UC Berkeley EECS
Lecturer
Michael Ball

Computational Structures in Data Science

Tree Recursion

Announcements

- Midterm Grading: Out later this week
  - We are taking bugs into account that happened during the test.
  - We'll have a 1 week window for regrades after scores are released.
- Clobber Policy:
  - You will be able to replace you midterm score with your final exam score if it's higher. You don't need to do anything to take advantage of this.
- Maps
  - First project will be out Wednesday! You have all you need to know, but Wednesday's lecture may be helpful.
  - You'll have a couple weeks to do it.
- CA Online Voter Registration Deadline is 10/19
  - https://registertovote.ca.gov

Learning Objectives

- Write Recursive functions with multiple recursive calls
- Understand Recursive Fibonacci
- Understand the quicksort algorithm

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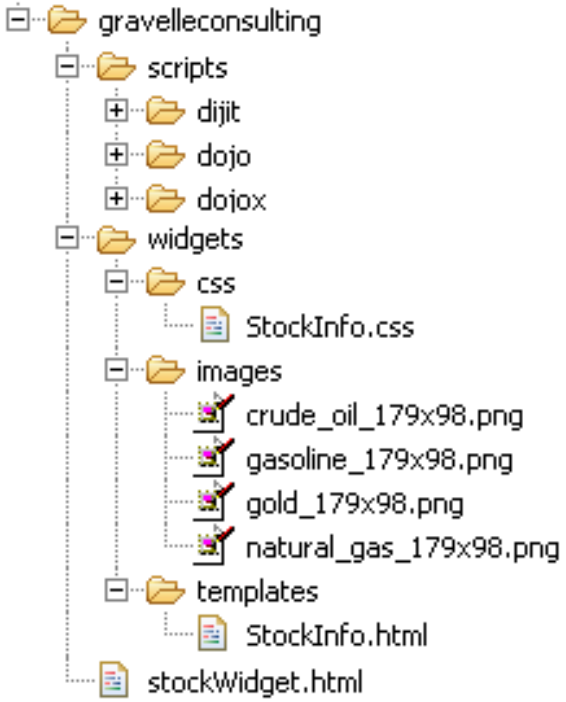
Tree Recursion: Fibonacci

Tree Recursion

- Recursion which involves multiple recursive calls to solve a problem.
- Drawing out a function usually looks like an “inverted” tree.

Example I

List all items on your hard disk



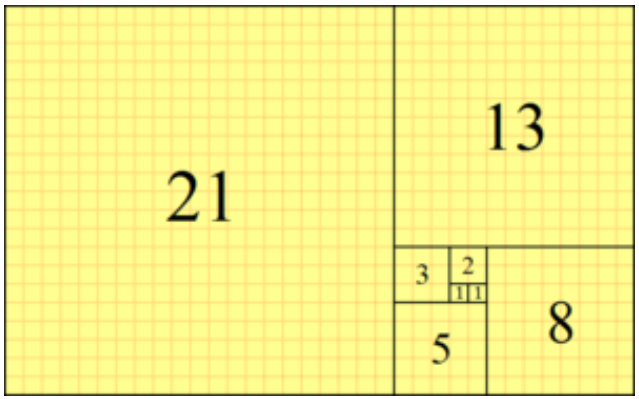
- Files
- Folders contain
  - Files
  - Folders

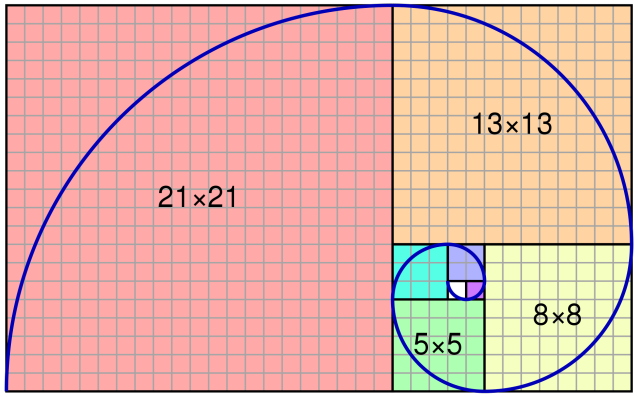
```
def process_directory(directory):
    for item in directory:
        if is_file(item):
            process_file(item)
        else:
            process_directory(item)
```

The Fibonacci Sequence


```
fibonacci(n) = fibonacci(n-1) + fibonacci(n-2)
      where fibonacci(1) == 1 and fibonacci(0) == 0
```

