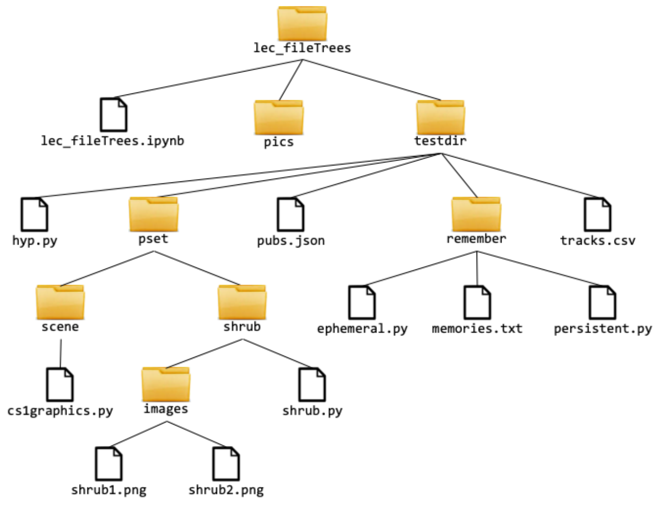
Recursive File Tree Traversal



CS111 Computer Programming

Department of Computer Science
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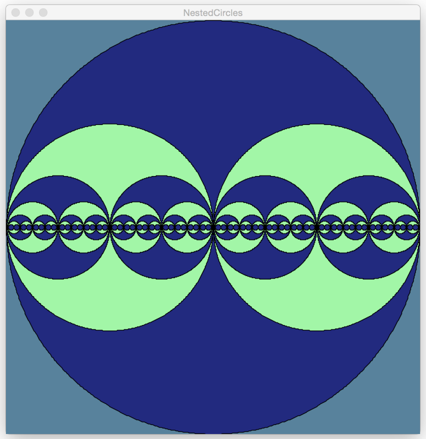
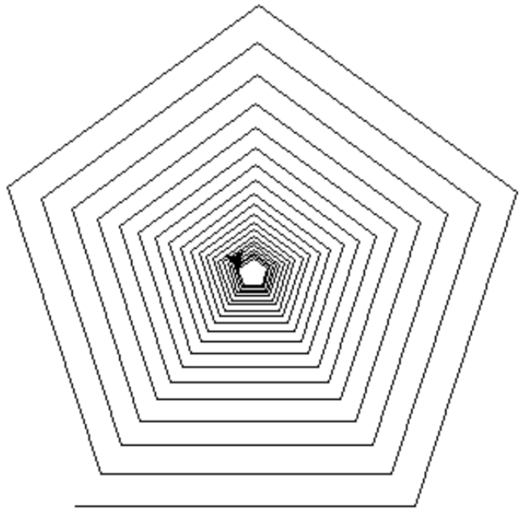
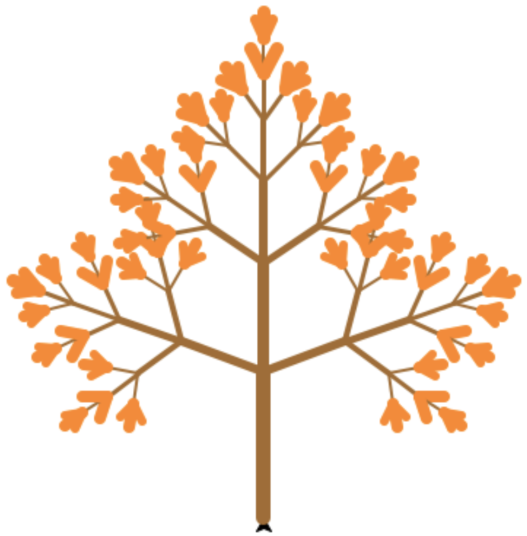
Motivation: Practical Recursion on File Systems

So far we have used recursion to make self-similar pictures with Turtles.



