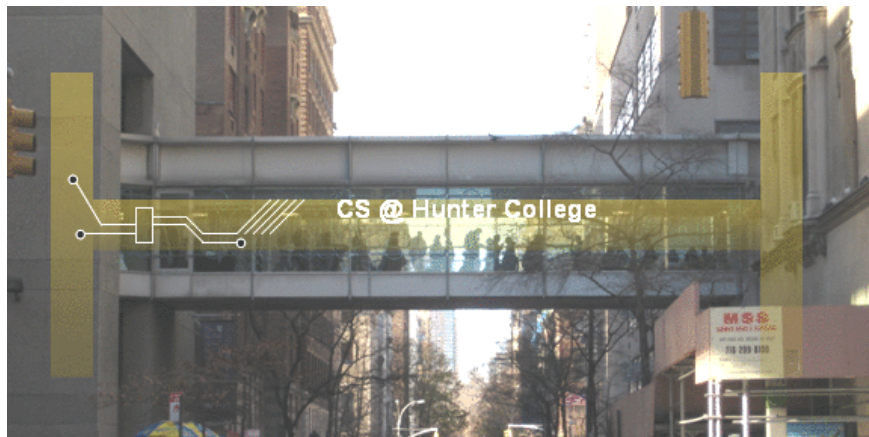


CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

- This lecture will be recorded

Frequently Asked Questions

From email.

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- **Could you spend more time on circuits/logical expressions/truth tables/decisions?**

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Yes, we will start with that today.

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Yes, we will, since
 - 1) it's fundamental, and*
 - 2) the same ideas are used for accessing formatted data (today's topic).*

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Yes, we will start with that today.
- **I still don't get indices and the brackets. Could you spend more time on that?**
Yes, we will, since
 - 1) *it's fundamental, and*
 - 2) *the same ideas are used for accessing formatted data (today's topic).*
- **I still don't get what is meant by input?**
Input is data provided to a program each time it runs, it may change at each run. In this course we wrote programs that get input from the user via the `input()` function or by reading a file.

Today's Topics



- Recap: Logical Expressions & Circuits
- Design: Cropping Images
- Accessing Formatted Data

Today's Topics



- **Recap: Logical Expressions & Circuits**
- Design: Cropping Images
- Accessing Formatted Data

Recap: Logical Operators

and

in1		in2	<i>returns:</i>
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True

Recap: Logical Operators

and

in1		in2	<i>returns:</i>
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True

or

in1		in2	<i>returns:</i>
False	or	False	False
False	or	True	True
True	or	False	True
True	or	True	True

Recap: Logical Operators

and

in1		in2	returns:
False	and	False	False
False	and	True	False
True	and	False	False
True	and	True	True

or

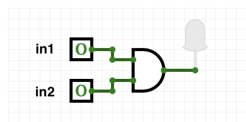
in1		in2	returns:
False	or	False	False
False	or	True	True
True	or	False	True
True	or	True	True

not

	in1	returns:
not	False	True
not	True	False

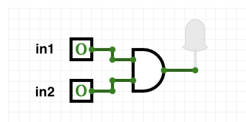
Logical Operators & Circuits

- Each logical operator (and, or, & not) can be used to join together expressions.



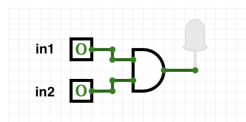
Logical Operators & Circuits

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Example: in1 and in2

Logical Operators & Circuits

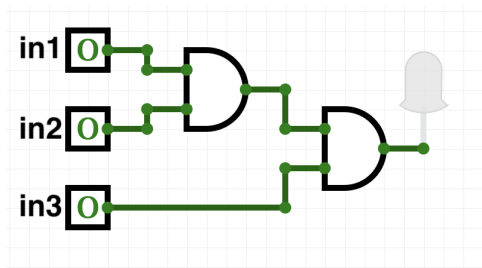


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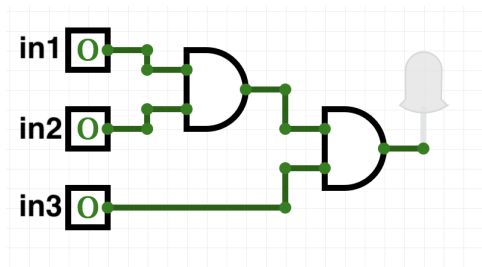
Example: in1 and in2

- Each logical operator (and, or, & not) has a corresponding logical circuit that can be used to join together inputs.