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89…





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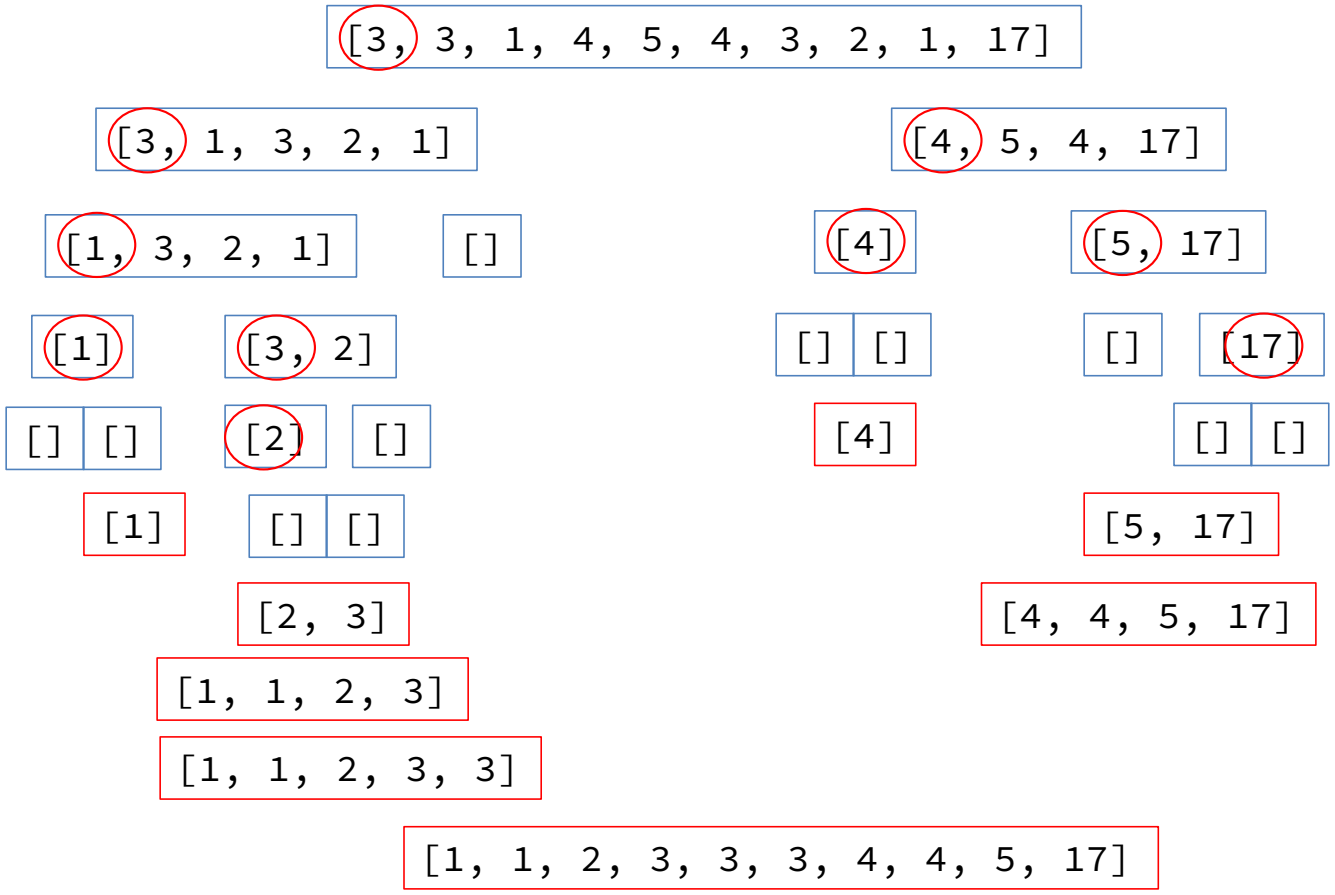
Tree Recursion: Quicksort

Quicksort

- A fairly simple to sorting algorithm
- Goal: Sort the list by breaking it into partially sorted parts
  - Pick a "pivot", a starting item to split the list
  - Remove the pivot from your list
  - Split the list into 2 parts, a smaller part and a bigger part
  - Then recursively sort the smaller and bigger parts
  - Combine everything together: the smaller list, the pivot, then the bigger list

QuickSort Example



Tree Recursion

- Break the problem into multiple smaller sub-problems, and Solve them recursively

```
def split(x, s):
    return [i for i in s if i <= x], [i for i in s if i > x]

def quicksort(s):
    """Sort a sequence - split it by the first element,
    sort both parts and put them back together."""
    if not s:
        return []
    else:
        pivot = s[0]
        smaller, bigger = split(pivot, s[1:])
        return quicksort(smaller) + [pivot] + quicksort(bigger)

>>> quicksort([3,3,1,4,5,4,3,2,1,17])
[1, 1, 2, 3, 3, 3, 4, 4, 5, 17]
```