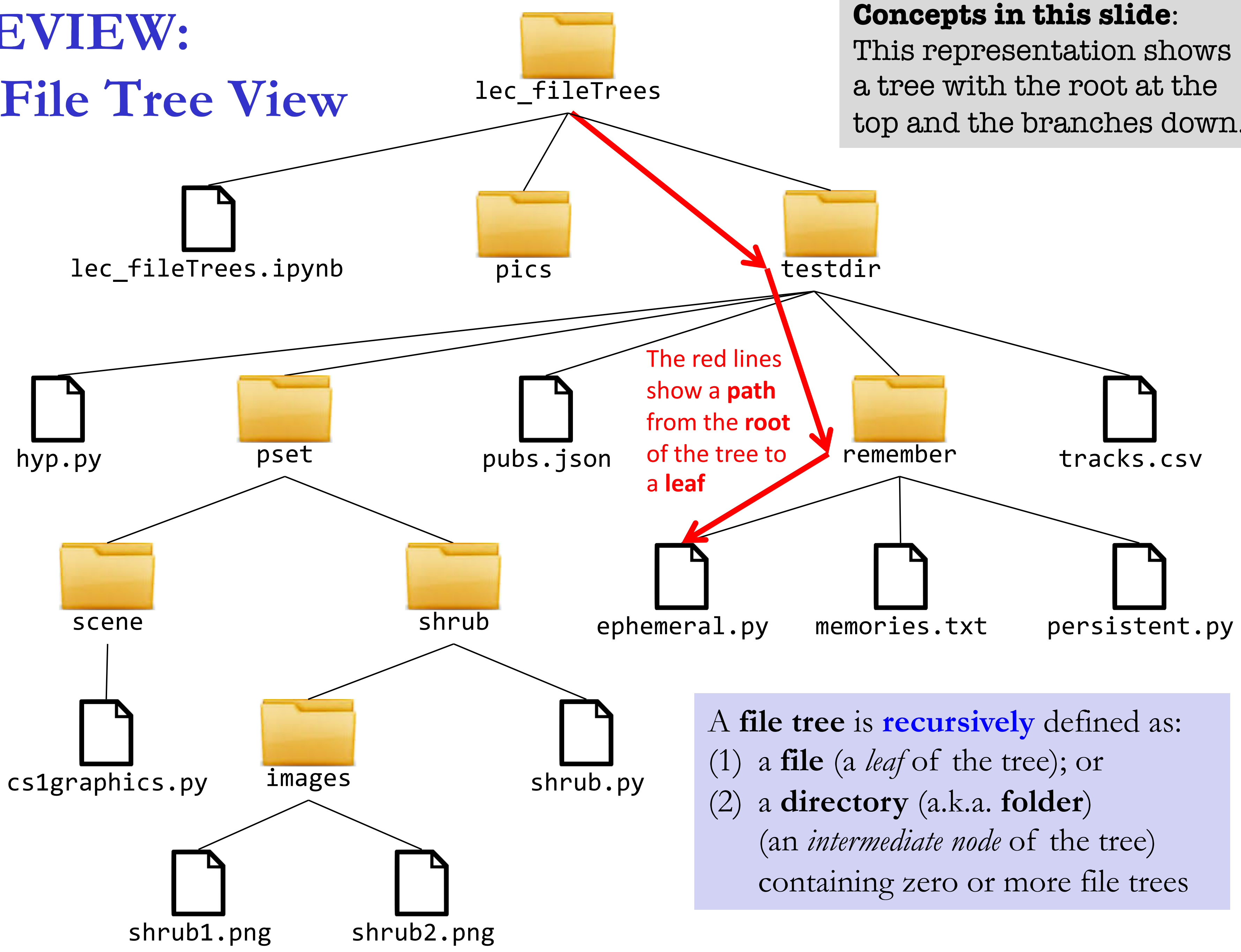



But can recursion be used to solve more practical problems? **YES!**

Today we'll see that the file system on your computer is organized in a recursive way, and so it's most natural to process it using recursive functions. There are many practical recursive functions that "walk" over trees of folders and files.

REVIEW: A File Tree View

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

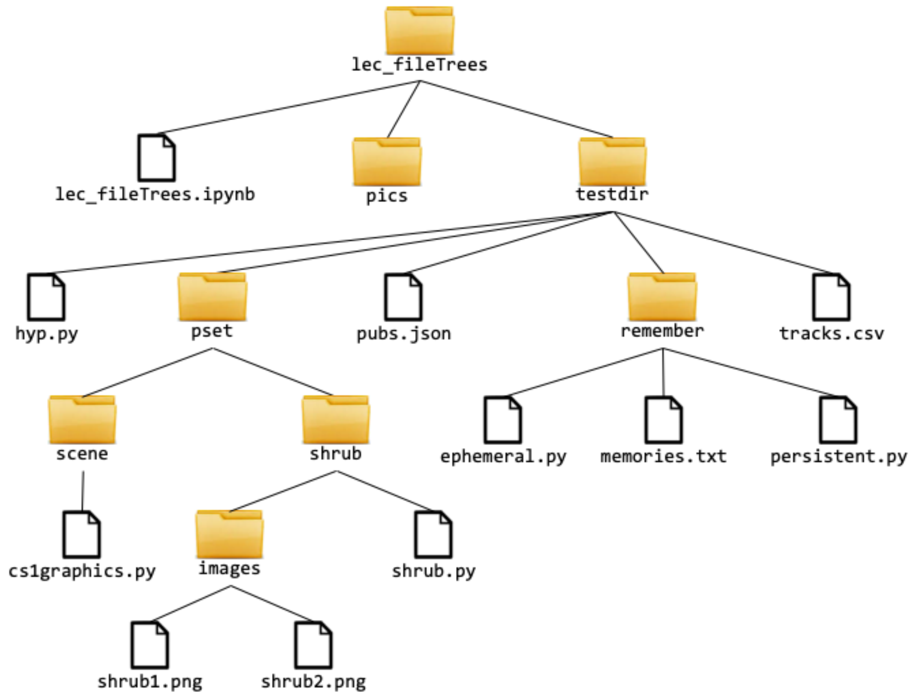


A **file tree** is **recursively** defined as:

(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 Tree Traversal: Print all Dirs and Files



```
In [25]: printFileTree('testdir')
testdir
testdir/hyp.py
testdir/pset
testdir/pset/scene
testdir/pset/scene/cs1graphics.py
testdir/pset/shrub
testdir/pset/shrub/images
testdir/pset/shrub/images/shrub1.png
testdir/pset/shrub/images/shrub2.png
testdir/pset/shrub/shrub.py
testdir/pubs.json
testdir/remember
testdir/remember/ephemeral.py
testdir/remember/memories.txt
testdir/remember/persistent.py
testdir/tracks.csv
```

`printFileTree` is a recursive function that visits all nodes of the file tree and prints out the relative pathnames of all the nonhidden files and directories it encounters.

```
In [26]: printFileTree('testdir/hyp.py')
testdir/hyp.py

In [27]: printFileTree('testdir/remember')
testdir/remember
testdir/remember/ephemeral.py
testdir/remember/memories.txt
testdir/remember/persistent.py
```

File Tree Traversal: Broken Version

```
def printFileTreeBroken(root):
    '''Print all directories and files
    (one per line) starting at root,
    which is a directory or file name'''
    if os.path.isfile(root):
        print(root)
    elif os.path.isdir(root):
        print(root)
        for fileOrDir in os.listdir(root):
            printFileTreeBroken(fileOrDir)
```

Implicit `else: pass` at end handles other file types and nonexistent file names by doing nothing for them.

```
In [28]: printFileTreeBroken('testdir')
testdir
.DS_Store
```

Why does this print only two names?

```
In [29]: os.listdir('testdir')
Out[29]: ['.DS_Store', '.numbers', 'hyp.py', 'pset', 'pubs.json',
'remember', 'tracks.csv']

In [30]: os.path.isfile('hyp.py')
Out[30]: False

In [31]: os.path.isfile('testdir/hyp.py')
Out[31]: True
```

