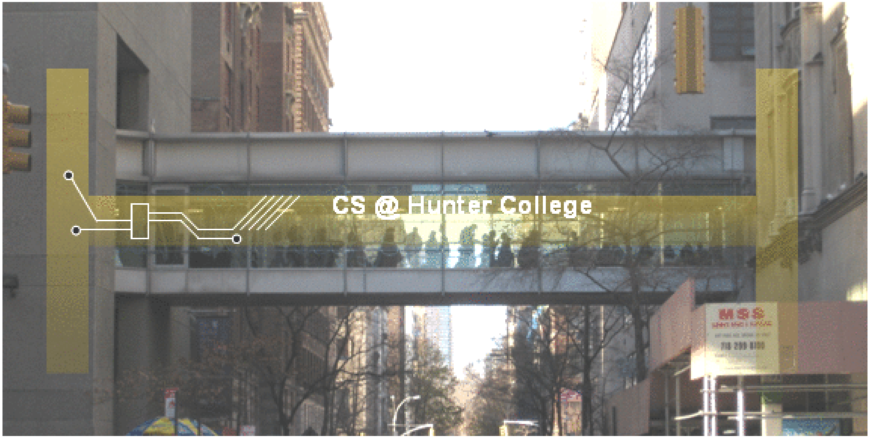
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Today's Topics

- **Recap: Slicing & Images**
- Introduction to Functions
- NYC Open Data

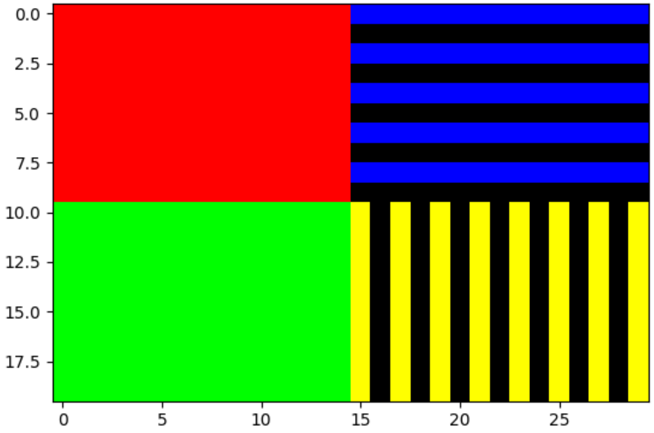
Image and Array

```
import matplotlib.pyplot as plt
import numpy as np #code link in trinket
#code link in replit
height= 20
width = 30

#An image is an array with height, width and
#depth 3 for r(ed) g(reen) b(lue)
img = np.zeros((height, width, 3))
img[ :height//2, :width//2, 0 ] = 1
#which does this statement do? Same as
#img[:height//2, :width//2] = [1,0,0]
```

Image and Array: II

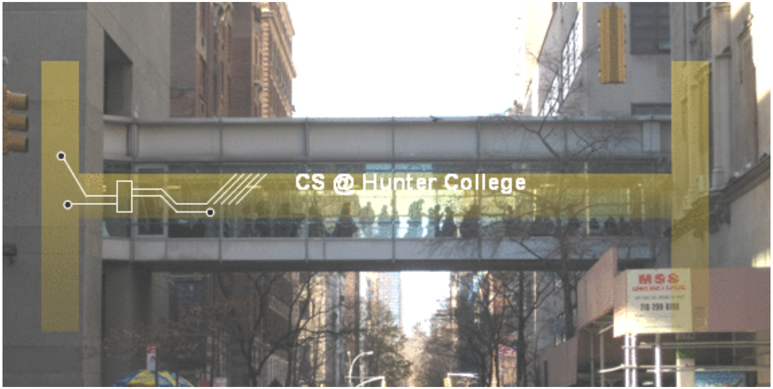
```
img[height//2:, :width//2, 1] = 1
#which does this statement do? Same as
#img[height//2:, :width//2] = [0,1,0]

img[:height//2:2, width//2:, 2] = 1
#What does this statement do?

img[height//2:, width//2::2] = [1, 1, 0]
#What does this statement do?

plt.imshow(img)
plt.show()
```

output for the above program



Challenge: Cropping Images

Crop an image to select the top quarter (upper left corner)



Challenge: Cropping Images

```
import matplotlib.pyplot as plt
import numpy as np #link to replit
#In replit, if do not see cropped image,
   click Tools in left pane, choose Output.
img = plt.imread("csBridge.png")
height = img.shape[0]
width = img.shape[1]
img2 = img[0:height//2, 0:width//2]
#img2 is top left of img. Same as
#img2 = img[:height//2, :width//2].
plt.imshow(img2)
plt.show()
plt.imsave("top_left_csBridge.png", img2)
```

