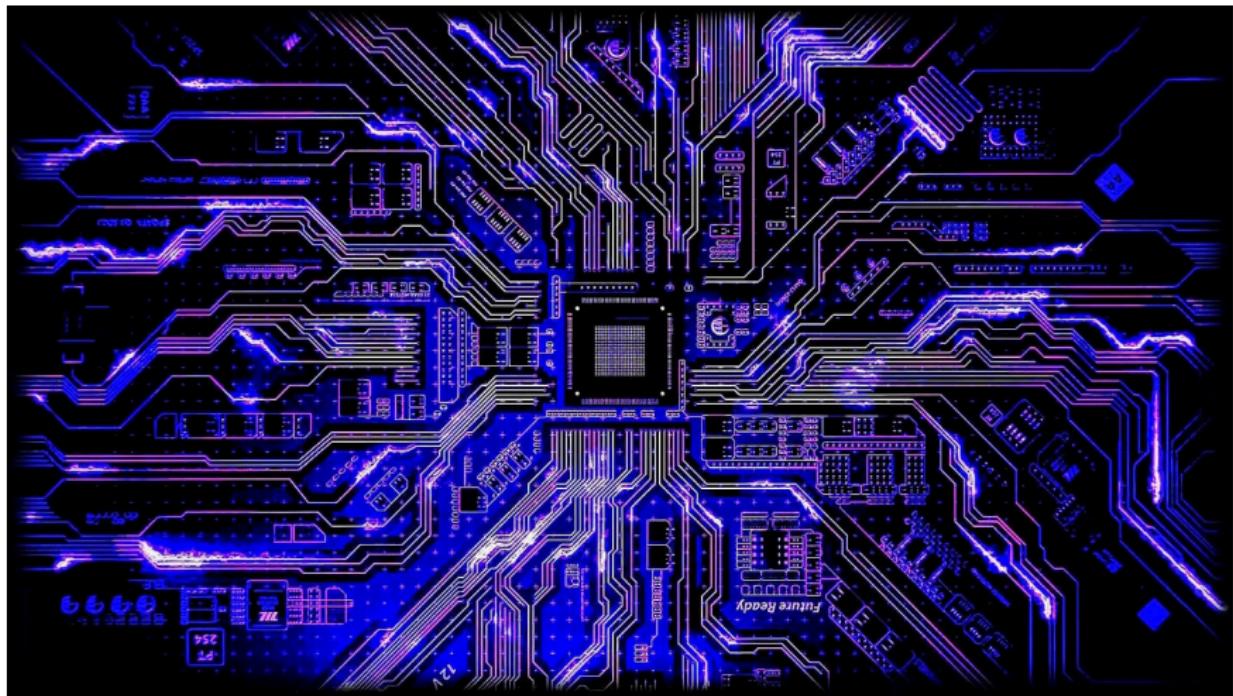


CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

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

or

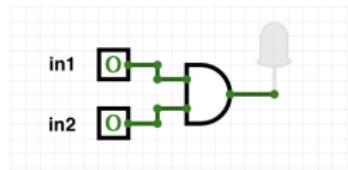
in1		in2	<i>returns:</i>
False	or	False	False
False	or	True	True
True	or	False	True
True	or	True	True

not

	in1	<i>returns:</i>
not	False	True
not	True	False

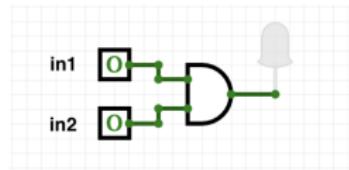
Logical Operators & Circuits

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



Logical Operators & Circuits

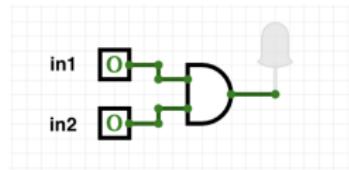
- Each logical operator (and, or, & not) can be used to join together expressions.



Example: $\text{in1} \text{ and } \text{in2}$

Logical Operators & Circuits

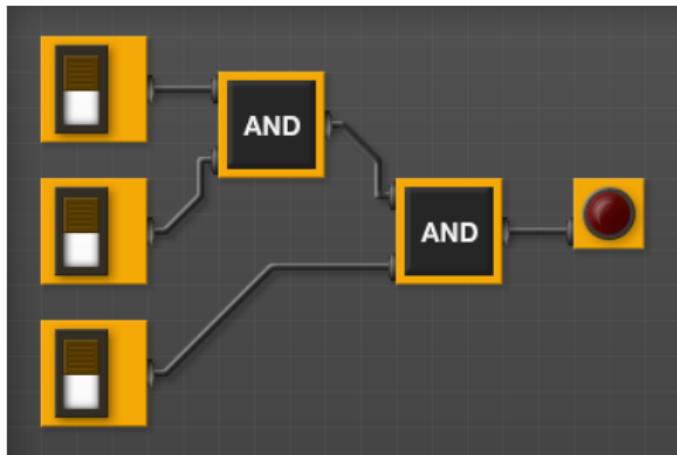
- Each logical operator (and, or, & not) can be used to join together expressions.



