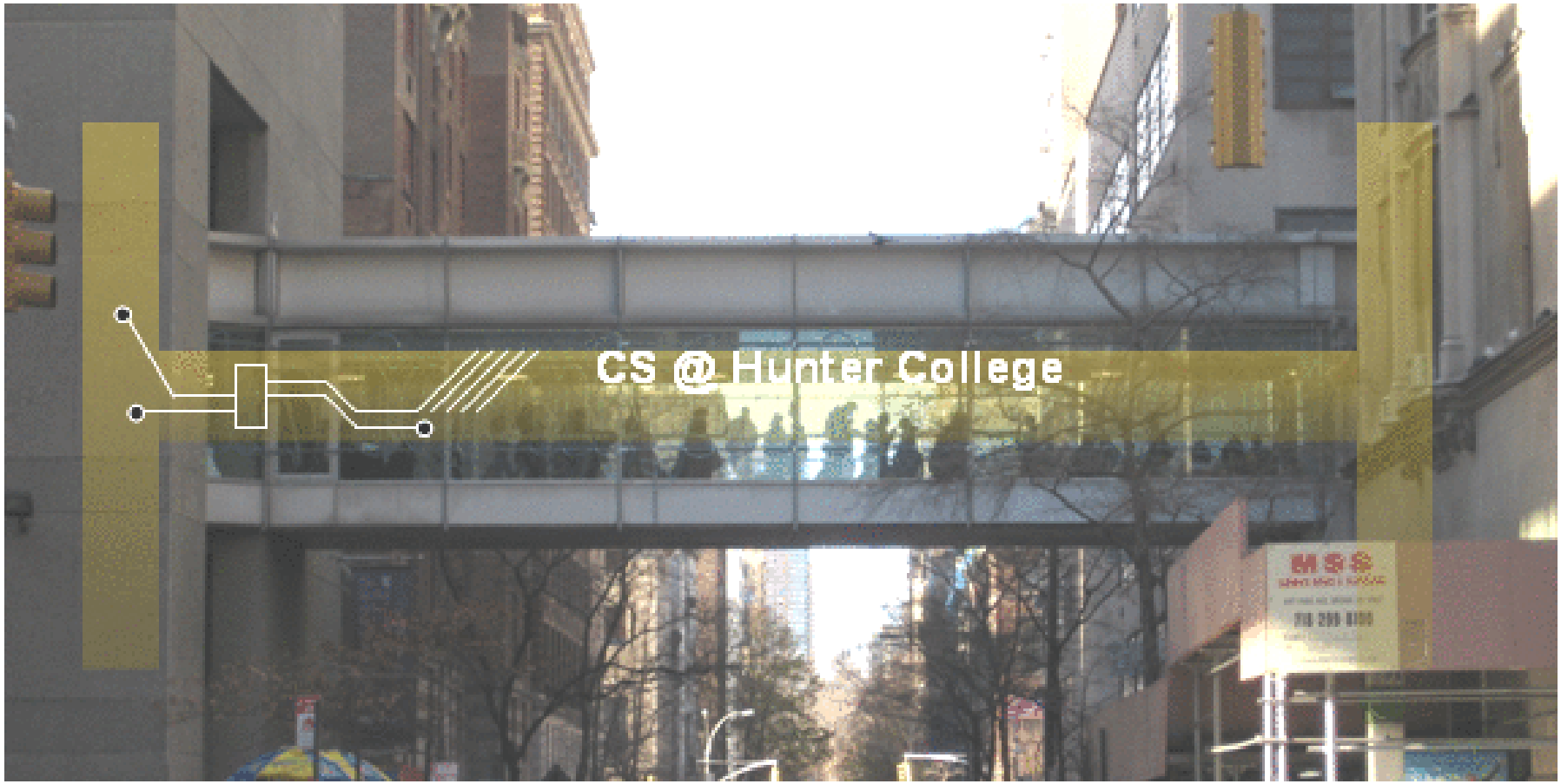
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Two Dimensional Array Slicing

```
import numpy as np

numRows = 6
numCols = 6
a = np.zeros((numRows, numCols))
#create a table with 6 rows and 6 columns,
#each element is initialized to be zero.
#Do not forget parentheses around
#numRows, numCols.
```

Two Dimensional Array Slicing: II

```
for i in range(numRows):
    for j in range(numCols):
        a[i, j] = i*10 + j
#range(numRows) returns [0, 1, 2, 3, 4, 5],
#where outer loop variable i chooses from.
#When i is 0, run
#    for j in range(numCols):
#        a[i, j] = i*10 + j
#When i is 1, run
#    for j in range(numCols):
#        a[i, j] = i*10 + j
#The last round of i is 5.
```

Two Dimensional Array Slicing: III

```
for i in range(numRows):
    for j in range(numCols):
        print("%3i"%(a[i, j]), end="")
        #"%3i"%(a[i, j]) prints a[i, j] --
        #element of a at ith row and
        #jth column -- as an 3-digit int.
        #"%3i" is a place holder and is
           filled by a[i, j].
        #If a[i, j] does not have 3 digits,
        #pad space(s) to the left.
        #end="" print w/o a new line.

    print() #print a new line after each row
```

Two Dimensional Array Slicing: III

```
32 print(a[0, 3:5])
```

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Two Dimensional Array Slicing: III

```
32 print(a[0, 3:5])
```

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2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

print

```
[3. 4.]
```

Two Dimensional Array Slicing: IV

```
print(a[4:, 4:])
```

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Two Dimensional Array Slicing: IV

```
33 print(a[4:, 4:])
```

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Print out

```
[[44. 45.]
 [54. 55.]]
```

Two Dimensional Array Slicing: V

```
print(a[:, 2])
```

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Two Dimensional Array Slicing: V

```
print(a[:, 2])
```

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

row \ col	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Print out

```
[ 2. 12. 22. 32. 42. 52.]
```

Two Dimensional Array Slicing: VI

```
print(a[2::2, ::2])
```

	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

Two Dimensional Array Slicing: VI

```
35 print(a[2::2, ::2])
```

	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
5	50	51	52	53	54	55

	0	1	2	3	4	5
0	0	1	2	3	4	5
1	10	11	12	13	14	15
2	20	21	22	23	24	25
3	30	31	32	33	34	35
4	40	41	42	43	44	45
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print

```
[[20. 22. 24.]
 [40. 42. 44.]]
```