File Tree Traversal: Better Version

Concepts in this slide:
Fixes the error from slide 5, by providing the complete relative pathname.

```
def printFileTreeBetter(root):
    if os.path.isfile(root):
        print(root)
    elif os.path.isdir(root):
        print(root)
        for fileOrDir in os.listdir(root):
            printFileTreeBetter(os.path.join(root, fileOrDir))
```

This acts like **`root + '/' + fileOrDir`**, but is clearer and less error prone.

```
In [32]: printFileTreeBetter('testdir')
testdir
testdir/.DS_Store
testdir/.numbers
testdir/hyp.py
testdir/pset
testdir/pset/.DS_Store
testdir/pset/scene
testdir/pset/scene/cs1graphics.py
…
```

Dot files are still printed, but we'd like to hide them.

Testing for Hidden Files

```
def isHiddenFile(path):
    base = os.path.basename(path)
    return (len(base) > 0
            and base[0] == '.'
            and base != '.'
            and base != '..')
```

'.' (current directory) and '..' (parent directory) are special cases of paths beginning with dots that are not hidden.

```
In [32]: isHiddenFile('.DS_Store')
Out[32]: True

In [33]: isHiddenFile('testdir/psets/.DS_Store')
Out[33]: True

In [35]: isHiddenFile('testdir/psets/memories.txt')
Out[35]: False

In [36]: isHiddenFile('.')
Out[36]: False
```

File Tree Traversal: Final Correct Version that Filters out Dot Files

```
def printFileTree(root):
    if isHiddenFile(root):
        pass # filter out dot files
    elif os.path.isfile(root):
        print(root)
    elif os.path.isdir(root):
        print(root)
        for fileOrDir in os.listdir(root):
            printFileTree(os.path.join(root, fileOrDir))
```

```
In [32]: printDirectoryTree('testdir')
testdir
testdir/hyp.py
testdir/pset
testdir/pset/scene
testdir/pset/scene/cs1graphics.py
testdir/pset/shrub
testdir/pset/shrub/images
testdir/pset/shrub/images/shrub1.png
testdir/pset/shrub/images/shrub2.png
…
```

Exercise 1: File Tree Traversal: Print Files Only

```
def printFiles(root):
    '''Print only the (nondirectory) files encountered
       in a file tree traversal starting at root'''
    # flesh this out
```

it's your turn

```
In [35]: printFiles('testdir')
testdir/hyp.py
testdir/pset/scene/cs1graphics.py
testdir/pset/shrub/images/shrub1.png
testdir/pset/shrub/images/shrub2.png
testdir/pset/shrub/shrub.py
testdir/pubs.json
testdir/remember/ephemeral.py
testdir/remember/memories.txt
testdir/remember/persistent.py
testdir/tracks.csv
```

Exercise 2: File Tree Traversal: Print Dirs Only

```
def printDirs(root):
    '''Print only the directories encountered in a
       file tree traversal starting at root'''
    # flesh this out
```

```
In [34]: printDirs('testdir')
testdir
testdir/pset
testdir/pset/scene
testdir/pset/shrub
testdir/pset/shrub/images
testdir/remember
```

Exercise 3: File Tree Traversal: Count Files Only

it's *your* turn

```
def countFiles(root):
    '''Returns the number of (nondirectory) files encountered
       in a file tree traversal starting at root'''

   if isHiddenFile(root):
       return ?? # What goes here?
   elif os.path.isfile(root):
       return ?? # What goes here?
   elif os.path.isdir(root):
       # flesh this out
```

```
In [37]: countFiles('testdir')
Out[37]: 10
```

Exercise 4: File Tree Traversal: Count Dirs Only

it's your turn

```
def countDirs(root):
    '''Returns the number of directories encountered in a
       file tree traversal starting at root'''

    if isHiddenFile(root):
         return ?? # What goes here?
    elif os.path.isdir(root):
         # flesh this out








    else:
         return ?? # What goes here?
```

```
In [36]: countDirs('testdir')
Out[36]: 6
```