Examples: Logical Circuit



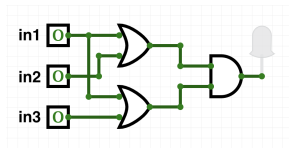
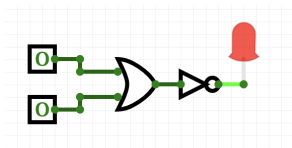
Examples: Logical Circuit



(in1 and in2) and in3

More Circuit Examples

Examples from last lecture:



Draw a circuit that corresponds to each logical expression:

- `not(in1 or in2)`
- `(in1 or in2) and (in1 or in3)`
- `(not(in1 and not in2)) or (in1 and (in2 and in3))`

Challenge:

Predict what the code will do:

```
x = 6
y = x % 4
w = y**3
z = w // 2
print(x,y,w,z)
x,y = y,w
print(x,y,w,z)
x = y / 2
print(x,y,w,z)
```

```
sports = ["Field Hockey","Swimming","Water Polo"]
mess = "Qoauxca BrletRce crcx qvBnqa ocUxk"
result = ""
for i in range(len(mess)):
    if i % 3 == 0:
        print(mess[i])
        result = result + mess[i]
print(sports[1], result)
```

Python Tutor

```
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print(x,y,w,z)
x,y = y,w
print(x,y,w,z)
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(Demo with pythonTutor)

Today's Topics



- Recap: Logical Expressions & Circuits
- **Design: Cropping Images**
- Accessing Formatted Data
- CS Survey: Astrophysics and astropy

Challenge: Design Question

From Final Exam, Fall 2017, V4, #6.



Design an algorithm that reads in an image and displays the lower left corner of the image.

Challenge: Design Question

From Final Exam, Fall 2017, V4, #6.



Design an algorithm that reads in an image and displays the lower left corner of the image.

Input:

Output:

Process: (*Brainstorm for a "To Do" list to accomplish this.*)

Design Question

Design a program that asks the user for an image and then display the upper left quarter of the image. (First, design the pseudocode, and if time, expand to a Python program.)

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 - ① Import libraries.

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 - ③ Read in image.
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- Example:
 - ① Import libraries.
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 - ④ Figure out size of image.
 - ⑤ Make a new image that's half the height and half the width.

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 - ⑥ Display the new image.

In Pairs or Triples: Design Question



- ① Import libraries.

In Pairs or Triples: Design Question



① Import libraries.

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

In Pairs or Triples: Design Question



- 1 Import libraries.

```
import matplotlib.pyplot as plt  
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- 2 Ask user for an image name.

In Pairs or Triples: Design Question



- ① Import libraries.

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inF = input('Enter file name:  ')
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- ③ Read in image.

```
img = plt.imread(inF) #Read in image from inF
```

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img = plt.imread(inF) #Read in image from inF
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```
height = img.shape[0] #Get height  
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```
img2 = img[height//2:, :width//2] #Crop to lower left corner
```

In Pairs or Triples: Design Question



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```
img2 = img[height//2:, :width//2] #Crop to lower left corner
```
- ⑥ Display the new image.

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

Today's Topics



- Recap: Logical Expressions & Circuits
- Design: Cropping Images
- **Accessing Formatted Data**
- CS Survey: Astrophysics and astropy

Structured Data

Undergraduate			
College	Full-time	Part-time	Total
Baruch	11,288	3,922	15,210
Brooklyn	10,198	4,208	14,406
City	10,067	3,250	13,317
Hunter	12,223	4,500	16,723
John Jay	9,831	2,843	12,674
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- Common to have data structured in a spread sheet.

Structured Data

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- In the example above, we have the first line that says “Undergraduate”.

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- In the example above, we have the first line that says “Undergraduate”.
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- Common to have data structured in a spread sheet.
- In the example above, we have the first line that says “Undergraduate”.
- Next line has the titles for the columns.
- Subsequent lines have a college and attributes about the college.
- Python has several ways to read in such data.