Today's Topics

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

Today's Topics

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

Image and Array

```
import matplotlib.pyplot as plt
import numpy as np

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

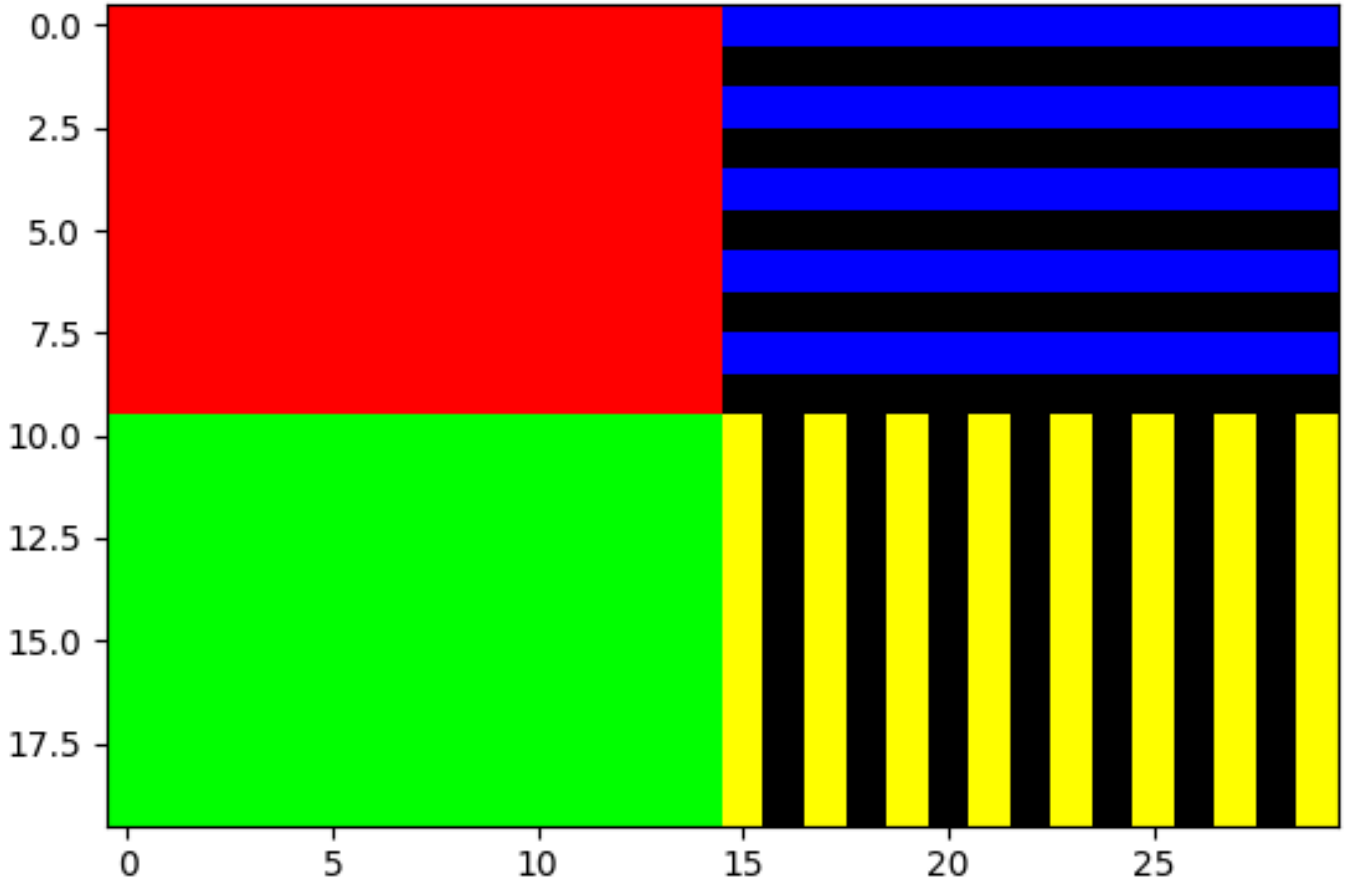
```
img[height//2:, :width//2, 1] = 1
#which does this statement do? Same as
#img[height//2:, :width//2] = [0,1,0]

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?

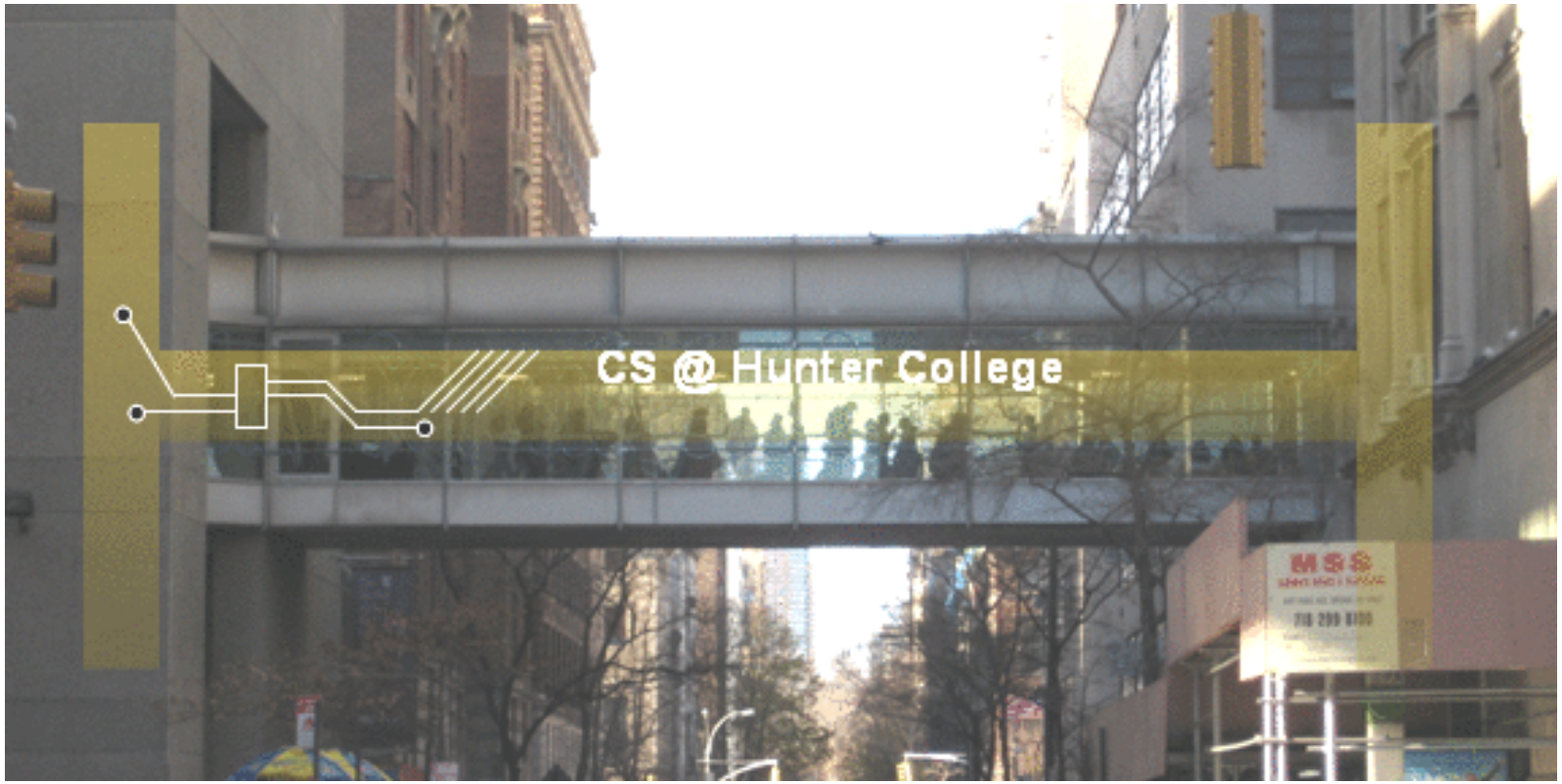
plt.imshow(img)
plt.show()
```

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

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

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import numpy as np
img = plt.imread('csBridge')
plt.imshow(img)
plt.show()
height = img.shape[0]
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img2 = img[:height//2, :width//2]
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```

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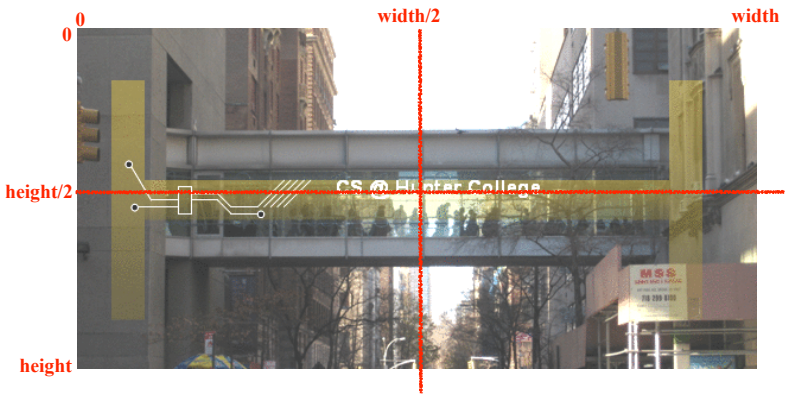

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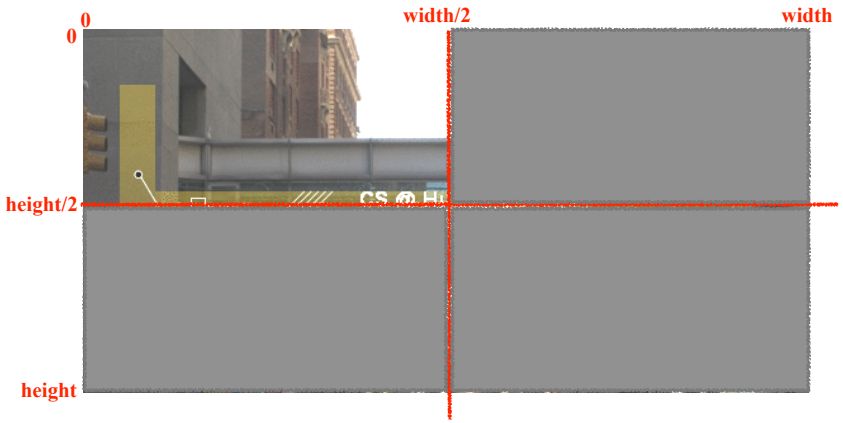

Challenge: Cropping Images

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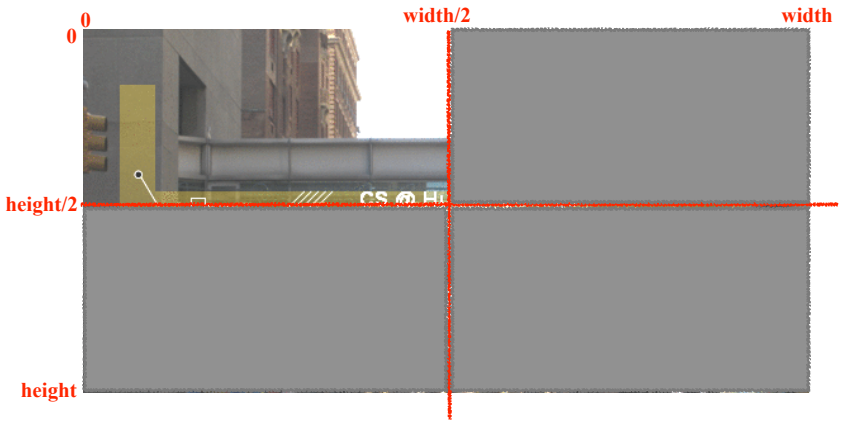

- How would you select the lower left corner?

Challenge: Cropping Images

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plt.show()
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img2 = img[:height//2, :width//2]
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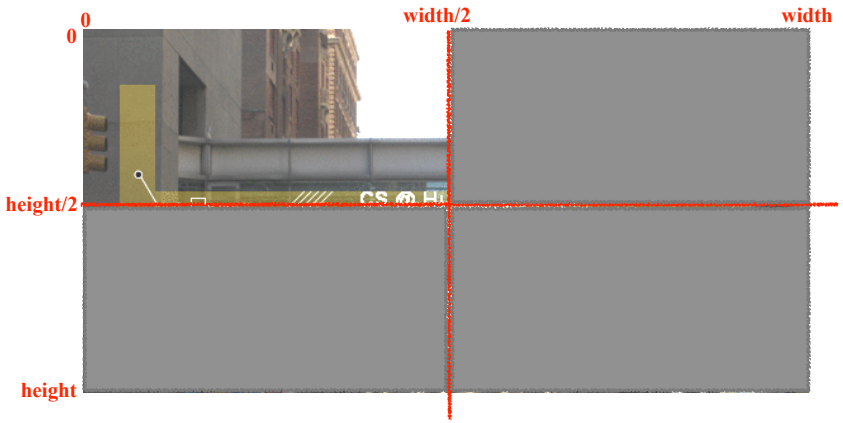

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  `img2 = img[height//2:, :width//2]`

