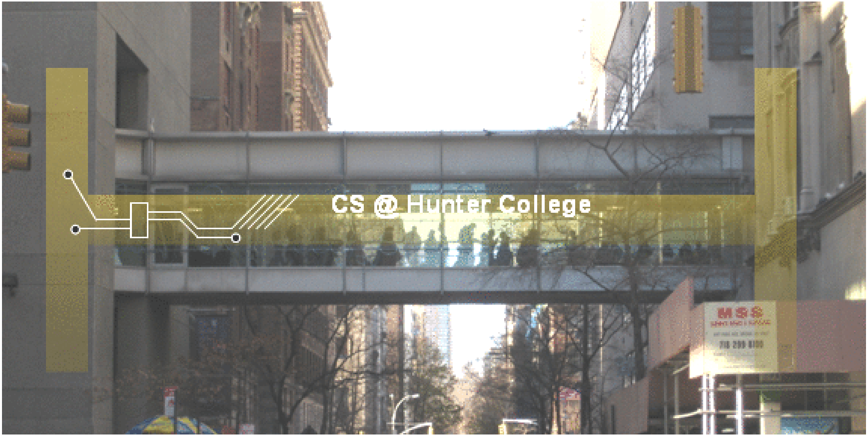
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

- Each lecture includes a survey of computing research and tech in NYC.

  Today: Prof. Susan Epstein
  Machine Learning

Today's Topics

- Recap: Functions & Top Down Design
- Mapping GIS Data
- Loops
- CS Survey

In Pairs or Triples:

```
def prob4(amy, beth):
    if amy > 4:
        print("Easy case")
        kate = -1
    else:
        print("Complex case")
        kate = helper(amy,beth)
    return(kate)
```

```
def helper(meg,jo):
    s = ""
    for j in range(meg):
        print(j, ": ", jo[j])
        if j % 2 == 0:
            s = s + jo[j]
            print("Building s:", s)
    return(s)
```

- What are the formal parameters for the functions?
- What is the output of:

```
r = prob4(4,"city")
print("Return:  ", r)
```

- What is the output of:

```
r = prob4(2,"university")
print("Return:  ", r)
```

Python Tutor

```
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    if amy > 4:
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    else:
        print("Complex case")
        kate = helper(amy,beth)
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        if j % 2 == 0:
            s = s + jo[j]
            print("Building s:", s)
    return(s)
```

(Demo with `pythonTutor`)

In Pairs or Triples:

- Write the missing functions for the program:

```
def main():
    tess = setUp()     #Returns a purple turtle with pen up.
    for i in range(5):
        x,y = getInput()       #Asks user for two numbers.
        markLocation(tess,x,y) #Move tess to (x,y) and stamp.
```

Group Work: Fill in Missing Pieces

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def main():
    tess = setUp()    #Returns a purple turtle with pen up.
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Group Work: Fill in Missing Pieces

1. Write import statements.

```
import turtle
```

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def main():
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```

Third Part: Fill in Missing Pieces

1. Write import statements.
2. Write down new function names and inputs.

```
import turtle
def setUp():
    #FILL IN
def getInput():
    #FILL IN
def markLocation(t,x,y):
    #FILL IN




def main():
    tess = setUp()    #Returns a purple turtle with pen up.
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Third Part: Fill in Missing Pieces

1. Write import statements.
2. Write down new function names and inputs.
3. Fill in return values.

```
import turtle
def setUp():
    #FILL IN
    return(newTurtle)
def getInput():
    #FILL IN
    return(x,y)
def markLocation(t,x,y):
    #FILL IN



def main():
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```

Third Part: Fill in Missing Pieces

1. Write import statements.
2. Write down new function names and inputs.
3. Fill in return values.
4. Fill in body of functions.

```
import turtle
def setUp():
    newTurtle = turtle.Turtle()
    newTurtle.penup()
    return(newTurtle)
def getInput():
    x = int(input('Enter x: '))
    y = int(input('Enter y: '))
    return(x,y)
def markLocation(t,x,y):
    t.goto(x,y)
    t.stamp()
def main():
    tess = setUp()    #Returns a purple turtle with pen up.
    for i in range(5):
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Top-Down Design

- The last example demonstrates **top-down design**: breaking into subproblems, and implementing each part separately.

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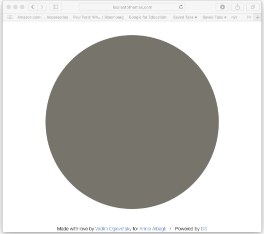
    - Break the problem into tasks for a "To Do" list.
    - Translate list into function names & inputs/returns.
    - Implement the functions, one-by-one.
- Excellent approach since you can then test each part separately before adding it to a large program.
- Very common when working with a team: each has their own functions to implement and maintain.

From Last Time: koalas



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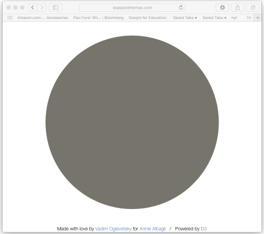

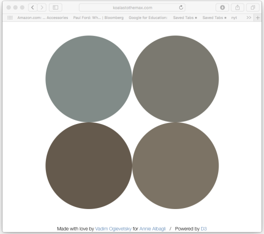

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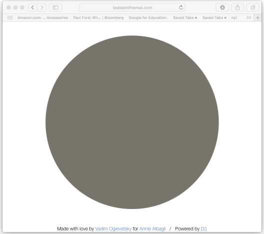

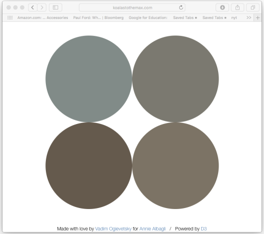

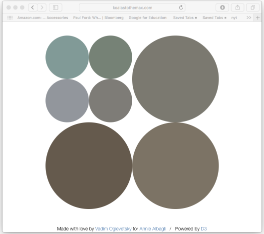

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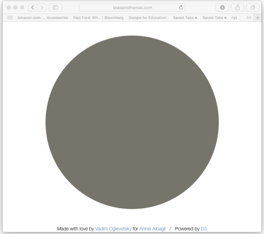

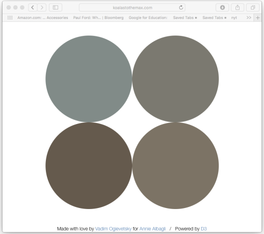

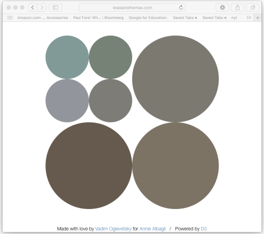

`http://koalastothemax.com`

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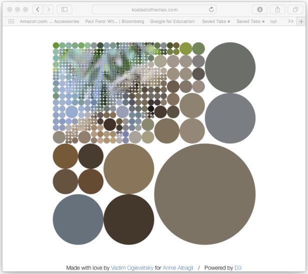

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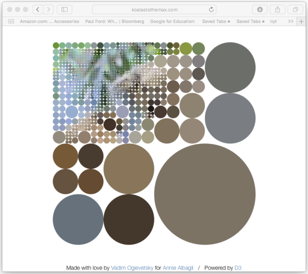

- Top-down design puzzle:
  - What does `koalastomax` do?
  - What does each circle represent?
- Write a high-level design for it.
- Translate into a `main()` with function calls.

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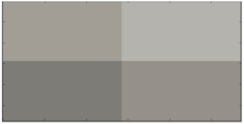

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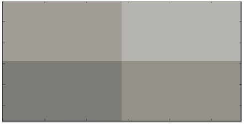
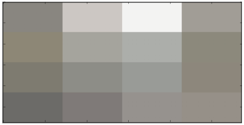

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 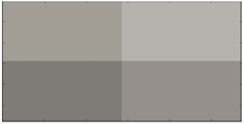 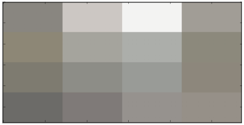

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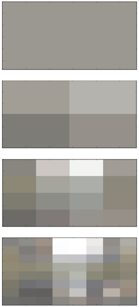

```python
def main():
    inFile = input('Enter image file name: ')
    img = plt.imread(inFile)

    #Divides the image in 1/2, 1/4, 1/8, ... 1/2^8, and displays each:
    for i in range(8):
        img2 = img.copy()    #Make a copy to average
        quarter(img2,i)      #Split in half i times, and average regions

        plt.imshow(img2)     #Load our new image into pyplot
        plt.show()           #Show the image (waits until closed to continue)

    #Shows the original image:
    plt.imshow(img)          #Load image into pyplot
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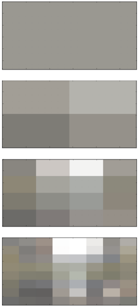

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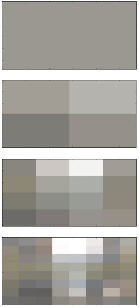
From Last Time: koalas



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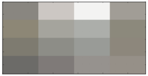
```

- The `main()` is written for you.
- Only fill in two functions: `average()` and `setRegion()`.

From Last Time: koalas

Process:

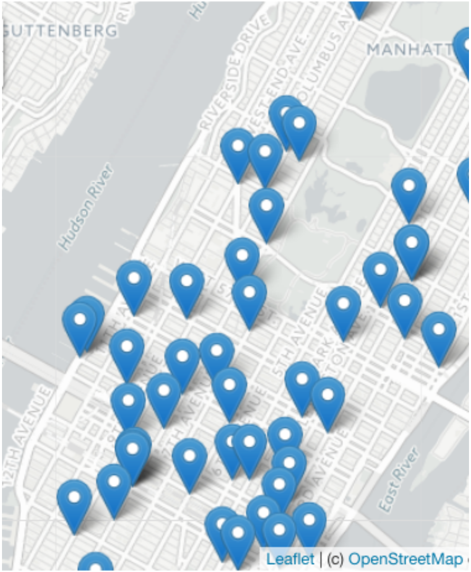


Get template from `github` → Fill in missing functions → Test locally idle3/python3 → Submit to Gradescope

Today's Topics

- Recap: Functions & Top Down Design
- **Mapping GIS Data**
- Loops
- CS Survey

Folium



GUTTENBERG
MANHATT
Hudson River
East River
RIVERSIDE DRIVE
COLUMBUS AV
12TH AVENUE
Leaflet | (c) OpenStreetMap

Folium

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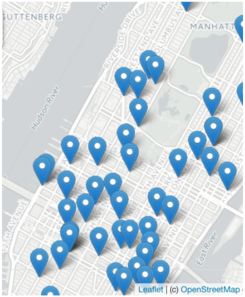
- Outputs `.html` files which you can open in a browser.
- An extra step:

Write code. → *Run program.* → *Open .html in browser.*

Demo



(Map created by Folium.)

Folium

- To use:

  ```
  import folium
  ```

Folium

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  `import folium`
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- Make markers:

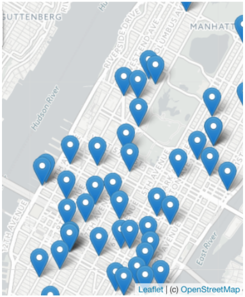
  `newMark = folium.Marker([lat,lon],popup=name)`

- Add to the map:

  `newMark.add_to(myMap)`

- Many options to customize background map ("tiles") and markers.

Demo



(Python program using Folium.)

In Pairs of Triples

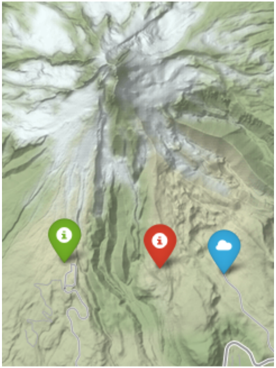
- Predict which each line of code does:

```
m = folium.Map(
    location=[45.372, -121.6972],
    zoom_start=12,
    tiles='Stamen Terrain'
)

folium.Marker(
    location=[45.3288, -121.6625],
    popup='Mt. Hood Meadows',
    icon=folium.Icon(icon='cloud')
).add_to(m)

folium.Marker(
    location=[45.3311, -121.7113],
    popup='Timberline Lodge',
    icon=folium.Icon(color='green')
).add_to(m)

folium.Marker(
    location=[45.3300, -121.6823],
    popup='Some Other Location',
    icon=folium.Icon(color='red', icon='info-sign')
).add_to(m)
```



(example from Folium documentation)

Today's Topics

- Recap: Functions & Top Down Design
- Mapping GIS Data
- **Loops**
- CS Survey

In Pairs or Triples:

Predict what the code will do:

```
dist = int(input('Enter distance: '))
while dist < 0:
    print('Distances cannot be negative.')
    dist = int(input('Enter distance: '))

print('The distance entered is', dist)
```

```
#Spring 2012 Final Exam, #8

nums = [1,4,0,6,5,2,9,8,12]
print(nums)
i=0
while i < len(nums)-1:
    if nums[i] < nums[i+1]:
        nums[i], nums[i+1] = nums[i+1], nums[i]
    i=i+1

print(nums)
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Python Tutor

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Indefinite Loops

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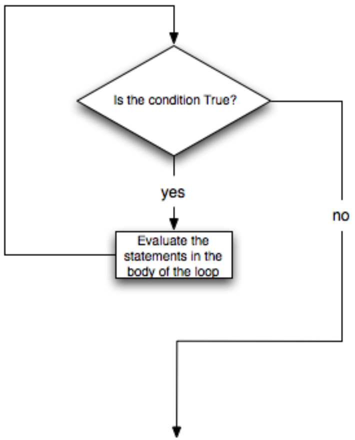

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- Indefinite loops repeat as long as the condition is true.
- Could execute the body of the loop zero times, 10 times, infinite number of times.
- The condition determines how many times.
- Very useful for checking input, simulations, and games.

Python's random package

- Python has a built-in package for generating pseudo-random numbers.

```
import turtle
import random

trey = turtle.Turtle()
trey.speed(10)

for i in range(100):
  trey.forward(10)
  a = random.randrange(0,360,90)
  trey.right(a)
```

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trey.speed(10)

for i in range(100):
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- To use:

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- Useful command to generate whole numbers:

  `random.randrange(start,stop,step)`

  which gives a number chosen randomly from the specified range.

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  which gives a number chosen (uniformly) at random from [0.0,1.0).
- Very useful for simulations, games, and testing.

Trinket

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(Demo turtle random walk)

Today's Topics

- Recap: Functions & Top Down Design
- Mapping GIS Data
- Loops
- **CS Survey**

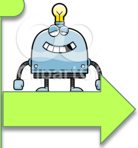
CS Survey Talk

Prof. Susan Epstein
(Machine Learning)

Computational agents

- Computational system implements decisions and actions on a physical device
- A computational agent executes a perpetual sense-decide-act loop

```
Do forever
    Sense the world
    Select an action
    Execute that action
```



- How to sense the world: infrared sonar radar Kinect microphone camera
- Given a set of possible actions, an agent decides by selecting one

Artificial intelligence (AI)

- An AI agent doesn't have to be a robot (embodied in the world)
- An AI agent doesn't have to be autonomous (make decisions entirely on its own)
- But it does have to be smart...
- That means it has to make smart decisions
- Artificial intelligence = simulation of intelligent (human) behavior by a computational agent

Do forever
- **Sense the world**
- **Select an action**
- **Execute that action**

Nest
- Controlled by Wi-Fi from a smartphone
- Reprograms itself based on human behavior

Fall 2018 CSCI 127 2/6

What AI does

- Tackles hard, interesting problems

    Does this image show cancer?

    Should I move this car through the intersection?

    How do I get to that concert?

- Builds models of perception, thinking, and action
- Uses these models to build smarter programs

Our autonomous robot navigators

- Despite uncertainty, noise, and constant changes in the world
- Learn models of their environment
- Make smart decisions with those models

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How our robots navigate

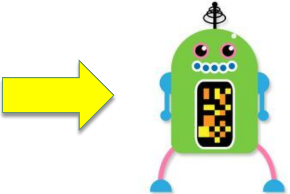
- We built SemaFORR, a robot controller that makes decisions autonomously
- First the robots learn to travel by building a model of the world we put them in
- Then they prove they can find both hard and easy targets there

- Apollo has already done this on a small part of the 10^{th} floor here
- And in simulation ROSie has traveled
  - Through much of Hunter, The Graduate Center, and MOMA
  - Through moving crowds of people
  - Without collision and without coming too close to people
  - And explained her behavior in natural language

How to build an intelligent agent

- Find good problems
- Start simple
- Run lots of experiments
- Analyze the results carefully
- …and repeat

Fun problems Good reasons Learning algorithms



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Want to know more?

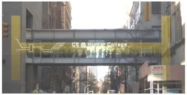
- Fall 2018: SCI 111 Brains, Minds, and Machines = cognitive neuroscience + cognitive psychology + AI
- Fall 2019: CSCI 350 Artificial Intelligence
- Fall 2018: CSCI 353 Machine Learning

- ...and then there's my lab, where workstations run 24/7, learning to be intelligent agents

Susan Epstein, Professor of Computer Science
1090C Hunter North
susan.epstein@hunter.cuny.edu
http://www.cs.hunter.cuny.edu/~epstein/

Recap

- On lecture slip, write down a topic you wish we had spent more time (and why).



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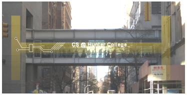

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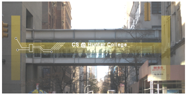

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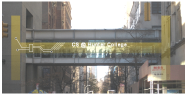

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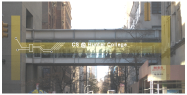

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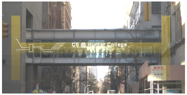

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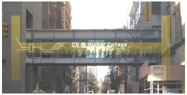

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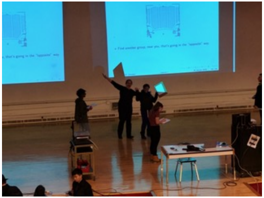
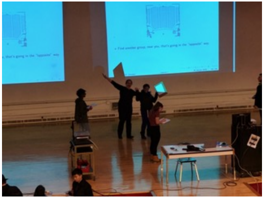
- Pass your lecture slips to the aisles for the UTAs to collect.

Practice Quiz & Final Questions



- Lightning rounds:

Practice Quiz & Final Questions



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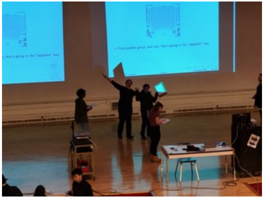  

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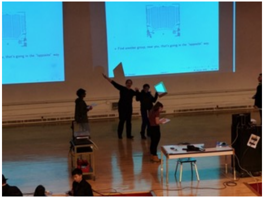

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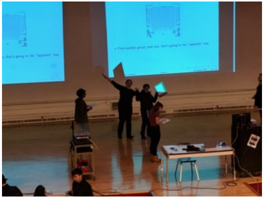

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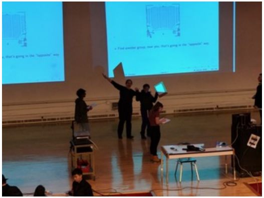

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- Theme: Functions & Top-Down Design (Summer 18, #7 & #5).