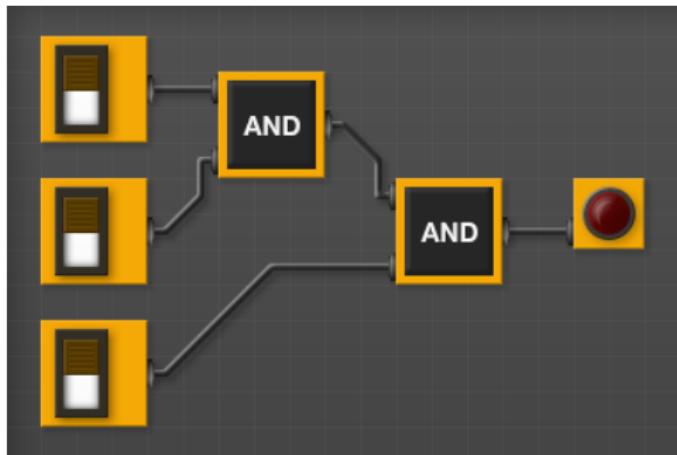
Example: in1 and in2

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

Examples: Logical Circuit



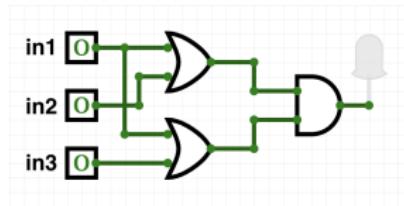
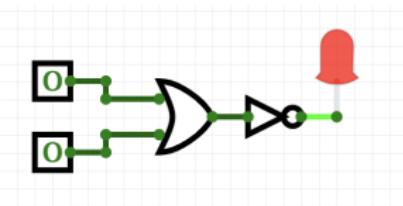
Examples: Logical Circuit



$(\text{in1 and in2}) \text{ and in3}$

More Circuit Examples

Examples from last lecture:



Draw a circuit that corresponds to each logical expression:

- $\text{not}(\text{in1 or in2})$
- $(\text{in1 or in2}) \text{ and } (\text{in1 or in3})$
- $(\text{not(in1 and not in2)}) \text{ or } (\text{in1 and (in2 and in3)})$

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 oclUxk"
result = ""
for i in range(len(mess)):
    if i % 3 == 0:
        print(mess[i])
        result = result + mess[i]
print(sports[1], result)
```

Python Tutor

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

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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How to approach this:

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- Don’t worry if you don’t know how to do all the items you write down.

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- Example:
 - ① Import libraries.

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- Example:
 - ① Import libraries.
 - ② Ask user for an image name.

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How to approach this:

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- Example:
 - ① Import libraries.
 - ② Ask user for an image name.
 - ③ Read in image.
 - ④ Figure out size of image.
 - ⑤ Make a new image that’s half the height and half the width.

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.)

How to approach this:

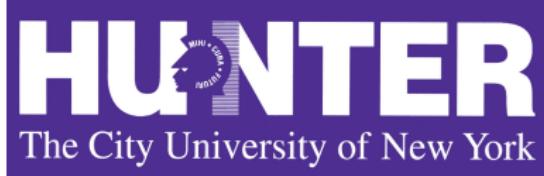
- Create a “To Do” list of what your program has to accomplish.
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 - ⑥ Display the new image.

In Pairs or Triples: Design Question



- ① Import libraries.

In Pairs or Triples: Design Question



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import matplotlib.pyplot as plt  
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In Pairs or Triples: Design Question



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In Pairs or Triples: Design Question



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- ② Ask user for an image name.

```
inF = input('Enter file name: ')
```

In Pairs or Triples: Design Question



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- ② Ask user for an image name.

```
inF = input('Enter file name: ')
```

- ③ Read in image.

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

In Pairs or Triples: Design Question



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- ③ Read in image.

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

- ④ Figure out size of image.

```
height = img.shape[0] #Get height  
width = img.shape[1] #Get width
```

In Pairs or Triples: Design Question



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import matplotlib.pyplot as plt  
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height = img.shape[0] #Get height  
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- ⑤ Make a new image that's half the height and half the width.

```
img2 = img[height//2:, :width//2] #Crop to lower left corner
```

In Pairs or Triples: Design Question



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```

- ⑤ Make a new image that's half the height and half the width.

```
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

College	Undergraduate		
	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
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Queens	11,693	4,633	16,326
Staten Island	9,584	2,948	12,532
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- Common to have data structured in a spread sheet.

Structured Data

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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” .

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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.

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- Next line has the titles for the columns.
- Subsequent lines have a college and attributes about the college.

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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

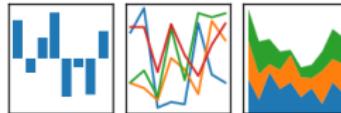
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- Next line has the titles for the columns.
- Subsequent lines have a college and attributes about the college.
- Python has several ways to read in such data.
- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

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

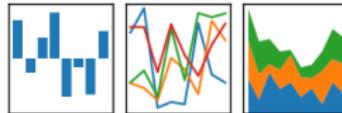


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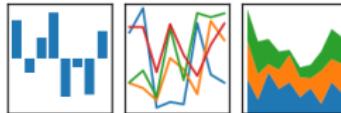


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Structured Data

pandas

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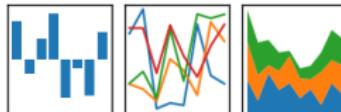


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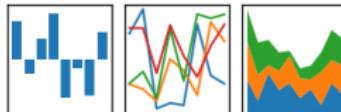


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<https://repl.it/>
- To use, add to the top of your program:

```
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.

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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
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

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

Reading in CSV Files

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- 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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- Often abbreviated: `df`.

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- 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.
- 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  
1690,4937,2017,727,788,111  
1771,21843,36231,2847,28423  
1790,33131,4549,6159,1781,3827,49447  
1800,60515,5740,6442,1755,4543,75955  
1810,68541,6254,7000,1800,4973,89734  
1820,123704,11487,8246,2792,6135,152056  
1830,202589,20535,9049,3023,7082,242278  
1840,312110,18013,14000,5346,10965,391114  
1850,355441,21800,18500,5800,11500,45115  
1860,513449,279122,32903,23593,25492,174777  
1870,942292,419921,45468,37393,33029,1479103  
1880,1164473,59943,5653,51980,33091,1911801  
1890,1364473,70000,65000,58000,34000,2150000  
1900,185093,116582,152999,200567,67621,2437202  
1910,233342,1634351,284041,430980,8569,476683  
1920,2246103,2018354,446000,732013,116500,591048  
1930,1667132,1800000,379128,235425,15830,4930446  
1940,1889924,2698285,1297634,1394711,174441,7454995  
1950,1960101,2738175,1550949,1451277,191555,7891957  
1960,1690000,23195,1800000,1451277,191555,7891984  
1970,1539231,2460700,1471071,135443,7984642  
1980,1428285,2230936,1891325,1168972,352121,7071639  
1990,1487536,2300664,1951598,1203789,378977,7322564  
2000,1537195,2485326,2229379,1332650,419782,8080879  
2010,1583873,2504705,2276722,1385108,471512,8175133  
2015,1444518,2636733,2339150,1459444,474558,8059405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

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

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  
1690,4937,2037,727,788,1040  
1771,21843,36231,2847,28423  
1790,33131,4549,6159,1781,3827,49447  
1800,60515,5740,6442,1755,4543,75955  
1810,67541,6211,6841,1755,4543,79334  
1820,123704,11187,8246,2792,6135,152056  
1830,202589,20535,9049,3023,7082,242278  
1840,312110,18013,14041,5348,10965,391114  
1850,355411,21801,18851,5348,10965,411115  
1860,613469,279122,32903,23593,25492,174777  
1870,942292,419921,45468,37393,33029,1479103  
1880,1164473,59943,56568,51980,33091,1911801  
1890,1367001,70000,65000,58000,33091,2141534  
1900,185093,116582,152999,200567,67621,2437202  
1910,233142,1634351,2841,430980,8569,476683  
1920,2246103,2018354,44601,44601,73201,11631,503083  
1930,2667112,2400000,579128,579128,5583,5030446  
1940,1889924,2698285,1297634,1394711,174441,7454995  
1950,1960101,2738175,1550949,1451277,191555,7991957  
1960,1690231,2303219,1890931,1460701,191555,781984  
1970,1539231,2460701,1874473,1472701,193443,781984  
1980,1426285,2230936,1891325,1168972,352121,7071639  
1990,1487536,2300664,1951598,1320789,378977,7322564  
2000,1537195,2485326,2223379,1332650,419782,8080879  
2010,1583873,2504705,2272722,1385108,474558,8175133  
2015,1444518,2546733,2339150,1459444,474558,8059405
```

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()