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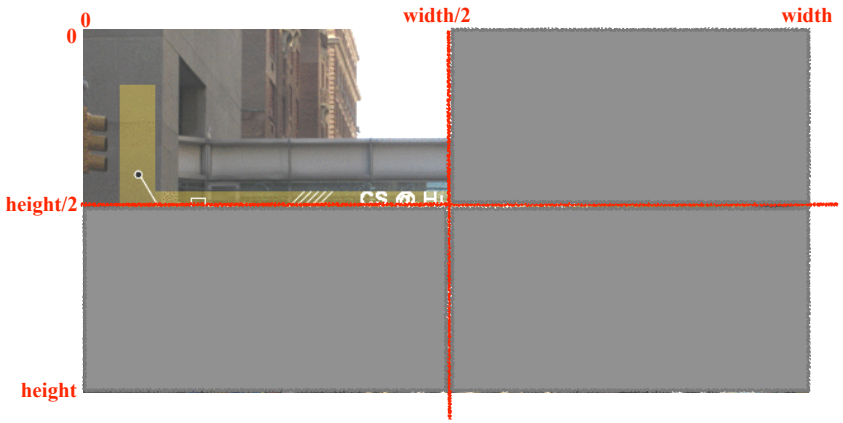

- How would you select the lower left corner?
  `img2 = img[height//2:, :width//2]`
- How would you select the upper right corner?

Challenge: Cropping Images

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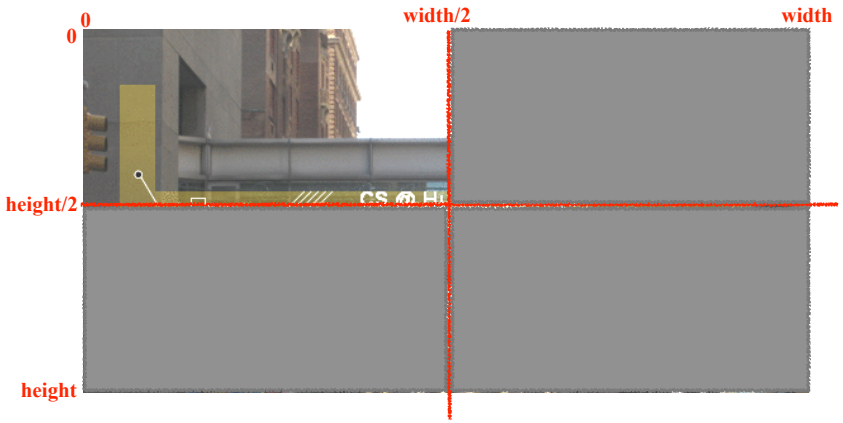

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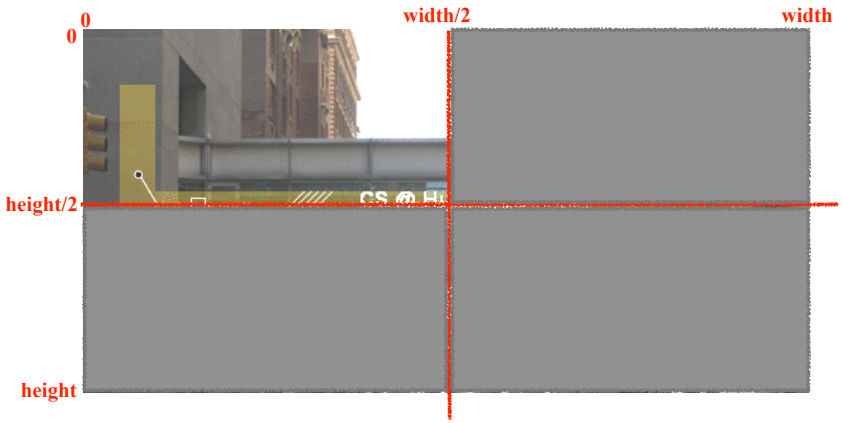

- How would you select the lower left corner?
  `img2 = img[height//2:, :width//2]`
- How would you select the upper right corner?
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- How would you select the lower right corner?

Challenge: Cropping Images

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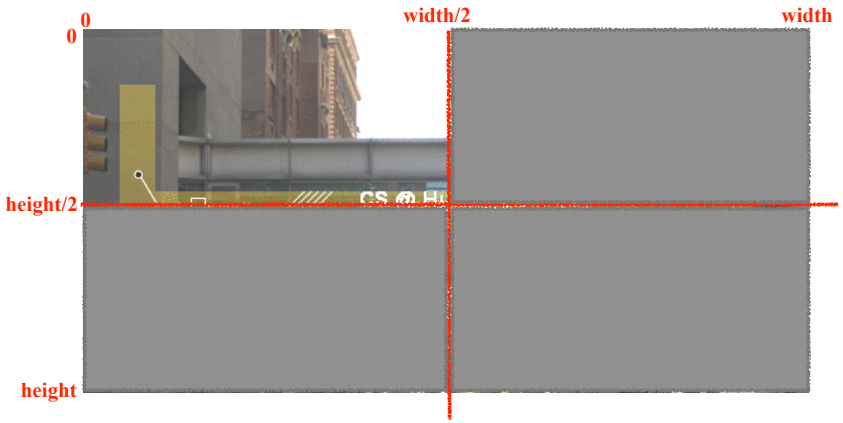

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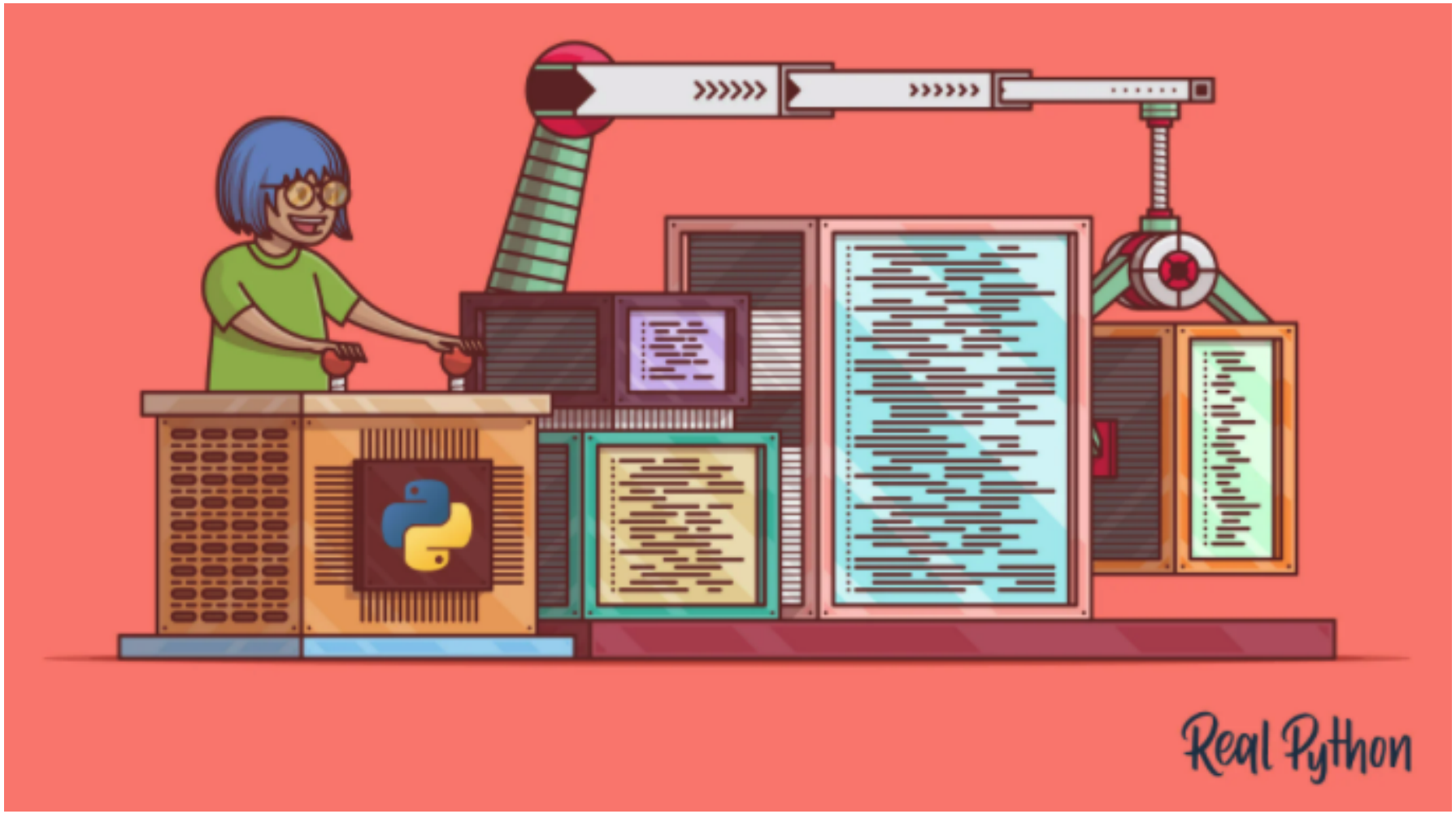
- How would you select the lower right corner?
  `img2 = img[height//2:, width//2:]`

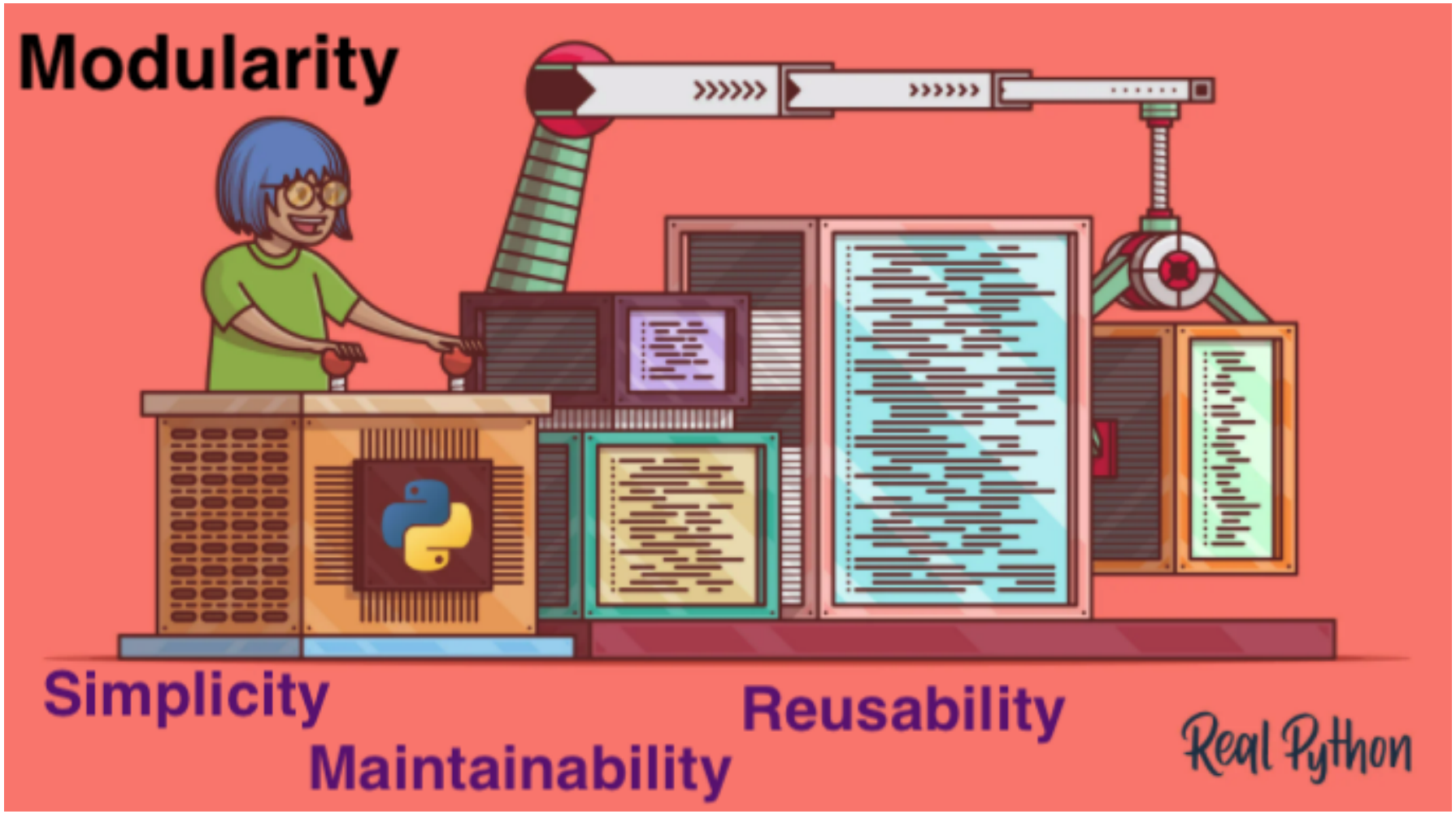
Today's Topics

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

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__":
     main()
```

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- Many languages require that all code must be organized with functions.

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- Naming conventions same as variables

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- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:

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- Can write, or **define** your own functions,

Functions

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- Many languages require that all code must be organized with functions.
- 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

```
#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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```

Python Tutor

```
#Name:  your name here
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if __name__ == "__main__":
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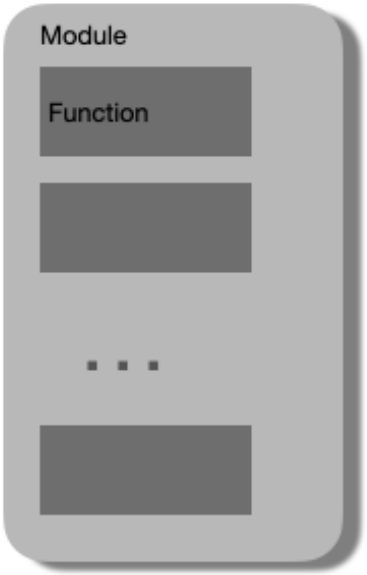
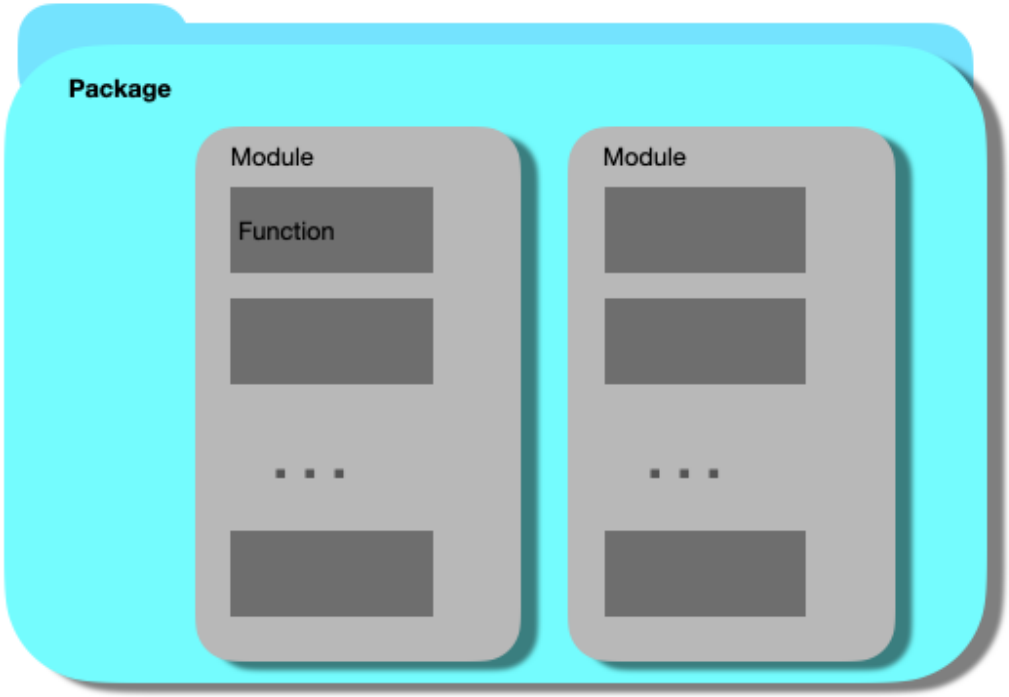
```

(Demo with `pythonTutor`)

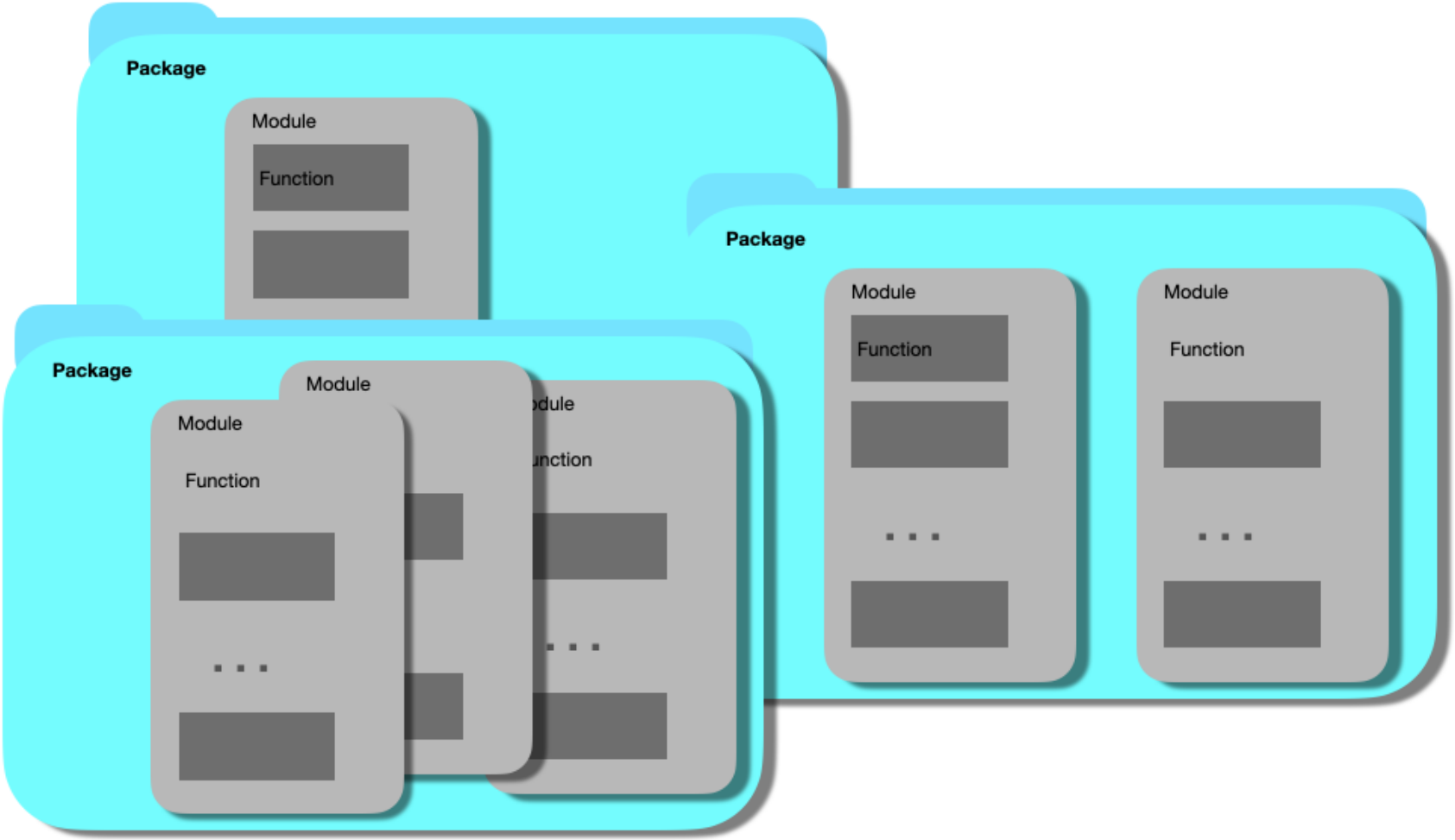
functions - modules - packages



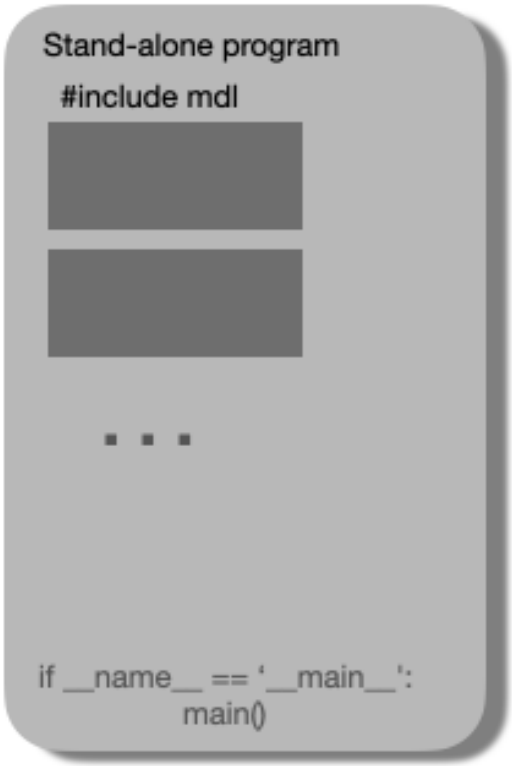
functions - modules - packages



functions - modules - packages



Stand-alone program



Challenge:

Predict what the code will do:

```
def totalWithTax(food,tip):
    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):
    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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- You can have multiple functions.
- Each function defines the **scope** of its local variables

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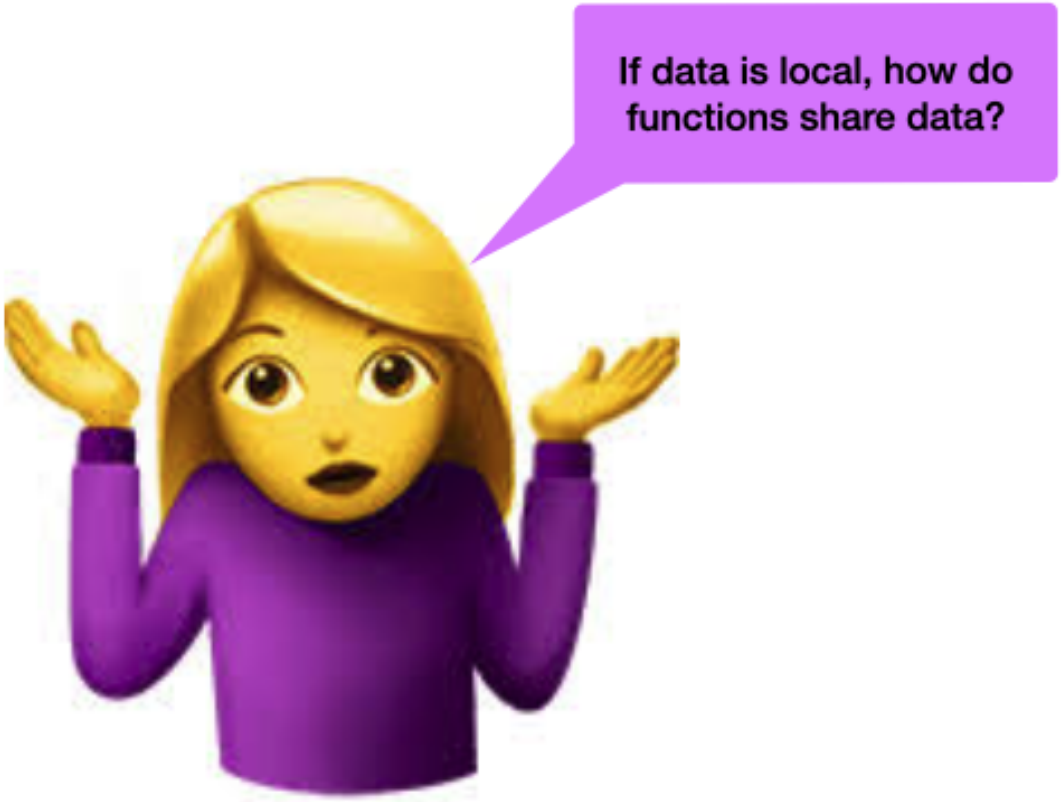
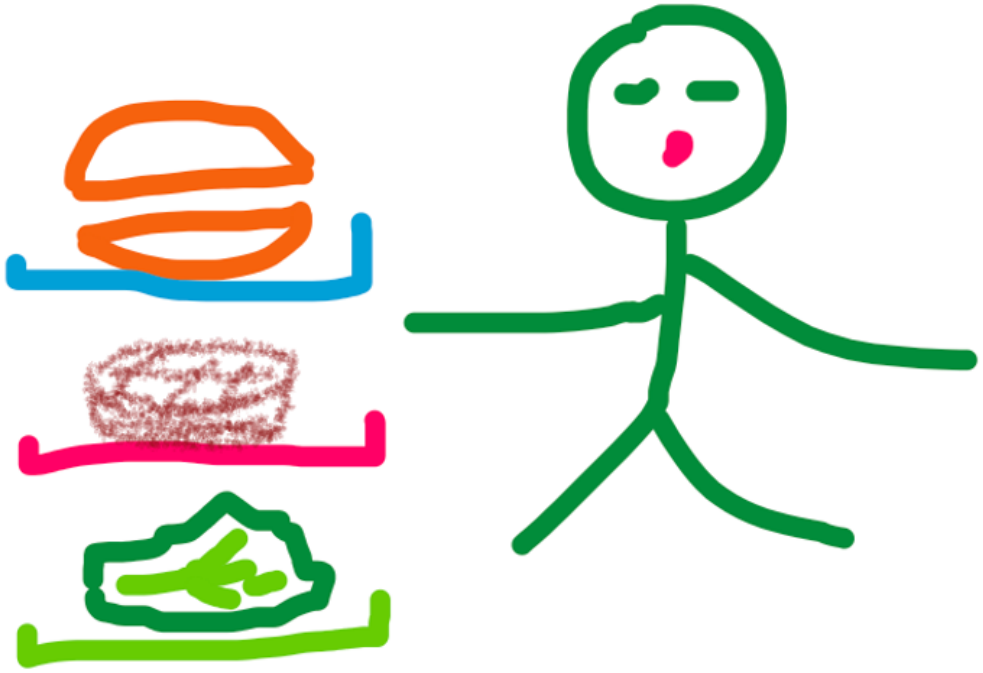
- You can have multiple functions.
- Each function defines the **scope** of its local variables
- A variable defined inside a function is **local**, i.e. defined only inside that function.

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

Input Parameters & Return Values

- Functions can have **input parameters**.

```
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)
```

Input Parameters & Return Values

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def totalWithTax(food,tip):
    total = 0
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- The "placeholders" in the function definition: **formal parameters**.