Structured Data

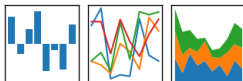
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- In the example above, we have the first line that says “Undergraduate”.
- Next line has the titles for the columns.
- Subsequent lines have a college and attributes about the college.
- Python has several ways to read in such data.
- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$

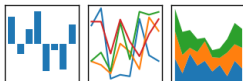


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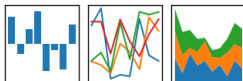


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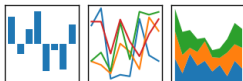


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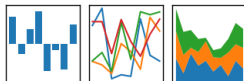


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- See Lab 1 for directions on downloading it to your home machine.
- If you can't install on your computer, it is supported in <https://repl.it/>
- To use, add to the top of your program:

```
import pandas as pd
```

CSV Files

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- Excel .xls files have much extra formatting.

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- The text file version is called **CSV** for comma separated values.

CSV Files

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- The text file version is called **CSV** for comma separated values.
- Each row is a line in the file.

CSV Files

Undergraduate			
College	Full-time	Part-time	Total
Baruch	11,288	3,922	15,210
Brooklyn	10,198	4,208	14,406
City	10,067	3,250	13,317
Hunter	12,223	4,500	16,723
John Jay	9,831	2,843	12,674
Lehman	6,600	4,720	11,320
Medgar Evers	4,760	2,059	6,819
NYCCT	10,912	6,370	17,282
Queens	11,693	4,633	16,326
Staten Island	9,584	2,948	12,532
York	5,066	3,192	8,258

- Excel .xls files have much extra formatting.
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- Each row is a line in the file.
- Columns are separated by commas on each line.

CSV Files

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,
First census after the consolidation of the five boroughs,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,4549,6159,1781,3827,49447
1800,60515,5740,6642,1755,4563,79215
1810,96373,8303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,5346,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813669,279122,32903,23593,25492,1174779
1870,942292,419921,45468,37393,33029,1478103
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51693,2507414
1900,1850093,1166582,152999,200507,67021,3437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018356,469042,732016,116531,5620048
1930,1867312,2560401,1079129,1265258,158346,6930446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1960101,2738175,1550849,1451277,191555,7891957
1960,1698281,2627319,1809578,1424815,221991,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1891325,1168972,352121,7071639
1990,1487536,2300664,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1585873,2504700,2230722,1385108,468730,8175133
2015,1644518,2636735,2339150,1455444,474558,8550405
```

nycHistPop.csv

Reading in CSV Files

College	Undergraduate		
	Full-time	Part-time	Total
Baruch	11,288	3,922	15,210
Brooklyn	10,198	4,208	14,406
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Medgar Evers	4,760	2,059	6,819
NYCCT	10,912	6,370	17,282
Queens	11,693	4,633	16,326
Staten Island	9,584	2,948	12,532
York	5,066	3,192	8,258

- To read in a CSV file: `myVar = pd.read_csv("myFile.csv")`

Reading in CSV Files

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Medgar Evers	4,760	2,059	6,819
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York	5,066	3,192	8,258

- To read in a CSV file: `myVar = pd.read_csv("myFile.csv")`
- Pandas has its own type, **DataFrame**, that is perfect for holding a sheet of data.

Reading in CSV Files

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	Full-time	Part-time	Total
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- Often abbreviated: `df`.

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- Often abbreviated: `df`.
- It also has **Series**, that is perfect for holding a row or column of data.

Example: Reading in CSV Files

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,45049,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,40203,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419801,45468,37393,33829,1470183
1880,1164673,599495,56559,51980,38991,1911690
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4768883
1920,2284103,2018256,469042,732018,116531,5420048
1930,1867312,2580461,1079129,1262558,159346,690446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738075,1500849,1452177,191555,78931957
1960,1698281,2627319,1809578,1624815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7094862
1980,1428285,2230936,1801325,1168872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1494873,2504790,2230722,1385108,448730,8175133
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

```
import matplotlib.pyplot as plt
import pandas as pd
```

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,45449,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,40203,7444,2267,5347,139734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419921,45448,37393,33829,1470193
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018296,469042,732018,116511,2620048
1930,1867312,2580461,1079129,1265258,159346,690446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738275,1500449,1452177,191555,7892197
1960,1698281,2627319,1809578,1424815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1891325,1168872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8006278
2010,1494873,2504790,2230722,1385108,448730,8175123
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