Year,Borough,Population
1698,Manhattan,7277188
1771,21843,36231,2847,28423
1790,33131,4549,6159,1781,3827,49447
1800,60515,5740,6442,1755,4543,75955
1810,70000,60000,60000,1750,4500,75000
1820,123704,11487,8246,2792,6135,152056
1830,20589,20535,9049,3023,7082,242278
1840,31510,11013,14000,5346,10965,391114
1850,35540,12800,14800,5800,11500,41500
1860,813469,279122,32903,23593,25492,174777
1870,942292,419921,45468,37393,33029,1479103
1880,1164473,59940,56568,51980,33091,1911801
1890,1385000,718000,68000,58000,33000,210000
1900,1850093,116582,152999,200567,67621,2437202
1910,233142,1634351,2841,430980,8569,476683
1920,22401103,2018354,44600,720201,116000,50000
1930,26711103,2270000,479128,435254,55821,4930446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1960101,2738175,1550849,1451277,191555,7991957
1960,1690000,2319319,1809000,1400000,180000,781984
1970,1539231,2460700,187473,1472701,135443,798460
1980,1426285,2230936,1891325,1168972,352121,7071639
1990,1487536,2300664,1951598,1203789,378977,7322564
2000,1537195,2485326,2229379,1332650,413782,8080879
2010,1583873,2504705,2272722,1385108,474558,8175133
2015,1444518,2546733,2339150,1459444,474558,8059405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

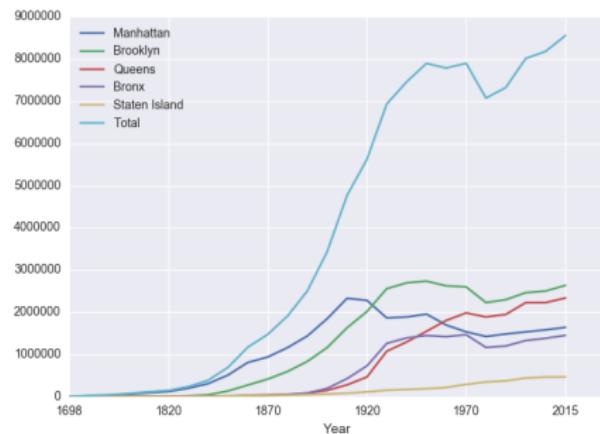
```
import matplotlib.pyplot as plt  
import pandas as pd
```

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

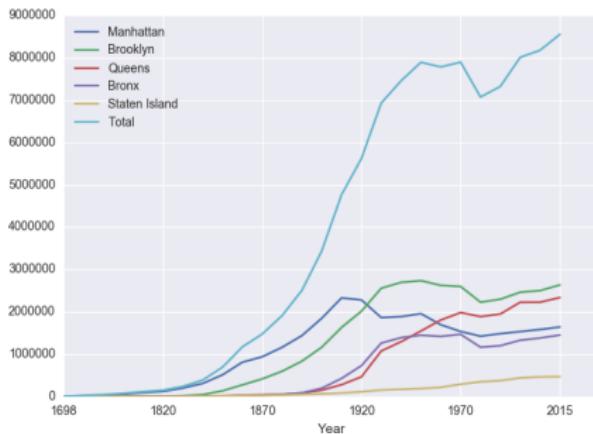
```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City.....  
All population figures are consistent with present-day boundaries.....  
First census after the consolidation of the five boroughs.....  
.....  
Year,Borough,Population  
1699,Manhattan, Brooklyn, Queens, Bronx, Staten Island, Total  
1771,21843,36232,,2847,28423  
1790,33131,4549,6159,1781,3827,49447  
1800,60515,5740,6442,1755,4543,75935  
1810,68111,6354,7040,1831,4937,93734  
1820,123704,11187,8246,2792,6135,152056  
1830,202589,20535,9049,3023,7082,242278  
1840,312110,18013,14044,5348,10965,391114  
1850,355449,21800,18850,5835,11500,45115  
1860,613469,279122,32903,23593,25492,174777  
1870,942292,419921,45468,37393,33029,1479103  
1880,1164473,59943,5653,51980,33091,1911801  
1890,1380711,72000,6800,55000,38000,218000  
1900,1850093,1165852,152999,200567,67621,2437202  
1910,233142,1634351,2841,430980,8569,476683  
1920,2210103,2018354,44601,73201,11600,50048  
1930,2667111,2500000,479128,352454,55821,5930446  
1940,1889924,2499285,1297634,1394711,174441,7454995  
1950,1960101,2738175,1550849,1451277,191555,7991957  
1960,1690000,2300000,1800000,1500000,1200000,781984  
1970,1539231,2465000,1471701,1271000,1050000,798460  
1980,1426285,2230936,1891325,1168972,352121,7071639  
1990,1497536,2300664,1951598,1203789,378977,7322564  
2000,1537195,2485326,2229379,1332450,419728,8080879  
2010,1583873,2504705,2216722,1385108,419728,8175133  
2015,1444518,2636733,2339150,1459446,474558,8059405
```