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

Input Parameters & Return Values

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Formal Parameters

Actual Parameters

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Input Parameters & Return Values

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Formal Parameters

Actual Parameters

- 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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Actual Parameters

Formal Parameters

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Predict what the code will do:

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```

Omit code of function mystery.

```
def enigma(v,c):
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    for i in range(c):
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Python Tutor

```
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prob4()
```

(Demo with `pythonTutor`)

Challenge:

Predict what the code will do:

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

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

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

Challenge:

Fill in the missing code:

```
def monthString(monthNum):
    """
    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)
```

IDLE

```python
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(Demo with IDLE)

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- 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
5800	0.81	0.9	5.05	Main Sequence	yellow-white	F
16500	0.013	0.014	11.89	White Dwarf	Blue White	B
3192	0.00362	0.1967	13.53	Red Dwarf	Red	M
6380	1.35	0.98	2.93	Main Sequence	yellow-white	F
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- **Libraries:** pandas

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

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

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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')
```

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())
```

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())
```

Accessing Structured Data: NYC Open Data

- Freely available source of data.

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- Will use `pandas`, `pyplot` & `folium` libraries to analyze, visualize and map the data.

Accessing Structured Data: NYC Open Data

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- Maintained by the NYC data analytics team.
- We will use several different ones for this class.
- Will use `pandas`, `pyplot` & `folium` libraries to analyze, visualize and map the data.
- Lab 7 covers accessing and downloading NYC OpenData datasets.

Example: OpenData Film Permits

NYC OpenData

Home Data About Learn

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
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
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
454905	Shooting Permit	12/06/2018 07:00...	12/06/2018 10:00...	12/04/2018 02:17...	Mayor's Offic...	35 STREET betwe...	Queens

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Find in this Dataset

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EventID	EventType	StartDateTi...	EndDateTime	EnteredOn	EventAg...	ParkingHeld	Borou...	Com...	Police...	Categ...	SubC...	Count...	ZipCo...
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	2	108	Television	Episodic s...	United Sta...	11101
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...
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	4	83	Television	Episodic s...	United Sta...	11237
454905	Shooting Permit	12/06/2018 07:00...	12/06/2018 10:00...	12/04/2018 02:17...	Mayor's Offic...	35 STREET betwe...	Queens	1	114	Television	Cable-epis...	United Sta...	11101, 11...

- What's the most popular street for filming?

Example: OpenData Film Permits

NYC OpenData

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- What's the most popular street for filming?
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Example: OpenData Film Permits

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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

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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
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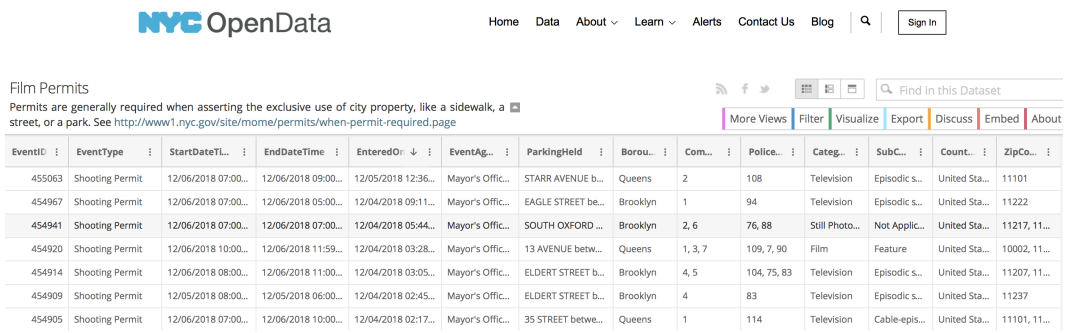

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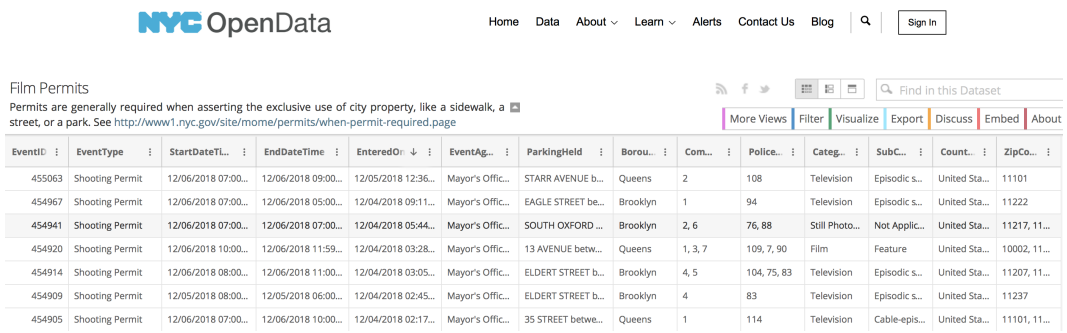

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#March 2019
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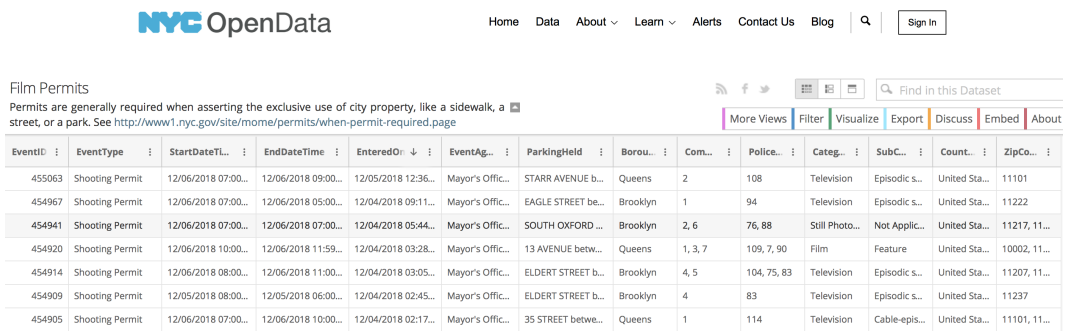

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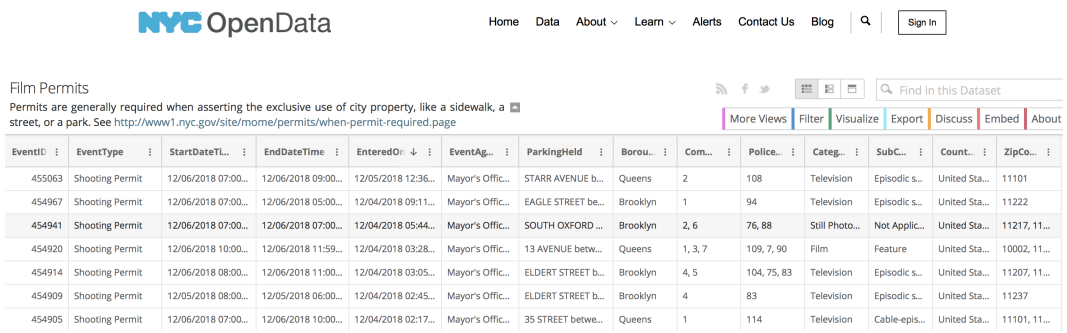

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print(tickets["ParkingHeld"]) #Print out streets (multiple times)
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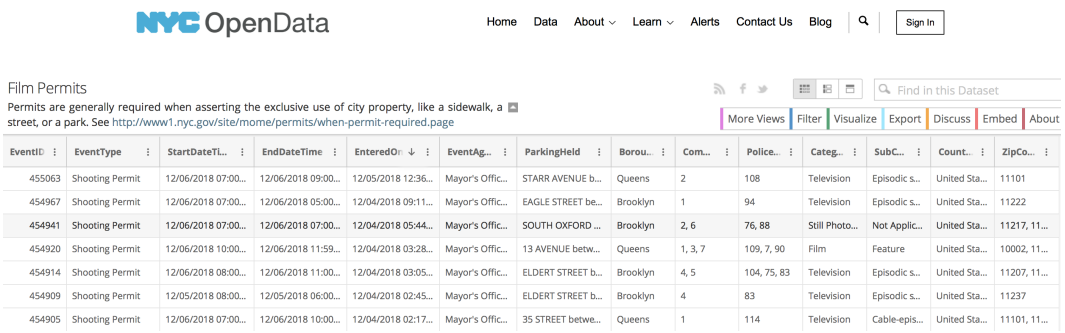

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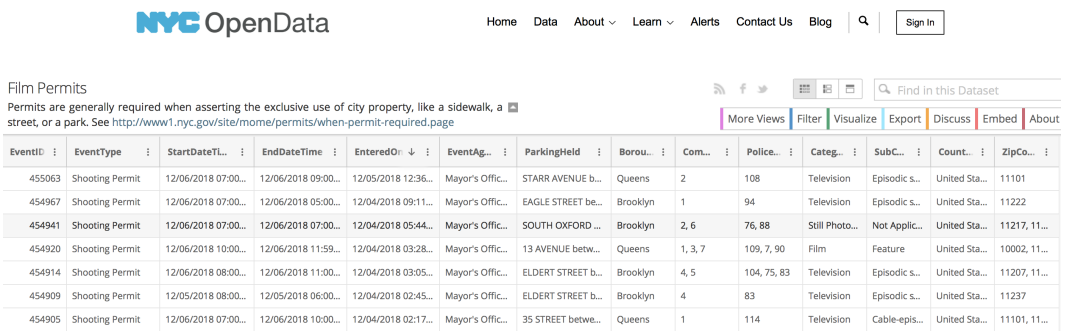

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print(tickets["ParkingHeld"].value_counts()[:10])  #Print 10 most popular
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Can approach the other questions in the same way:

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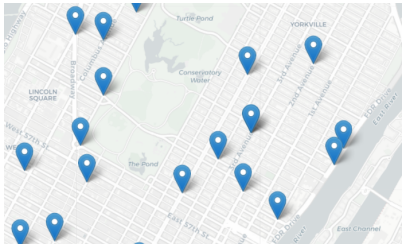
Recap



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

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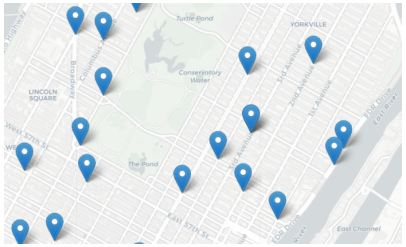

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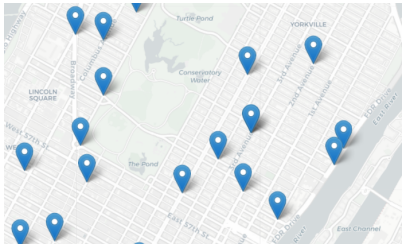

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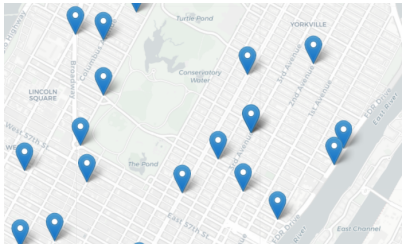

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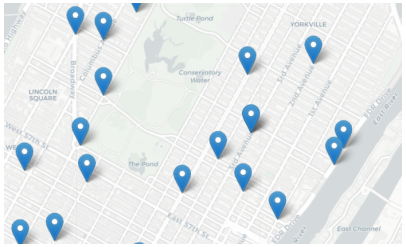

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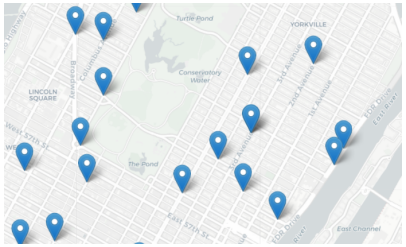
Recap



- **Functions** are a way to break code into pieces, that can be easily reused.
- 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.
- Accessing Formatted Data: NYC OpenData

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()
```

```
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)
```