```
import matplotlib.pyplot as plt
import pandas as pd
```

```
pop = pd.read_csv('nycHistPop.csv', skiprows=5)
```

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,30131,4548,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,8023,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419821,45468,37393,33829,1470183
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284123,2018256,469042,732016,116511,5620048
1930,1867312,2560461,1079129,1265258,159346,4590446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738275,1500849,1451277,191555,78991957
1960,1698281,2627319,1809578,1624815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1801325,1168872,352121,7071639
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1648473,2504700,2230722,1385108,448730,81751523
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

```
import matplotlib.pyplot as plt
import pandas as pd
```

```
pop = pd.read_csv('nycHistPop.csv', skiprows=5)
```

```
pop.plot(x="Year")
plt.show()
```

Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,.....
All population figures are consistent with present-day boundaries.....
First census after the consolidation of the five boroughs.....

```
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,30131,4549,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,9303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419921,45468,37393,33829,1470193
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51693,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018256,469042,732016,116511,5620048
1930,1867312,2560451,1079129,1265258,159346,4590446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738075,1550849,1451277,191555,78991957
1960,1698281,2627319,1809578,1624815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2210936,1891325,1168972,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1484873,2504790,2230722,1385108,448730,81751123
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

```
import matplotlib.pyplot as plt
import pandas as pd
```

```
pop = pd.read_csv('nycHistPop.csv', skiprows=5)
```

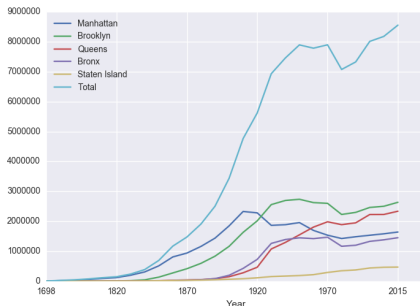
```
pop.plot(x="Year")
plt.show()
```

Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,
All population figures are consistent with present-day boundaries.
First census after the consolidation of the five boroughs.

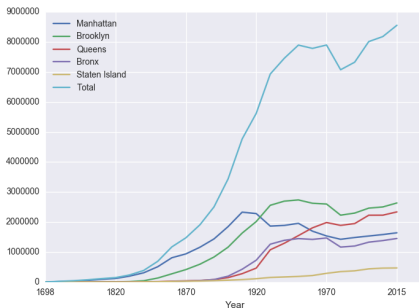
```
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island,Total
1698,4937,2017,,727,7681
1771,21863,3623,,2847,28423
1790,33131,4548,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,9303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,5344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419901,45468,37393,33829,1470183
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1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430989,85969,4766883
1920,2284193,2018256,469042,732016,116531,5620048
1930,1867312,2560461,1079129,1265588,159346,6906446
1940,1889924,2698295,1297634,1394711,174441,7454995
1950,1940101,2738275,1505049,1452277,291559,7892957
1960,1698281,2627319,1809578,1624815,221993,7781984
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2000,1537195,2465326,2229379,1326450,443728,8006278
2010,1484873,2504760,2230722,1385108,468730,8175133
2015,1644518,2636735,2339155,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

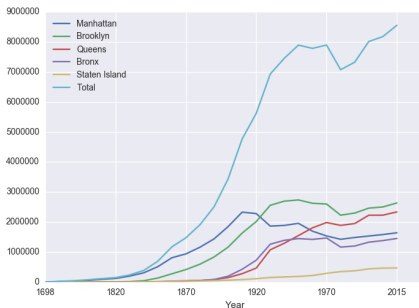


Series in Pandas



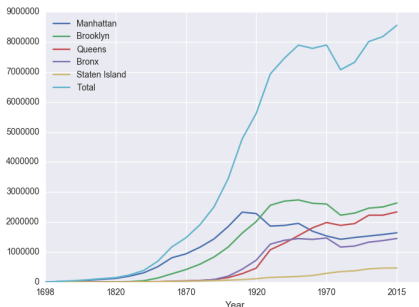
- Series can store a column or row of a DataFrame.

Series in Pandas



- Series can store a column or row of a DataFrame.
- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.

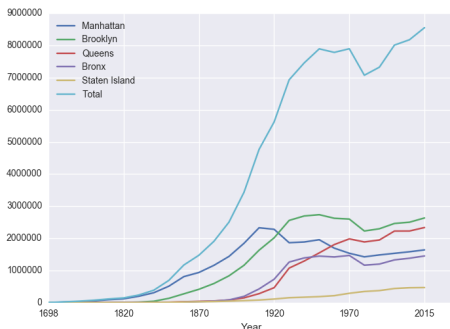
Series in Pandas



- Series can store a column or row of a DataFrame.
- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.
- Example:

```
print("The largest number living in the Bronx is",  
pop["Bronx"].max())
```

Challenge:



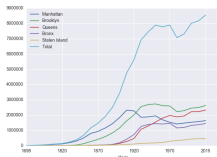
Predict what the following will do:

- `print("Queens:", pop["Queens"].min())`
- `print("S I:", pop["Staten Island"].mean())`
- `print("S I:", pop["Staten Island"].std())`
- `pop.plot.bar(x="Year")`
- `pop.plot.scatter(x="Brooklyn", y="Total")`
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`

Solutions

Predict what the following will do:

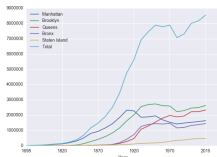
- `print("Queens:", pop["Queens"].min())`



Solutions

Predict what the following will do:

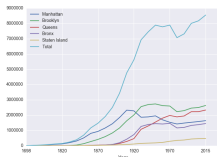
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".



Solutions

Predict what the following will do:

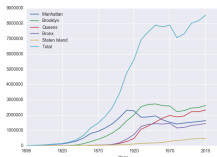
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`



Solutions

Predict what the following will do:

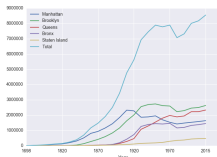
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".



Solutions

Predict what the following will do:

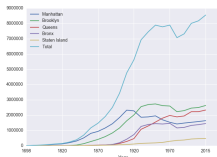
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`



Solutions

Predict what the following will do:

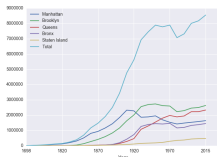
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".



Solutions

Predict what the following will do:

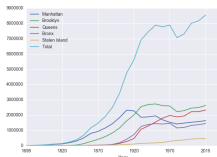
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`



Solutions

Predict what the following will do:

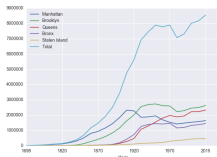
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
Bar chart with x-axis "Year".



Solutions

Predict what the following will do:

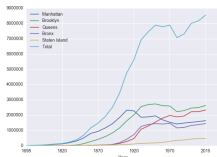
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y="Total")`



Solutions

Predict what the following will do:

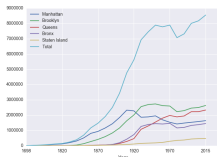
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y="Total")`
Scatter plot of Brooklyn versus Total values.



Solutions

Predict what the following will do:

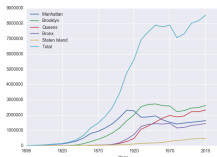
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y="Total")`
Scatter plot of Brooklyn versus Total values.
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`



Solutions

Predict what the following will do:

- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y="Total")`
Scatter plot of Brooklyn versus Total values.
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`
New column with the fraction of population that lives in the Bronx.



Challenge:

Write a complete Python program that reads in the file, `cunyF2016.csv`, and produces a scatter plot of full-time versus part-time enrollment.

Undergraduate			
College	Full-time	Part-time	Total
Baruch	11,288	3,922	15,210
Brooklyn	10,198	4,208	14,406
City	10,067	3,250	13,317
Hunter	12,223	4,500	16,723
John Jay	9,831	2,843	12,674
Lehman	6,800	4,720	11,320
Medgar Evers	4,760	2,059	6,819
NYCCT	10,912	6,370	17,282
Queens	11,693	4,633	16,326
Staten Island	9,584	2,948	12,532
York	5,066	3,192	8,258

`cunyF2016.csv`

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`cunyF2016.csv`

Solution:

- 1 *Include `pandas` & `pyplot` libraries.*

Challenge:

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cunyF2016.csv

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Solution:

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Solution:

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cunyF2016.csv

Write a complete Python program that reads in the file, `cunyF2016.csv`, and produces a scatter plot of full-time versus part-time enrollment.

Solution:

- 1 *Include pandas & pyplot libraries.*
- 2 *Read in the CSV file.*
- 3 *Set up a scatter plot.*
- 4 *Display plot.*

Challenge:

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`cunyF2016.csv`

Solution:

- 1 *Include pandas & pyplot libraries.*
`import matplotlib.pyplot as plt`
`import pandas as pd`

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`cunyF2016.csv`

Solution:

- 1 *Include pandas & pyplot libraries.*

```
import matplotlib.pyplot as plt  
import pandas as pd
```

- 2 *Read in the CSV file.*

```
pop=pd.read_csv('cunyF2016.csv',skiprows=1)
```

Challenge:

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`cunyF2016.csv`

Solution:

- 1 *Include pandas & pyplot libraries.*
`import matplotlib.pyplot as plt`
`import pandas as pd`
- 2 *Read in the CSV file.*
`pop=pd.read_csv('cunyF2016.csv',skiprows=1)`
- 3 *Set up a scatter plot.*
`pop.plot.scatter(x="Full-time",y="Part-time")`

Challenge:

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`cunyF2016.csv`

Solution:

- 1 *Include pandas & pyplot libraries.*
`import matplotlib.pyplot as plt`
`import pandas as pd`
- 2 *Read in the CSV file.*
`pop=pd.read_csv('cunyF2016.csv',skiprows=1)`
- 3 *Set up a scatter plot.*
`pop.plot.scatter(x="Full-time",y="Part-time")`
- 4 *Display plot.*

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`cunyF2016.csv`

Solution:

- 1 *Include pandas & pyplot libraries.*
`import matplotlib.pyplot as plt`
`import pandas as pd`
- 2 *Read in the CSV file.*
`pop=pd.read_csv('cunyF2016.csv',skiprows=1)`
- 3 *Set up a scatter plot.*
`pop.plot.scatter(x="Full-time",y="Part-time")`
- 4 *Display plot.*
`plt.show()`

Lecture Quiz

- Log-in to Gradescope
- Find LECTURE 6 Quiz
- Take the quiz
- **You have 3 minutes**

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/08	Albury	13.4	22.9	0.6
5/22/15	BadgerysCree	11	15.6	1.6
3/17/11	BadgerysCree	18.1	25.8	16.6
7/27/10	Cobar	5.3	17.2	0
9/5/10	Moree	12.1	19.8	23.4
1/23/12	CoffsiHarbour	20	24.4	28
7/15/11	Moree	2.8	19	0
1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
* * *				

AustraliaRain.csv

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at each location:

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/08	Albury	13.4	22.9	0.6
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9/5/10	Moree	12.1	19.8	23.4
1/23/12	CoffsHarbour	20	24.4	28
7/15/11	Moree	2.8	19	0
1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
* * *				

AustraliaRain.csv

① *Import libraries.*
`import pandas as pd`

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7/15/11	Moree	2.8	19	0
1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
* * *				

AustraliaRain.csv

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

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1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
	• • •			

AustraliaRain.csv

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location.*
`groupAvg = rain.groupby('Location')`

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at each location:

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Date	Location	MinTemp	MaxTemp	Rainfall
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1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
* * *				

AustraliaRain.csv

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location.*
`groupAvg = rain.groupby('Location')`
- 4 *Print the average rainfall at each location.*
`print(groupAvg['Rainfall'].mean())`

groupby()

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
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7/15/11	Moree	2.8	19	0
1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.8
* * *				

AustraliaRain.csv

Adelaide	1.572185
Albany	2.255073
Albury	1.925710
AliceSprings	0.869355
BadgerysCreek	2.207925
Ballarat	1.688830
Bendigo	1.621452
Brisbane	3.160536
Cairns	5.765317
Canberra	1.735038
Cobar	1.129262
CoffsHarbour	5.054592
Darlington	2.148554

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at each location:

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location.*
`groupAvg = rain.groupby('Location')`
- 4 *Print the average rainfall at each location.*
`print(groupAvg['Rainfall'].mean())`

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at one location, e.g. Albury:

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/08	Albury	13.4	22.9	0.6
5/2/15	BadgerysCree	11	15.6	1.6
3/17/11	BadgerysCree	16.1	25.8	16.6
1/27/10	Cobar	5.3	17.2	0
9/5/10	Monea	12.1	19.8	23.4
1/23/12	Coffshalehurst	20	24.4	26
7/15/11	Monea	2.8	19	0
1/28/11	Newcastle	22.2	29	0
12/2/15	Monea	26.1	32	4.8
...				

AustraliaRain.csv

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at one location, e.g. Albury:

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/08	Albury	13.4	22.9	0.0
5/22/15	BadgerysCreek	11	15.6	1.6
3/17/11	BadgerysCreek	16.1	25.8	16.6
7/27/10	Cobar	5.3	17.2	0
9/5/10	Morree	12.1	19.8	23.4
1/23/12	Coffshaleburn	20	24.4	26
7/15/11	Morree	2.8	19	0
1/28/11	Newcastle	22.2	28	0
12/2/15	Morree	26.1	32	4.8
...				

AustraliaRain.csv

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location get data for group Albury.*
`AlburyAvg =
rain.groupby('Location').get_group('Albury')`

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at one location, e.g. Albury:

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
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5/22/15	BadgersCreek	11	15.6	1.6
3/17/11	BadgersCreek	16.1	25.8	16.6
7/27/10	Colar	5.3	17.2	0
9/5/10	Monea	12.1	19.8	23.4
1/23/12	Coffeyhurst	20	24.4	26
7/15/11	Monea	2.8	19	0
1/28/11	Newcastle	22.2	28	0
12/2/15	Monea	26.1	32	4.8
...				

AustraliaRain.csv

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location get data for group Albury.*
`AlburyAvg =
rain.groupby('Location').get_group('Albury')`
- 4 *Print the average rainfall in Albury.*
`print(AlburyAvg['Rainfall'].mean())`

groupby()

Sometimes you have **recurring values in a column** and you want to examine the data for a particular value.

For example, to find the average rainfall at one location, e.g. Albury:

Date	Location	MinTemp	MaxTemp	Rainfall
1/2/108	Albury	15.4	22.9	9.9
5/23/15	BadgersCree	11	15.5	1.5
3/17/11	BadgersCree	18.1	25.8	16.6
7/27/10	Colbar	5.3	17.2	0
3/5/10	Moree	12.1	19.8	23.6
1/23/12	CoffinHarbour	20	24.4	20
7/15/11	Moree	3.8	19	0
1/28/10	Newcastle	22.2	28	0
12/2/15	Moree	20.1	32	4.9
...				

AustraliaRain.csv