nycHistPop.csv

In Lab 6

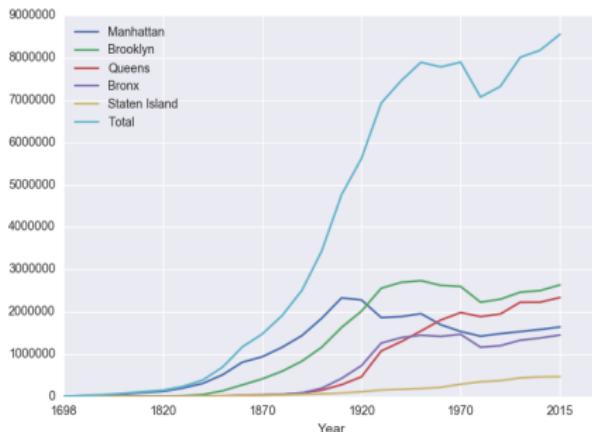


Series in Pandas



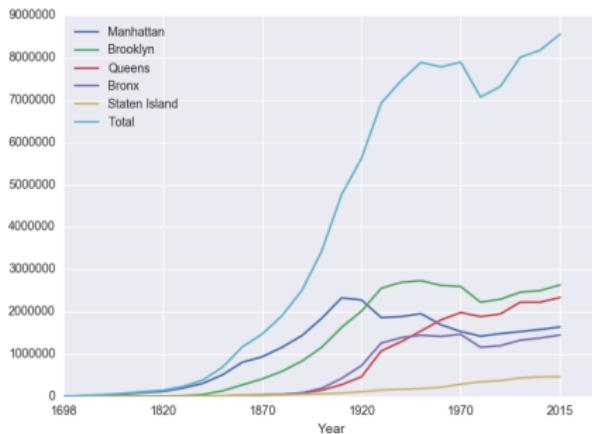
- Series can store a column or row of a DataFrame.

Series in Pandas



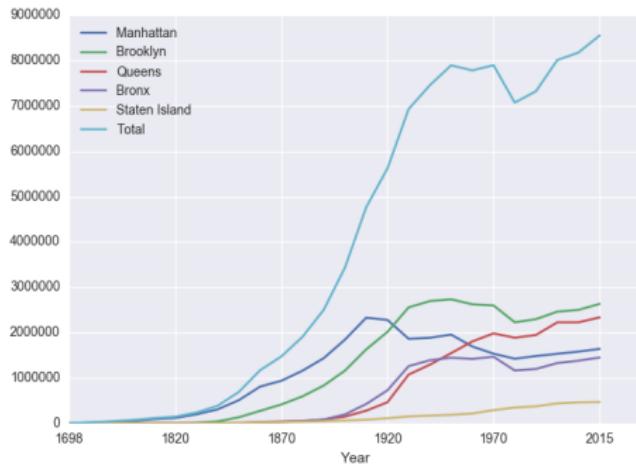
- Series can store a column or row of a DataFrame.
- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.

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())`

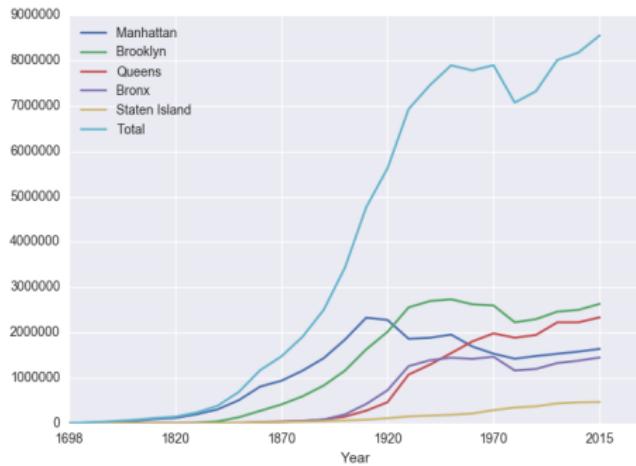
Challenge:



Predict what the following will do:

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

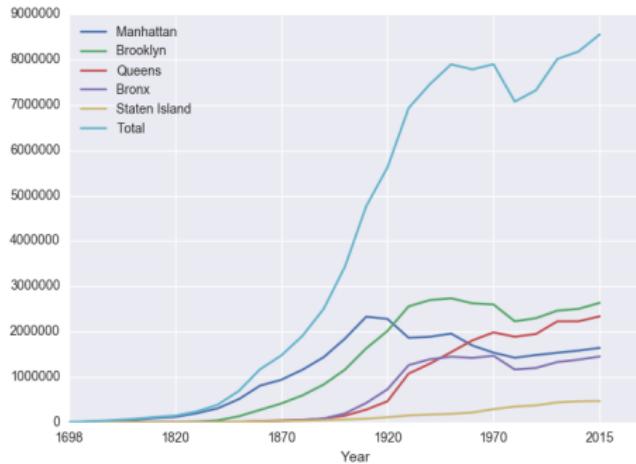
Challenge:



Predict what the following will do:

- `print("Queens:", pop["Queens"].min())`
- `print("S I:", pop["Staten Island"].mean())`

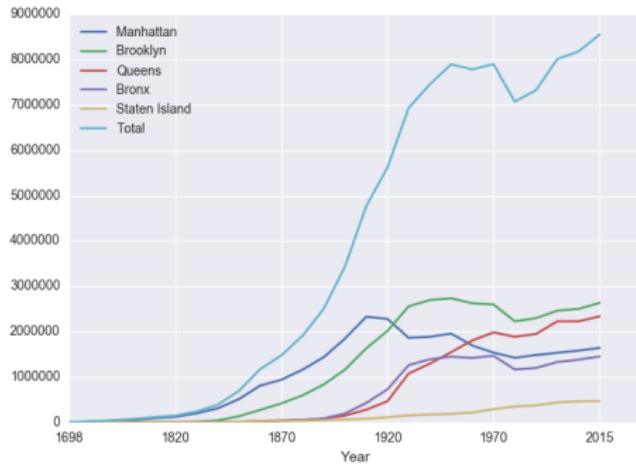
Challenge:



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())`

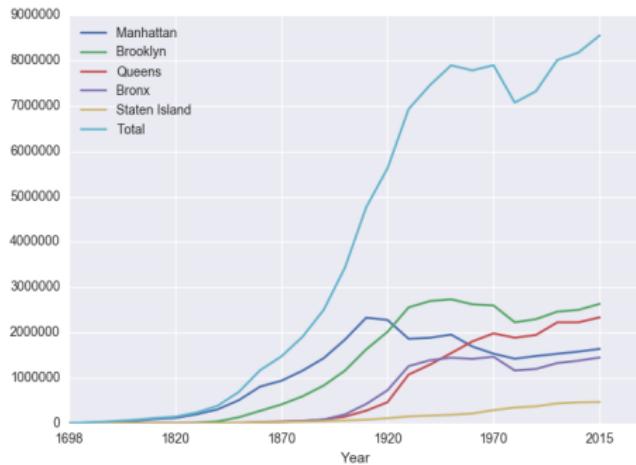
Challenge:



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")`

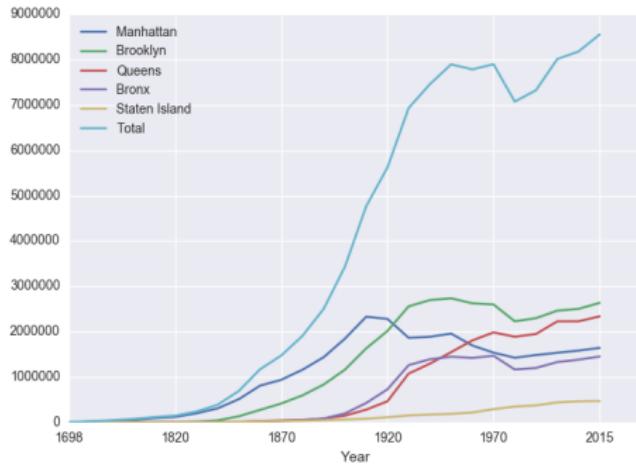
Challenge:



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")`

Challenge:



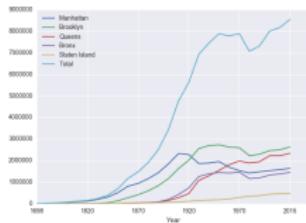
Predict what the following will do:

- `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:

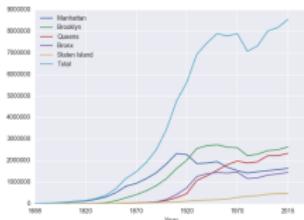
- `print("Queens:", pop["Queens"].min())`



Solutions

Predict what the following will do:

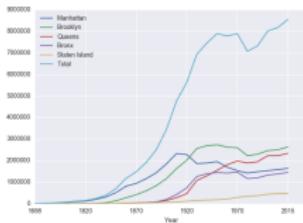
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".



Solutions

Predict what the following will do:

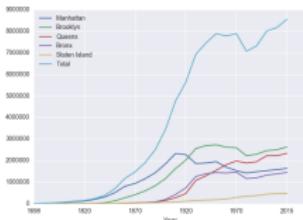
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`



Solutions

Predict what the following will do:

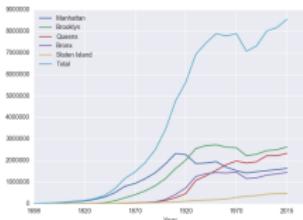
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".



Solutions

Predict what the following will do:

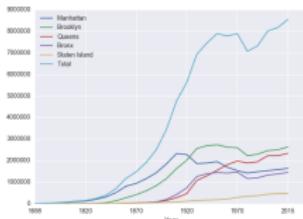
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`



Solutions

Predict what the following will do:

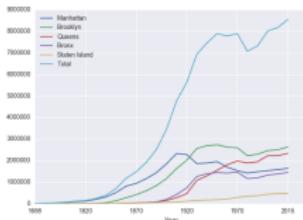
- `print("Queens:", pop["Queens"].min())`
Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
Standard deviation of values in the column "Staten Island".



Solutions

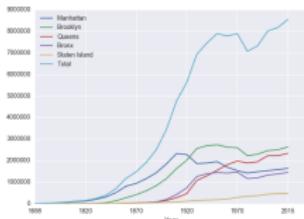
Predict what the following will do:

- `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

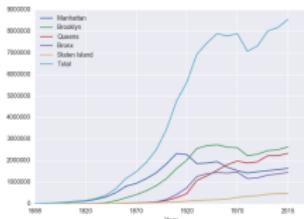
Predict what the following will do:



- `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

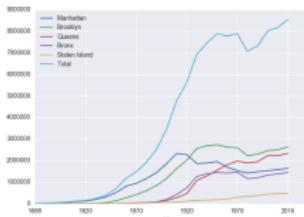
Predict what the following will do:



- `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

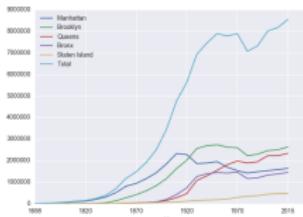
Predict what the following will do:



- `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

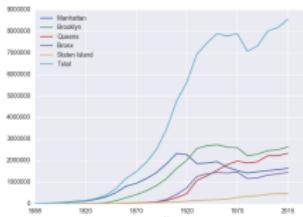
Predict what the following will do:



- `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.

College	Undergraduate		
	Full-time	Part-time	Total
Banach	11,288	3,922	15,210
Brooklyn	10,198	4,208	14,406
City	10,087	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	4,833	16,526
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.*

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cunyF2016.csv

Solution:

① *Include pandas & pyplot libraries.*

② *Read in the CSV file.*

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Solution:

- ① *Include pandas & pyplot libraries.*
- ② *Read in the CSV file.*
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- ④ *Display plot.*

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.

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Solution:

- ① *Include pandas & pyplot libraries.*

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import matplotlib.pyplot as plt  
import pandas as pd
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`cunyF2016.csv`

Solution:

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- ② *Read in the CSV file.*
`pop=pd.read_csv('cunyF2016.csv',skiprows=1)`

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```

- 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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- ② *Read in the CSV file.*

```
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```

- ③ *Set up a scatter plot.*

```
pop.plot.scatter(x="Full-time",y="Part-time")
```

- ④ *Display plot.*

```
plt.show()
```

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 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

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
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	CoffsHarbour	20	24.4	28
7/15/11	Moree	2.8	19	0
1/28/10	Newcastle	22.2	28	0
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AustraliaRain.csv

1 Import libraries.

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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()

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7/15/11 Moree		2.8	19	0
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...				

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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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
12/1/08	Albury	13.4	22.9	0.6
5/22/15	BadgerysCree	11	15.6	1.6
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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

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
Dartmoor	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
12/1/99	Albury	13.5	22.0	6.8
1/2/11	Balgownie	11.0	15.0	0
3/1/11	Balgownie	18.1	25.8	16.6
7/2/11	Cobar	5.3	17.2	0
8/2/11	Cobar	12.1	18.8	23.4
1/3/12	Coffs Harbour	20	24.4	20
7/1/11	Mt Isa	2.8	19	0
1/2/11	Newcastle	22.2	28	0
12/2/11	Perth	20.5	32	4.8

AustraliaRain.csv

groupby()

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

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/95	Albury	13.5	22.0	6.8
1/2/95	Bendigo	11.0	18.0	0.0
3/1/95	Bendigo/Crows	18.1	25.8	16.6
7/2/95	Cobar	5.3	17.2	0
8/2/95	Coolamine	12.1	18.8	23.4
1/3/95	Coffs Harbour	20	24.4	20
7/1/95	Mallee	2.8	19	0
1/2/95	Newcastle	22.2	28	0
1/2/95	Perth	20.5	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:

Date	Location	MinTemp	MaxTemp	Rainfall
12/1/95	Albury	13.5	22.0	6.8
1/2/95	Bendigo	11	18.0	0
3/1/95	Bendigo/Cerro	18.1	25.8	16.6
7/2/95	Cobar	5.3	17.2	0
8/2/95	Coolamine	12.1	18.8	23.4
1/2/95	Coffs Harbour	20	24.4	20
7/1/95	Mallee	2.8	19	0
1/2/95	Newcastle	22.2	28	0
1/2/95	Perth	20.5	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:

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/10	Albury	13.4	22.9	6.8
1/2/11	Bendigo	11.1	19.4	0
3/17/11	BodgrynaGree	18.1	25.8	16.9
7/27/10	Cobar	5.3	17.2	16.9
1/2/11	Melbourne	12.1	19.8	23.4
1/2/12	Melbourne	10.8	24.0	20
7/15/11	Moor	2.8	19	0
1/2/10	Newcastle	22.2	28	0
12/21/10	Moor	20.1	32	4.8
...				

AustraliaRain.csv

1.9257104647275156

- ① Import libraries.

```
import pandas as pd
```

- ② Read in the CSV file.

```
rain =  
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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/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
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/Lo)	Radius(R/Ro)	Absolute magnitude(Mv)	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

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L ₀)	Radius(R/R ₀)	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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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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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

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

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L ₀)	Radius(R/R ₀)	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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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

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

Design Challenge - Solution

Stars						
Temperature (K)	Luminosity(L/L ₀)	Radius(R/R ₀)	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
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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

- **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 ₀)	Radius(R/R ₀)	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')\n    .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())
```

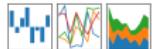
- ▶ OR **groupby** '**Star Type**' and **get group** '**Hypergiant**' to print average '**Radius**'

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

Recap

- Recap: Logical Expressions & Circuits

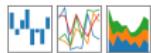
pandas
 $y_t = \beta^T x_t + \mu_t + \epsilon_t$



Recap

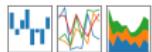
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.

pandas
 $y_t = \beta_0 x_t + \mu_t + \epsilon_t$



Recap

pandas
 $y_t = \beta_0 x_{it} + \mu_i + \epsilon_{it}$



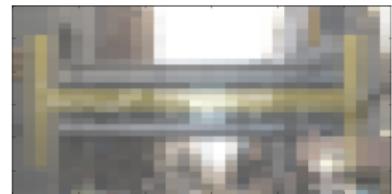
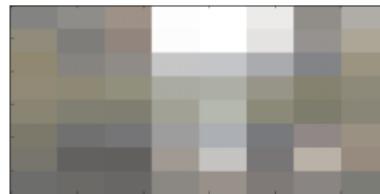
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.
 - ▶ Can manipulate individual columns or rows ('Series').

Recap

pandas

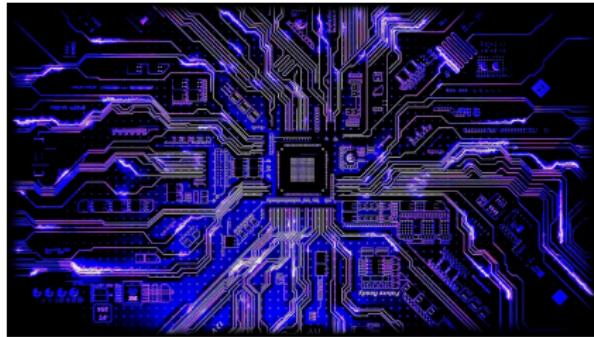
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
 - ▶ Pandas library has elegant solutions for accessing & analyzing structured data.
 - ▶ Can manipulate individual columns or rows ('Series').
 - ▶ Has useful functions for the entire sheet ('DataFrame') such as plotting.

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.

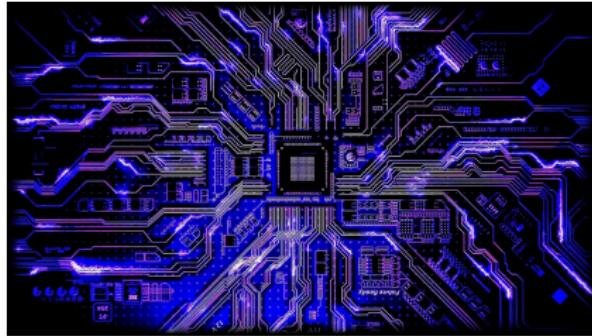
Weekly Reminders!



Before next lecture, don't forget to:

- Read and work through Lab 6!

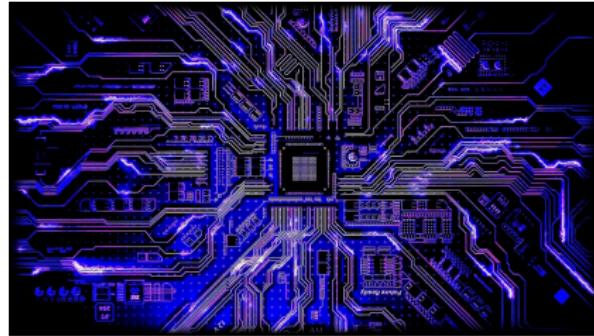
Weekly Reminders!



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- Submit this week's programming assignments

Weekly Reminders!



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- Submit this week's programming assignments