Challenge: Cropping Images

```python
import matplotlib.pyplot as plt
import numpy as np
img = plt.imread('csBridge')
plt.imshow(img)
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img2 = img[:height//2, :width//2]
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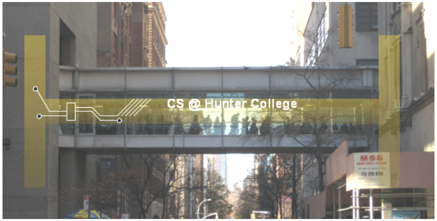

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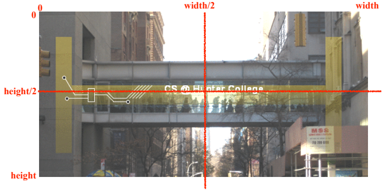

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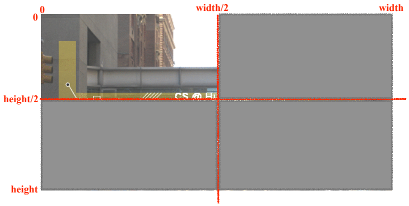

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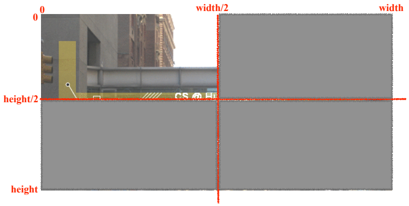

- How would you select the lower left corner?

Challenge: Cropping Images

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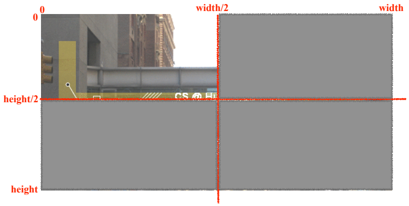

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$$\boxed{img2 = img[height//2 :, :width//2]}$$

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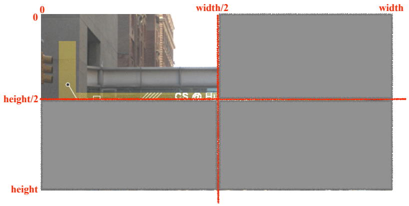

- How would you select the lower left corner?

$$\boxed{img2 = img[height//2 :, :width//2]}$$

- How would you select the upper right corner?

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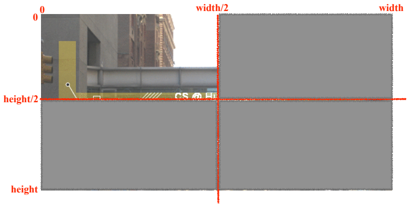

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  img2 = img[height//2 :, :width//2]

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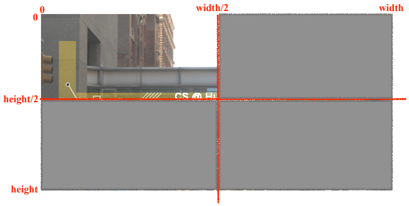

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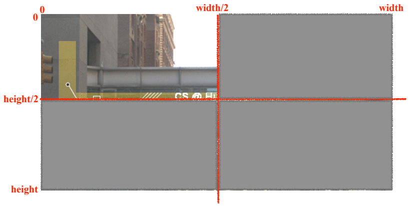

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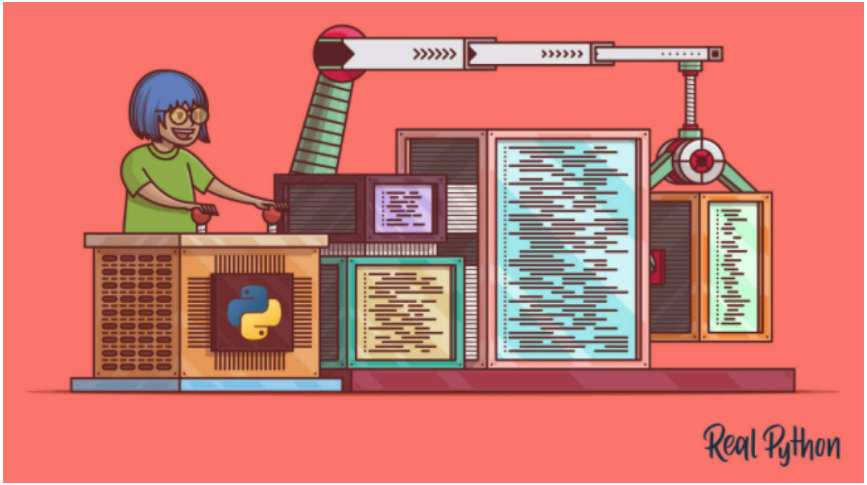
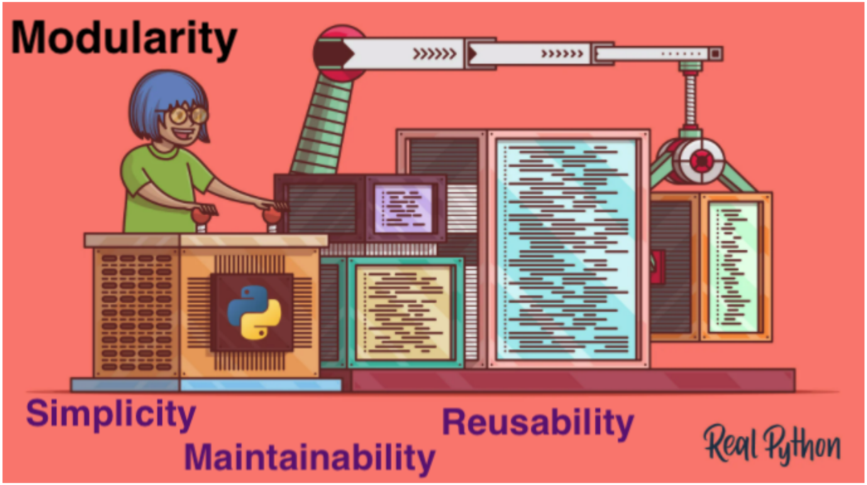
Modularity



Modularity


Modularity
Simplicity
Maintainability
Reusability
Real Python

Functions

- Functions are a way to break code into pieces, that can be easily reused.

```
#Name:  your name here
#Date:  October 2017
#This program, uses functions,
#     says hello to the world!

def main():
     print("Hello, World!")

if __name__ == "__main__":
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- Can write, or **define** your own functions,

Functions

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- The opening function is often called `main()`
- Naming conventions same as variables
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis: Example: `print("Hello", "World")`
- Can write, or **define** your own functions, which are stored, until invoked or called.

“Hello, World!” with Functions

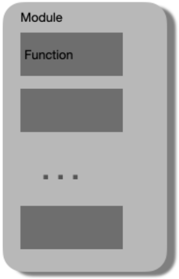
link in PythonTutor

```
#Name:  your name here
#Date:  March 2017
#This program, uses functions,
#     says hello to the world!

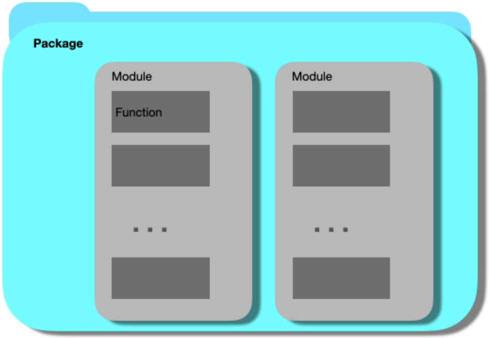
def main():
     print("Hello, World!")

 if __name__ == "__main__":
     main()
```