```
1.9257104647275156
```

- 1 *Import libraries.*
`import pandas as pd`
- 2 *Read in the CSV file.*
`rain =
pd.read_csv('AustraliaRain.csv', skiprows=1)`
- 3 *Group the data by location get data for group Albury.*
`AlburyAvg =
rain.groupby('Location').get_group('Albury')`
- 4 *Print the average rainfall in Albury.*
`print(AlburyAvg['Rainfall'].mean())`

Design Challenge

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	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
3834	272000	1183	-9.2	Hypergiant	Red	M

- Design an algorithm that:
 - ▶ Prints the luminosity of the brightest star.
 - ▶ Prints the temperature of the coldest star.
 - ▶ Prints the average radius of a Hypergiant.

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	Star type	Star color	Spectral Class
3068	0.0024	0.17	16.12	Brown Dwarf	Red	M
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- **Libraries:** pandas

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	Star type	Star color	Spectral Class
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3834	272000	1183	-9.2	Hypergiant	Red	M

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

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	Star type	Star color	Spectral Class
3068	0.0024	0.17	16.12	Brown Dwarf	Red	M
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6380	1.35	0.98	2.93	Main Sequence	yellow-white	F
3834	272000	1183	-9.2	Hypergiant	Red	M

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

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	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
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6380	1.35	0.98	2.93	Main Sequence	yellow-white	F
3834	272000	1183	-9.2	Hypergiant	Red	M

- **Libraries:** pandas
- **Process:**
 - ▶ Print **max** of '**Luminosity**' column
 - ▶ Print **min** of '**Temperature**' column
 - ▶ **groupby** '**Star Type**' and take **averages**, then print **max** of '**Radius**' column

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L _o)	Radius(R/R _o)	Absolute magnitude(M _v)	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
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6380	1.35	0.98	2.93	Main Sequence	yellow-white	F
3834	272000	1183	-9.2	Hypergiant	Red	M

- **Libraries:** pandas
- **Process:**
 - ▶ Print **max** of '**Luminosity**' column
 - ▶ Print **min** of '**Temperature**' column
 - ▶ **groupby** '**Star Type**' and take **averages**, then print **max** of '**Radius**' column
 - ▶ OR **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())
```

