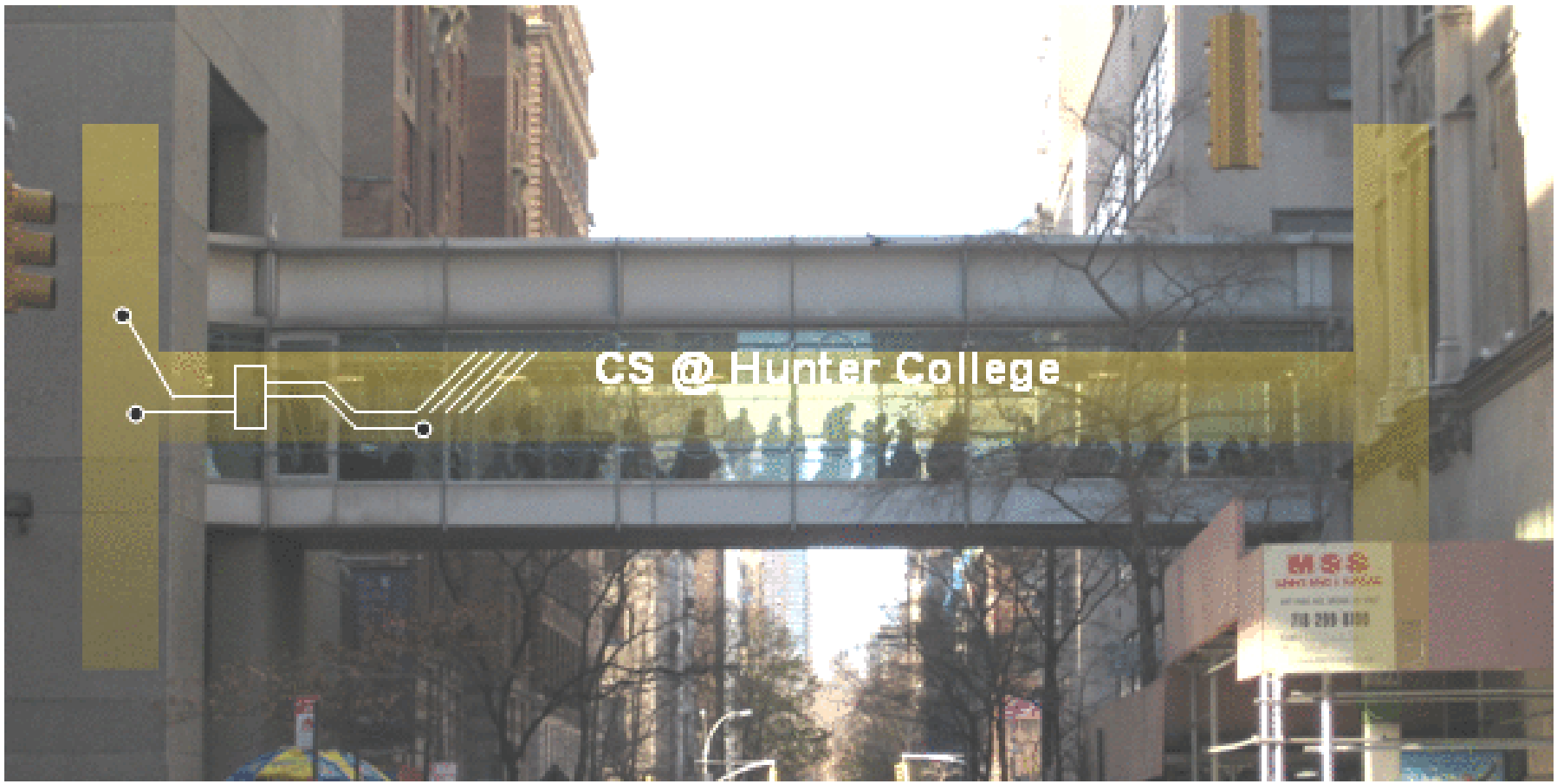
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Frequently Asked Questions

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  Yes, we will, since
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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).
- **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

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- **Recap: Logical Expressions & