UC Berkeley EECS
Lecturer
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Computational Structures in Data Science

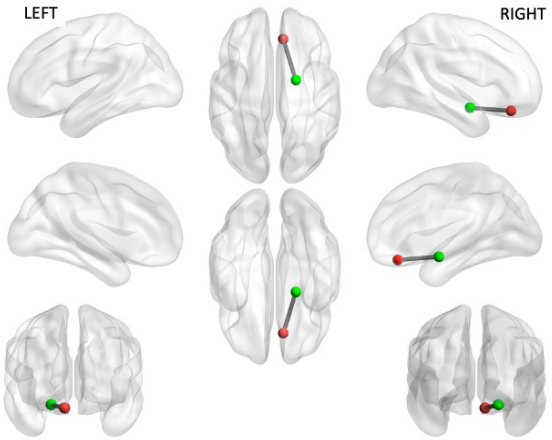
Lists & Higher Order Functions

Announcements

- Labs:
  - Practice questions are required.
  - Lab 3 okpy check is currently broken, but you'll still get credit when we grade.
- Midterm: Oct 7, 7-9pm
  - We will be using Zoom to proctor, details in a couple weeks
  - Also we will have an alternate for conflicts

Computing In the News: Predicting Anxiety

- "Smartphones can Predict Brain Function Associated with Anxiety and Depression" (Dartmouth)



Researchers used mobile sensing data to predict brain connectivity between the ventromedial prefrontal cortex (red) and right amygdala (green). The functional connectivity between these two regions is known to be associated with various aspects of mental health.
Image courtesy of Jeremy Huckins.

Learning Objectives

- Learn three new common Higher Order Functions:
  - Map, filter, reduce
- These each apply a function to a list (sequence) of data
- Map: Returns a new list
- Filter: Returns a list, possibly a shorter one.
- Reduce: "Combines" items together, probably doesn't return a list.

MAP

```
list(map(function_to_apply, list_of_inputs))
```

Transform each of items by a function.

e.g. square()

Inputs (Domain):

- Function
- Sequence

Output (Range):

- A sequence

```
def map(function, sequence):
    return [ function(item) for item in sequence ]

list(map(square, range(10)))
```

FILTER

```
list(filter(function, list_of_inputs))
```

Keeps each of item where the function is true.

Inputs (Domain):

- Function
- Sequence

Output (Range):

- A sequence

```
def filter(function, sequence):
    return [ item for item in sequence if function(item) ]
```

REDUCE

```
reduce(function, list_of_inputs)
```

Successively **combine** items of our sequence

- function: add(), takes 2 inputs gives us 1 value.

Inputs (Domain):

- Function, with 2 inputs
- Sequence

Output (Range):

- An item, the type is the output of our function.

```
def reduce(function, sequence):
    result = function(sequence[0], sequence[1])
    for index in range(2, len(sequence)):
        result = function(result, sequence[index])
    return result
```

Today's Task: Acronym

```
Input: "The University of California at Berkeley"

Output: "UCB"

def acronym(sentence):
      """YOUR CODE HERE"""
```

P.S. Pedantry alert: This is really an *initialism* but that's rather annoying to say and type. ☺ (However, the code we write is the same, the difference is in how you pronounce the result.) The more you know!

Three super important HOFS

* For the builtin filter/map, you need to then call list on it to get a list.
If we define our own, we do not need to call list

```
list(map(function_to_apply, list_of_inputs))
```

Applies function to each element of the list

```
list(filter(condition, list_of_inputs))
```

Returns a list of elements for which the condition is true

```
reduce(function, list_of_inputs)
```

Applies the function, combining items of the list into a "single" value.

Bonus / Review

- Left over slides we didn't get to.

What does this do?

```
list(map(capitalize,
    ['michael', 'Alex', 'Srinath', 'julia']
))

Assume capitalize('michael') == 'Michael'
```

A) `['michael', 'Alex', 'Srinath', 'julia']`
B) `['Michael', 'Alex', 'Srinath', 'Julia']`
C) []
D) Error
E) I'm lost.

What does this do?

```
list(filter(return_false,
    range(100)
))

Assume return_false(42) == False
```

A) `range(0, 100) # A standard range object`
B) `[0, 1, 2, … 96, 97, 98, 99]`
C) `[]`
D) Error
E) I'm lost.

Higher Order Functions

- **Functions that operate on functions**
- **A function**

```
def odd(x):
    return x%2==1

odd(3)
True
```

- **A function that takes a function arg**

```
def filter(fun, s):
    return [x for x in s if fun(x)]

filter(odd, [0,1,2,3,4,5,6,7])
[1, 3, 5, 7]
```

Why is this not 'odd' ?

Higher Order Functions (cont)

- **A function that returns (makes) a function**

```
def leq_maker(c):
    def leq(val):
        return val <= c
    return leq
```

```
>>> leq_maker(3)
<function leq_maker.<locals>.leq at 0x1019d8c80>

>>> leq_maker(3)(4)
False

>>> filter(leq_maker(3), [0,1,2,3,4,5,6,7])
[0, 1, 2, 3]
```