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 take **averages**, then print **max** of '**Radius**' column

```
print(stars.groupby('Star type')\
      .mean()['Radius(R/Ro)'].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())
```

- ▶ OR **groupby** '**Star Type**' and **get group** '**Hypergiant**' to print **average** '**Radius**'

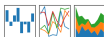
```
print(stars.groupby('Star type')\  
.get_group('Hypergiant').mean()['Radius(R/Ro)'])
```

Recap

- Recap: Logical Expressions & Circuits

pandas

$y_i = \beta^T x_i + \mu_i + \epsilon_i$

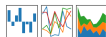


Recap

- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.

pandas

$y_i = \beta^T x_i + \mu_i + \epsilon_i$



Recap

- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.
 - ▶ Can manipulate individual columns or rows ('Series').

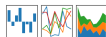


Recap

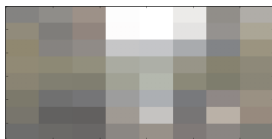
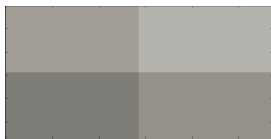
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.
 - ▶ Can manipulate individual columns or rows ('Series').
 - ▶ Has useful functions for the entire sheet ('DataFrame') such as plotting.

pandas

$y_i = \beta_0 x_{i0} + \beta_1 x_{i1} + \epsilon_i$



Practice Quiz & Final Questions



- Since you must pass the final exam to pass the course, we end every lecture with final exam review.
- Pull out something to write on (not to be turned in).
- Lightning rounds:
 - ▶ write as much you can for 60 seconds;
 - ▶ followed by answer; and
 - ▶ repeat.
- Past exams are on the webpage (under [Final Exam Information](#)).
- We're starting with Spring 2018, Version 1.

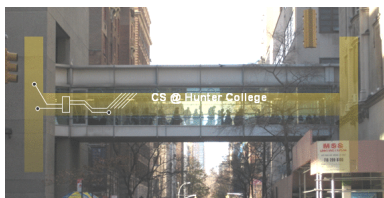
Weekly Reminders!



Before next lecture, don't forget to:

- Work on this week's Online Lab

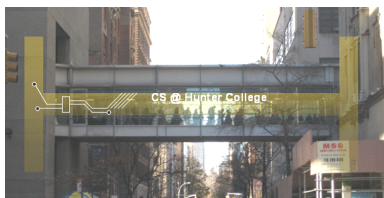
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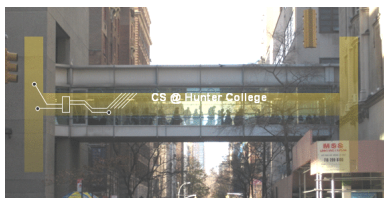
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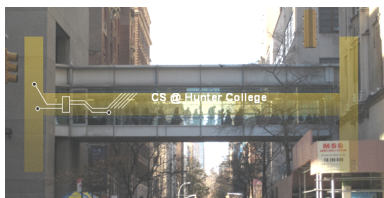
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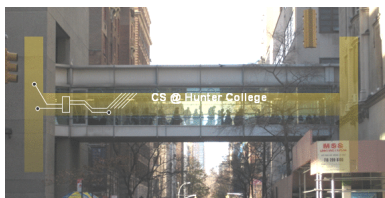
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- If you need help, [schedule an appointment for Tutoring](#) in lab 1001E 11am-5pm

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- Submit this week's [5 programming assignments](#) (programs 26-30)
- If you need help, [schedule an appointment for Tutoring](#) in lab 1001E 11am-5pm
- Take the Lecture Preview on Blackboard on Monday (or no later than 10am on Tuesday)