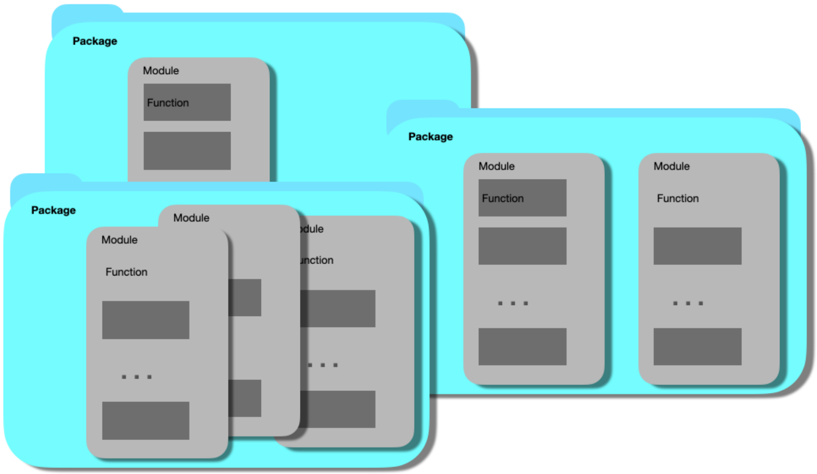
functions - modules - packages



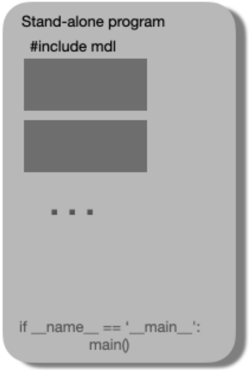
functions - modules - packages



functions - modules - packages



Stand-alone program



Challenge: *Predict what the code will do:*

```
def totalWithTax(food,tip): #link in PythonTutor
    total = 0
    tax = 0.1
    total = food + food * tax
    total = total + tip
    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip: ' ))
lTotal = totalWithTax(lunch, lTip)
print('Lunch total is', lTotal)
```

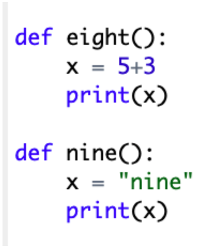
totalWithTax function: continued

```
def totalWithTax(food,tip): #link in PythonTutor
    total = 0
    tax = 0.1
    total = food + food * tax
    total = total + tip
    return(total)
```

Omit code to calculate lunch total...

```
dinner= float(input('Enter dinner total: '))
dTip = float(input('Enter dinner tip: ' ))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

Scope

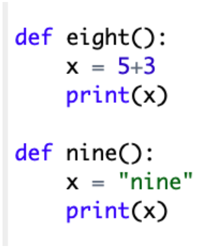


```
def eight():
    x = 5+3
    print(x)

def nine():
    x = "nine"
    print(x)
```

- You can have multiple functions.

Scope



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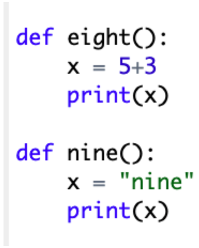
- Each function defines the **scope** of its local variables

Scope



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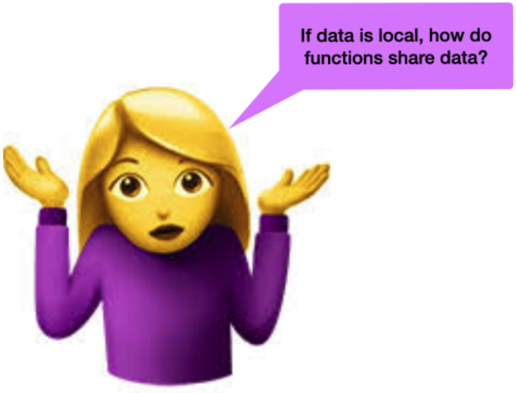
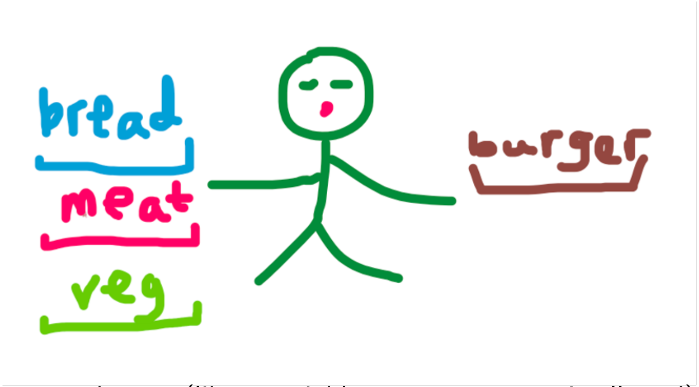
- You can have multiple functions.
- Each function defines the **scope** of its local variables
- A variable defined inside a function is **local**, i.e. defined only inside that function.

Local Data?



Function Example: burger



Function name: burger (like a variable name, no space is allowed)

Input:

- bread: representing for bread layer
- meat: representing for meat layer
- vegetable: representing for vegetable layer

Return: a hamburger

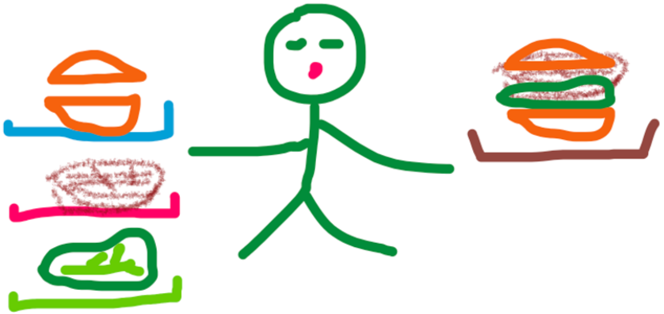
Burger function definition

Pseudocode of burger function.