Formal Parameters

Actual 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()
```

Actual Parameters

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- Since you must pass the final exam to pass the course, we end every lecture with final exam review.

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- Lightning rounds:
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  - write as much you can for 60 seconds;
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  - repeat.
- Past exams are on the webpage (under Final Exam Information).
- Theme: Functions!
  Starting with Spring 19 V3, #4(b).

Weekly Reminders!

Before next lecture, don't forget to:

- Work on this week's Online Lab

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- Submit this week's 5 programming assignments **(programs 31-35)**

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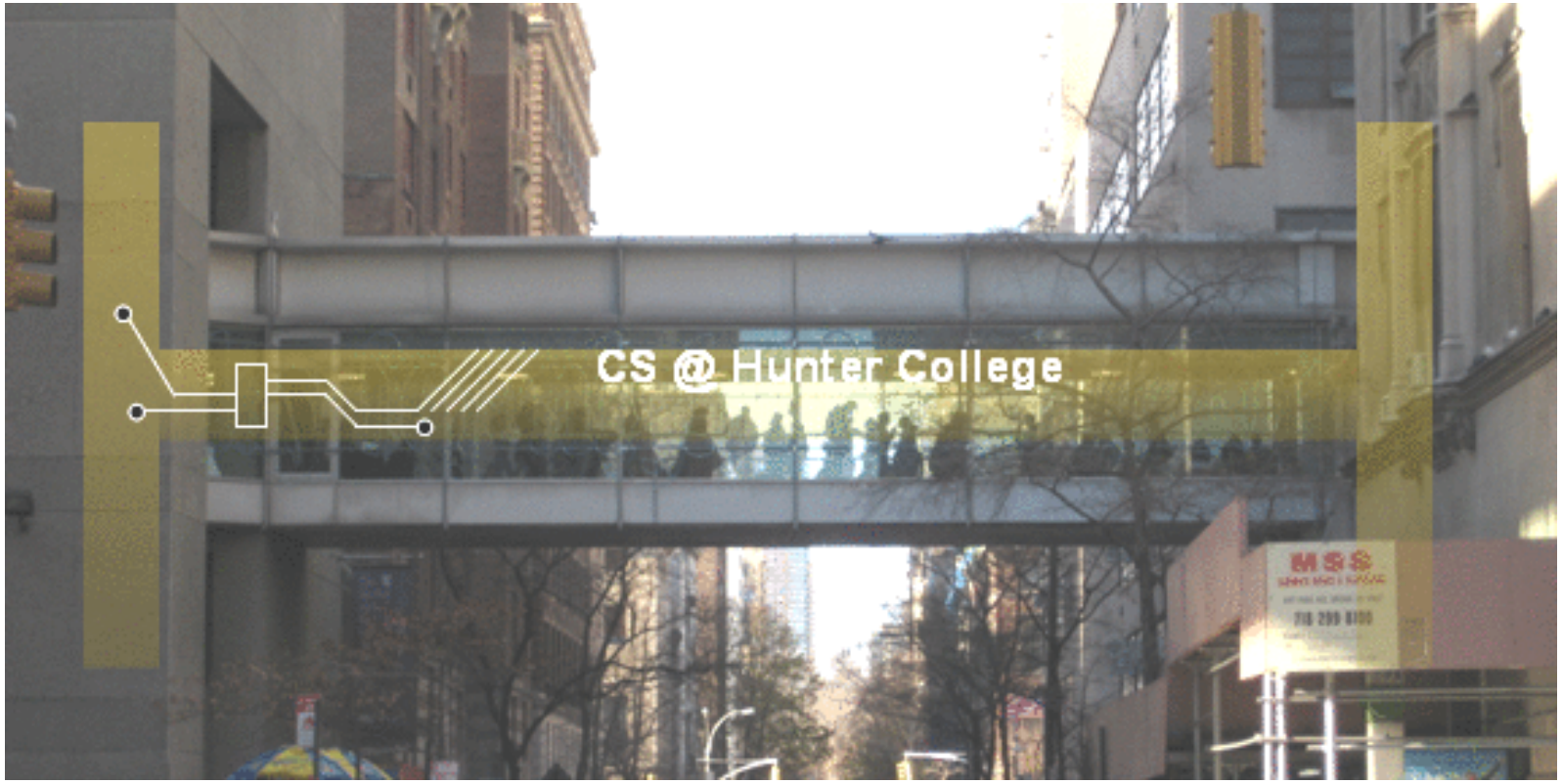
- Submit this week's 5 programming assignments **(programs 31-35)**
- If you need help, schedule an appointment for Tutoring in lab 1001G 11:30am-5:30pm
- Take the Lecture Preview on Blackboard on Monday (or no later than 10:15am on Tuesday)

Lecture Slips & Writing Boards



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