```
def burger(bread, meat, veg):
    pick a bread, put on top
    put meat
    put vegetable
    put a bread at the bottom

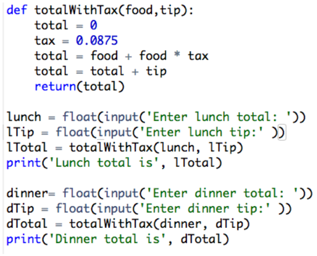
    return the burger made
```

Pseudocode to call burger function



```
def main():
    myBurger = burger("wheat bread", "beef",
        "lettuce")
    eat myBurger
```

Input Parameters & Return Values



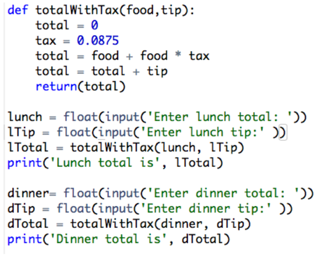
```
def totalWithTax(food,tip):
    total = 0
    tax = 0.0875
    total = food + food * tax
    total = total + tip
    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip:' ))
lTotal = totalWithTax(lunch, lTip)
print('Lunch total is', lTotal)

dinner= float(input('Enter dinner total: '))
dTip = float(input('Enter dinner tip:' ))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

- Functions can have **input parameters**.

Input Parameters & Return Values



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- Functions can have **input parameters**.
- Surrounded by parentheses, both in the function definition, and in the function call (invocation).

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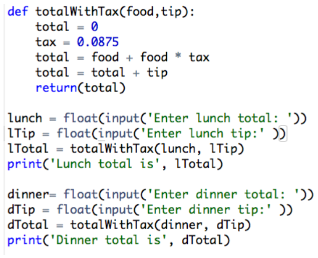

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- The "placeholders" in the function definition: **formal parameters**.

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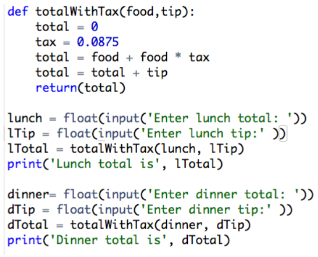

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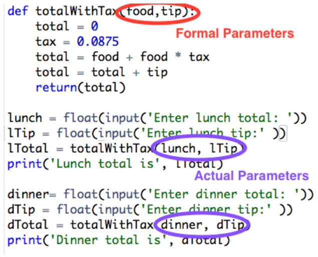
- The ones in the function call: **actual parameters**

Input Parameters & Return Values



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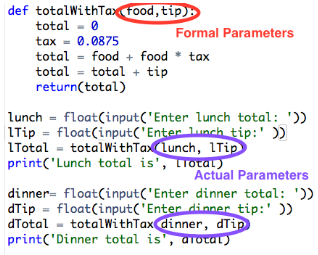

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    total = 0
    tax = 0.0875
    total = food + food * tax
    total = total + tip
    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip:' ))
lTotal = totalWithTax(lunch, lTip)
print('Lunch total is', lTotal)

dinner= float(input('Enter dinner total: '))
dTip = float(input('Enter dinner tip:' ))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

- Functions can have **input parameters**.
- Surrounded by parentheses, both in the function definition, and in the function call (invocation).
- The "placeholders" in the function definition: **formal parameters**.
- The ones in the function call: **actual parameters**.
- Functions can also **return values** to where it was called.

Challenge:

Circle the actual parameters and underline the formal parameters:

```
def prob4():
    verse = "jam tomorrow and jam yesterday,"
    print("The rule is,")
    c = mystery(verse)
    w = enigma(verse,c)
    print(c,w)
def mystery(v):
    print(v)
    c = v.count("jam")
    return(c)
def enigma(v,c):
    print("but never", v[-1])
    for i in range(c):
        print("jam")
    return("day.")
prob4()
```

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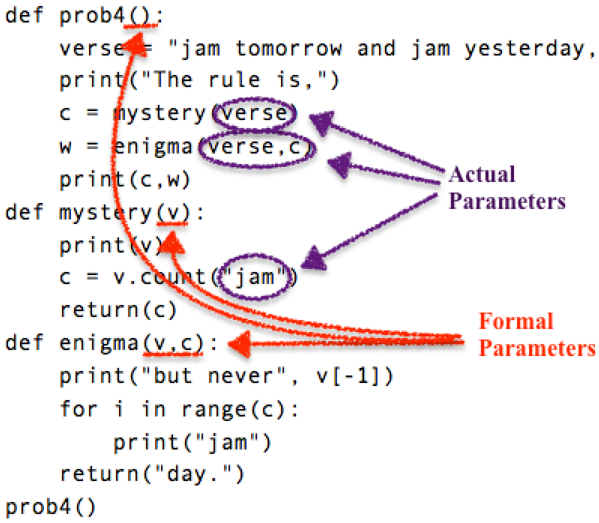

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Challenge: *Predict what the code will do:*

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    print(c,w)
```

Omit code of function mystery.

```
def  enigma(v,c):
     print("but  never", v[-1])
     for  i  in  range(c):
          print("jam")
     return("day.")
prob4()
```

Challenge: *Predict what the code will do:*

```
# From "Teaching with Python" by John Zelle
def happy(): #link to PythonTutor
    print("Happy Birthday to you!")

def sing(P):
    happy()
    happy()
    print("Happy Birthday dear " + P + "!")
    happy()

sing("Fred")
sing("Thomas")
sing("Hunter")
```

Challenge: *Fill in the missing code:*

```
def monthString(monthNum): #link in PythonTutor
    """
    Takes as input a number, monthNum, and
    returns the corresponding month name as a string.
    Example: monthString(1) returns "January".
    Assumes that input is an integer ranging from 1 to 12
    """

    monthString = ""

    ####################################
    ### FILL IN YOUR CODE HERE ###
    ### Other than your name above, ###
    ### this is the only section      ###
    ### you change in this program. ###
    ####################################

    return(monthString)


def main():
    n = int(input('Enter the number of the month: '))
    mString = monthString(n)
    print('The month is', mString)
```

Define monthString

```
def monthString(monthNum): #link in PythonTutor
    monthString = ""

    if monthNum == 1:
        monthString = "January"
    elif monthNum == 2:
        monthString = "February"
    elif monthNum == 3:
        monthString = "March"
    #... Omit code when monthNum in [4,11]
    elif monthNum == 12:
        monthString = "December"

    return(monthString)
```

Another solution to define monthString

```
def monthString(month): #link in PythonTutor
    monthNames = ['January', 'February', 'March', 'April',\
    'May', 'June', 'July', 'August', 'September',\
    'October', 'November', 'December']
    #\ means connect the next line
    #if you have codes spread more than one line,
    #you can use \ to connect these lines.

    if month < 1 or month > 12:
        return ""
    else:
        return monthNames[month-1]
        #if month == 1, return monthName[0],
        ##if month == 2, return monthName[1],
        #...
        #if month == 12, return monthName[11].
```

Github

- Used to collaborate on and share code, documents, etc.

Octocat

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- Github provides hosting for repositories (**‘repos’**) of code.
- Also convenient place to host websites (i.e. `huntercsci127.github.io`).
- In Lab6 you set up github accounts to copy (**‘clone’**) documents from the class repo. (More in future courses.)

Recap: Functions

```
#Name:  your name here
#Date:  October 2017
#This program, uses functions,
#     says hello to the world!

def main():
     print("Hello, World!")

if __name__ == "__main__":
     main()
```

- Functions are a way to break code into pieces, that can be easily reused.

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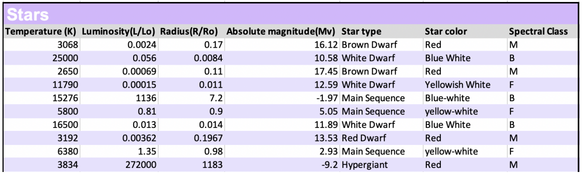
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis: Example: `print("Hello", "World")`
- Can write, or **define** your own functions, which are stored, until invoked or called.

Today's Topics

- Recap: Slicing & Images
- Introduction to Functions
- **NYC Open Data**

Design Challenge - Solution



Stars

Temperature (K)	Luminosity(L/Lo)	Radius(R/Ro)	Absolute magnitude(Mv)	Star type	Star color	Spectral Class
3068	0.0024	0.17	16.12	Brown Dwarf	Red	M
25000	0.056	0.0084	10.58	White Dwarf	Blue White	B
2650	0.00069	0.11	17.45	Brown Dwarf	Red	M
11790	0.00015	0.011	12.59	White Dwarf	Yellowish White	F
15276	1136	7.2	-1.97	Main Sequence	Blue-white	B
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3834	272000	1183	-9.2	Hypergiant	Red	M

- **Libraries:** pandas

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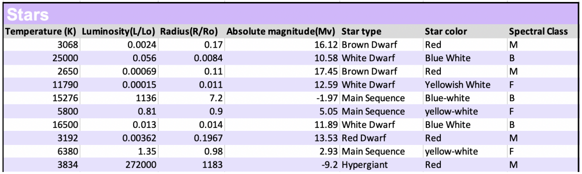

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- **Libraries:** pandas
- **Process:**
  - Print **max** of **'Luminosity'** column

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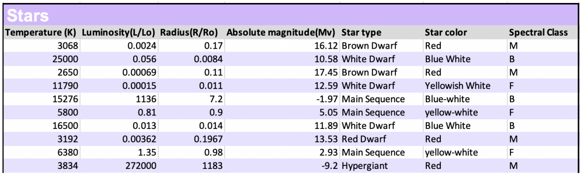

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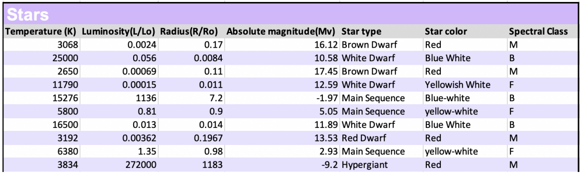

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- **Libraries:** pandas
- **Process:**
  - Print **max** of **'Luminosity'** column
  - Print **min** of **'Temperature'** column
  - **groupby 'Star Type'** and **get group 'Hypergiant'** to print **average 'Radius'**

Design Challenge - Code

- **Libraries:** pandas

```
import pandas as pd
stars = pd.read_csv('Stars.csv')
```

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- **Libraries:** pandas

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  import pandas as pd
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    ```
    print(stars['Luminosity(L/Lo)'].max())
    ```

Design Challenge - Code

- **Libraries:** pandas

  ```
  import pandas as pd
  stars = pd.read_csv('Stars.csv')
  ```

- **Process:**
  - Print **max** of **'Luminosity'** column

    ```
    print(stars['Luminosity(L/Lo)'].max())
    ```

  - Prints **min** of **'Temperature'** column and store it in temp variable

    ```
    print(stars['Temperature(K)'].min())
    ```

- **groupby 'Star Type'** and get a group of **Hypergiant**, then print **average of 'Radius'** column for this group.

```
grouped = stars.groupby('Star type')
hypergiant = grouped.get_group('
   Hypergiant')
print("Hypergiant average radius:",
   hypergiant['Radius(R/Ro)'].mean())
```

Link in replit

Accessing Structured Data: NYC Open Data

Open Data for All New Yorkers

Where can you find public Wi-Fi in your neighborhood? What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

- Freely available source of data.

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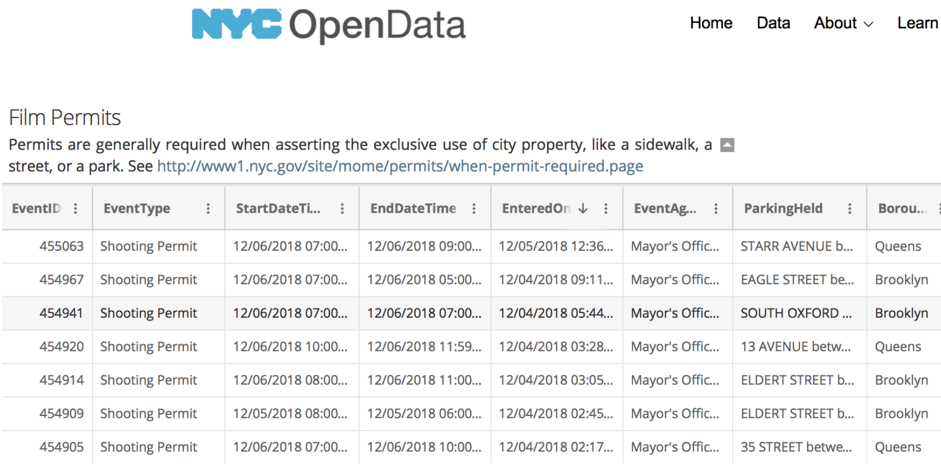
- Lab 7 covers accessing and downloading NYC OpenData datasets.

Example: OpenData Film Permits



Film Permits

Permits are generally required when asserting the exclusive use of city property, like a sidewalk, a street, or a park. See http://www1.nyc.gov/site/mome/permits/when-permit-required.page

EventID	EventType	StartDateTi...	EndDateTime	EnteredOn	EventAg...	ParkingHeld	Borou...
455063	Shooting Permit	12/06/2018 07:00...	12/06/2018 09:00...	12/05/2018 12:36...	Mayor's Offic...	STARR AVENUE b...	Queens
454967	Shooting Permit	12/06/2018 07:00...	12/06/2018 05:00...	12/04/2018 09:11...	Mayor's Offic...	EAGLE STREET be...	Brooklyn
454941	Shooting Permit	12/06/2018 07:00...	12/06/2018 07:00...	12/04/2018 05:44...	Mayor's Offic...	SOUTH OXFORD ...	Brooklyn
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454914	Shooting Permit	12/06/2018 08:00...	12/06/2018 11:00...	12/04/2018 03:05...	Mayor's Offic...	ELDERT STREET b...	Brooklyn
454909	Shooting Permit	12/05/2018 08:00...	12/05/2018 06:00...	12/04/2018 02:45...	Mayor's Offic...	ELDERT STREET b...	Brooklyn
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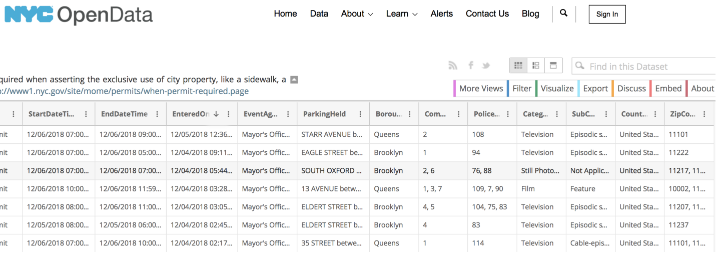

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454967	Shooting Permit	12/06/2018 07:00...	12/06/2018 05:00...	12/04/2018 09:11...	Mayor's Offic...	EAGLE STREET be...	Brooklyn	1	94	Television	Episodic s...	United Sta...	11222
454941	Shooting Permit	12/06/2018 07:00...	12/06/2018 07:00...	12/04/2018 05:44...	Mayor's Offic...	SOUTH OXFORD ...	Brooklyn	2, 6	76, 88	Still Photo...	Not Applic...	United Sta...	11217, 11...
454920	Shooting Permit	12/06/2018 10:00...	12/06/2018 11:59...	12/04/2018 03:28...	Mayor's Offic...	13 AVENUE betw...	Queens	1, 3, 7	109, 7, 90	Film	Feature	United Sta...	10002, 11...
454914	Shooting Permit	12/06/2018 08:00...	12/06/2018 11:00...	12/04/2018 03:05...	Mayor's Offic...	ELDERT STREET b...	Brooklyn	4, 5	104, 75, 83	Television	Episodic s...	United Sta...	11207, 11...
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- What's the most popular street for filming?

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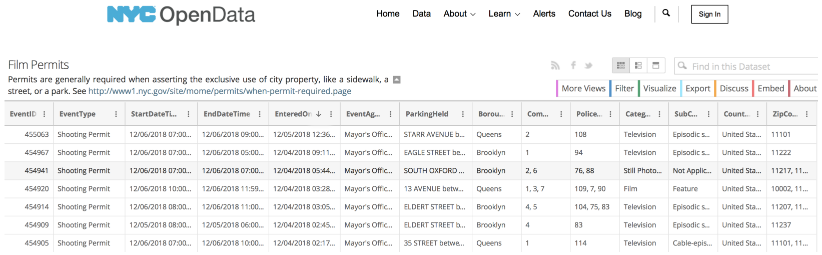

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- What's the most popular street for filming?
- What's the most popular borough?

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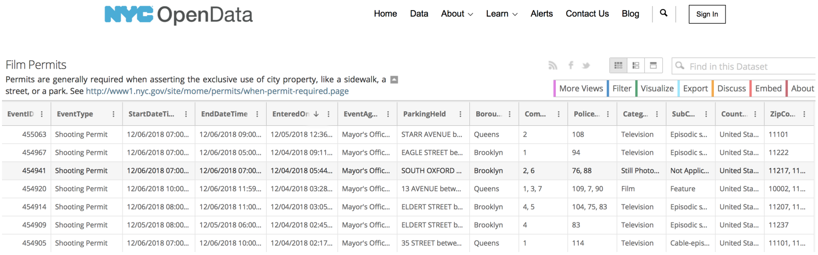

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454941	Shooting Permit	12/06/2018 07:00...	12/06/2018 07:00...	12/04/2018 05:44...	Mayor's Offic...	SOUTH OXFORD ...	Brooklyn	2, 6	76, 88	Still Photo...	Not Applic...	United Sta...	11217, 11...
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- What's the most popular street for filming?
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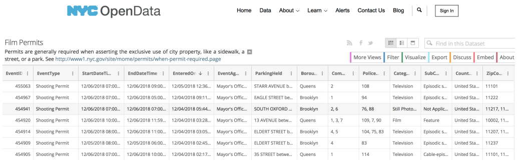
Example: OpenData Film Permits



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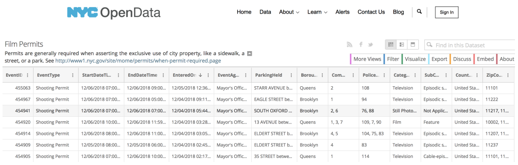

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#March 2019
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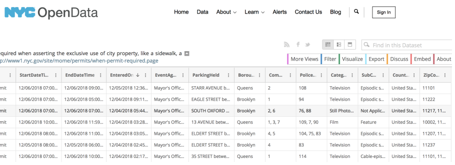

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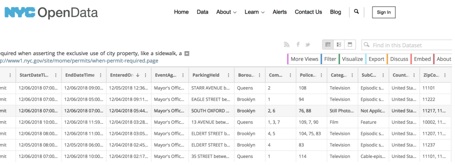

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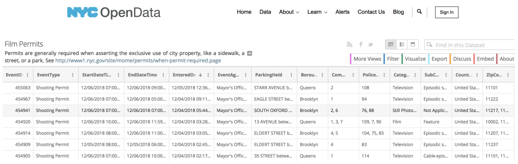

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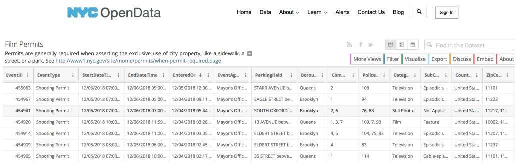

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print(tickets["ParkingHeld"].value_counts()[:10])  #Print 10 most popular
```

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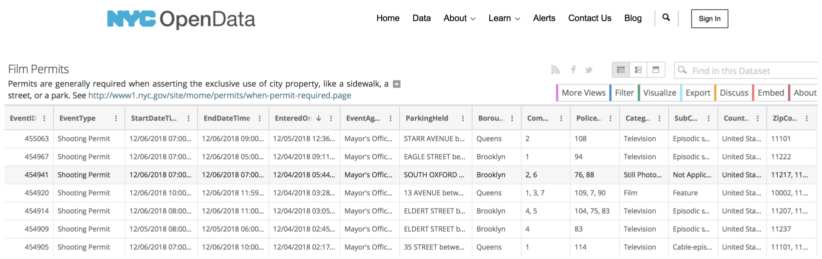

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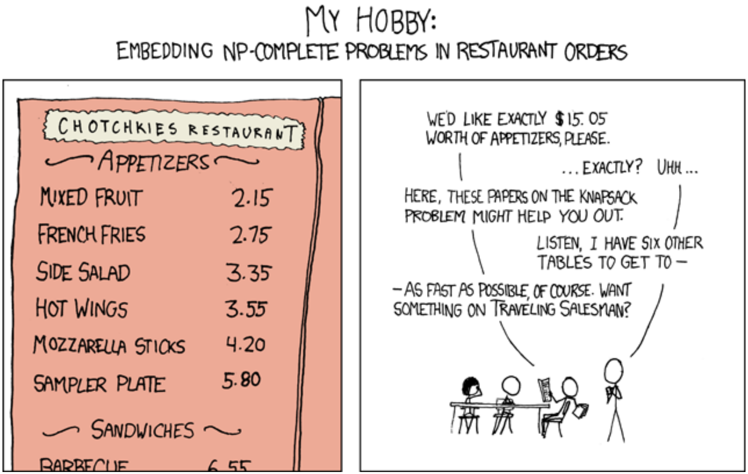
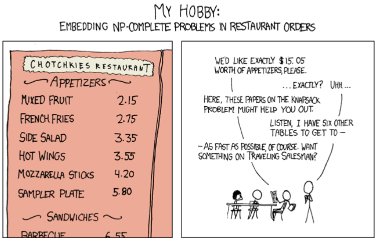
Can approach the other questions in the same way:

- What's the most popular street for filming?
- What's the most popular borough?
- How many TV episodes were filmed?

Design Challenge


MY HOBBY:
EMBEDDING NP-COMPLETE PROBLEMS IN RESTAURANT ORDERS
CHOTCHKIES RESTAURANT
APPETIZERS
MIXED FRUIT 2.15
FRENCH FRIES 2.75
SIDE SALAD 3.35
HOT WINGS 3.55
MOZZARELLA STICKS 4.20
SAMPLER PLATE 5.80
SANDWICHES
BARBECUE 6.55
WE'D LIKE EXACTLY $15.05 WORTH OF APPETIZERS, PLEASE.
...EXACTLY? UHH...
HERE, THESE PAPERS ON THE KNAPSACK PROBLEM MIGHT HELP YOU OUT.
LISTEN, I HAVE SIX OTHER TABLES TO GET TO –
– AS FAST AS POSSIBLE, OF COURSE. WANT SOMETHING ON TRAVELING SALESMAN?

Design Challenge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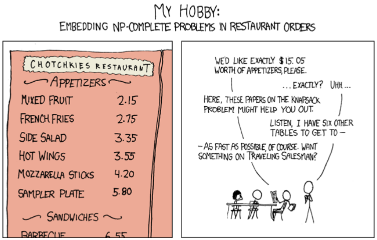
- Possible solutions:

Design Challenge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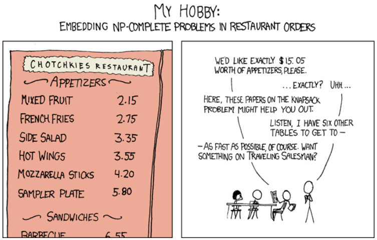
- Possible solutions:
  - 7 orders of mixed fruit, or

Design Challenge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...EXACTLY? UHH...
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LISTEN, I HAVE SIX OTHER TABLES TO GET TO –
– AS FAST AS POSSIBLE, OF COURSE. WANT SOMETHING ON TRAVELING SALESMAN?

- Possible solutions:
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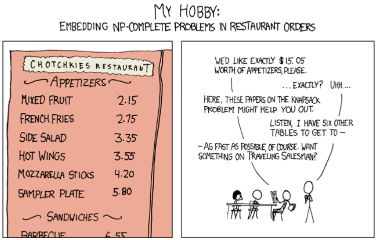
Design Challenge


MY HOBBY:
EMBEDDING NP-COMPLETE PROBLEMS IN RESTAURANT ORDERS
CHOTCHKIES RESTAURANT
APPETIZERS
MIXED FRUIT 2.15
FRENCH FRIES 2.75
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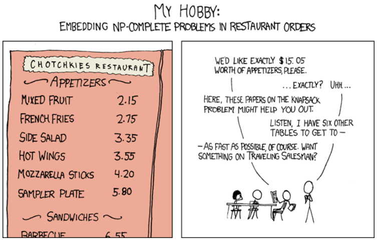
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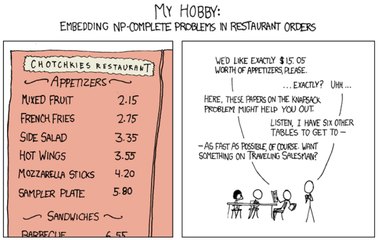
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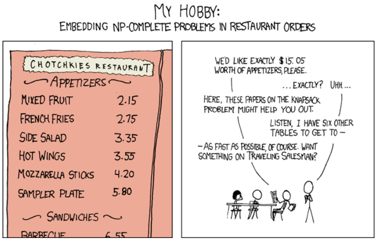
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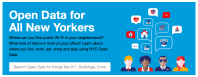
- "NP-Complete" problem: possible answers can be checked quickly, but not known how to compute quickly.

Recap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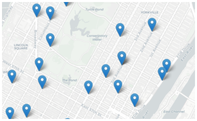

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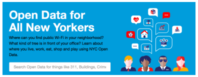
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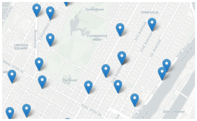

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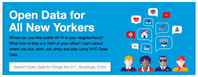
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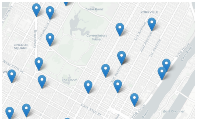

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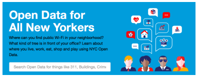
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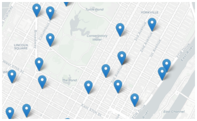

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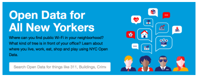
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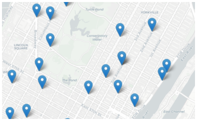

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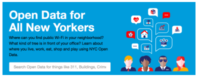
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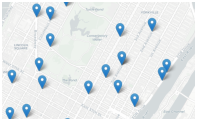

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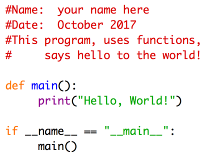
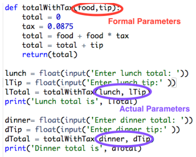
Practice Quiz & Final Questions



```
#Name:  your name here
#Date:  October 2017
#This program, uses functions,
#     says hello to the world!

def main():
     print("Hello, World!")

if __name__ == "__main__":
     main()
```



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def totalWithTax(food,tip):
    total = 0
    tax = 0.0875
    total = food + food * tax
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    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip:' ))
lTotal = totalWithTax(lunch, lTip)
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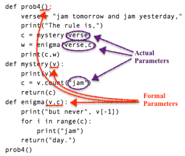

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def prob4():
    verse = "jam tomorrow and jam yesterday,"
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    c = mystery(verse)
    w = enigma(verse,c)
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def mystery(v):
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def enigma(v,c):
    print("but never", v[-1])
    for i in range(c):
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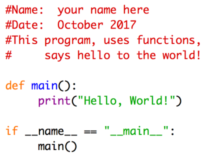

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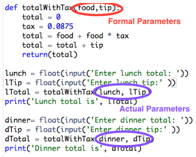

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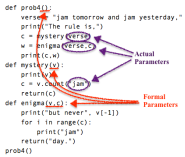

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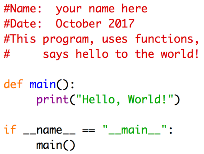

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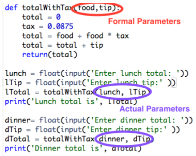

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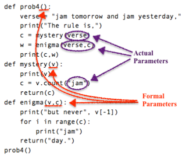

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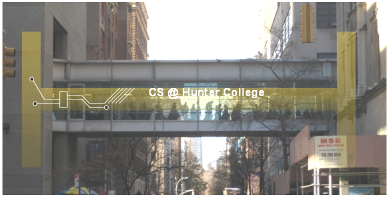
- Past exams are on the webpage (under Final Exam Information).
- Theme: Functions!
  Starting with Spring 19 V3, #4(b).

Weekly Reminders!



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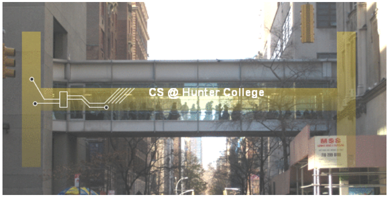

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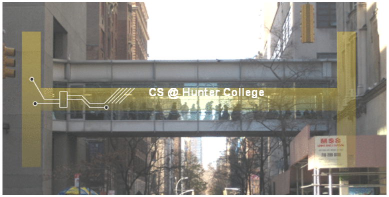

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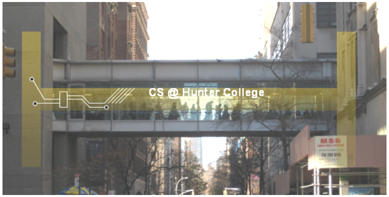

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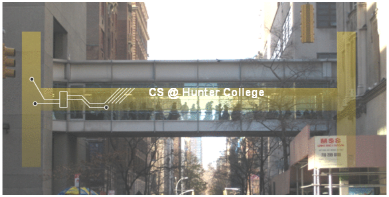

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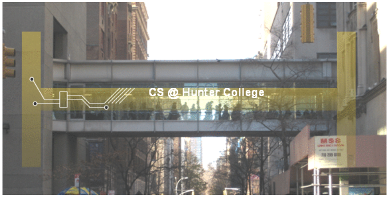

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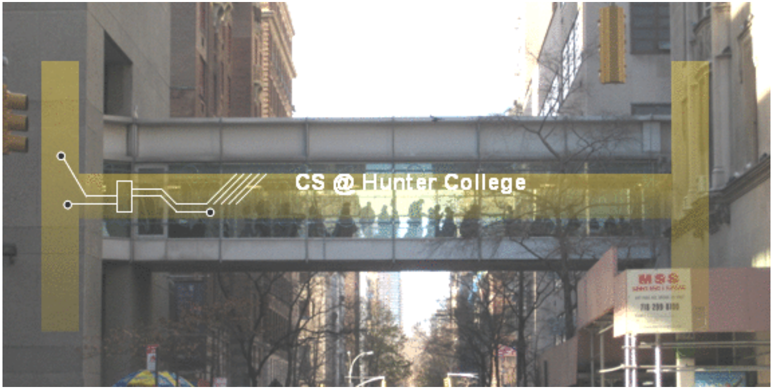
- Take the Lecture Preview on Blackboard on Monday (or no later than 10:15am on Tuesday)

Lecture Slips & Writing Boards



- Hand your lecture slip to a UTA.
- Return writing boards as you leave.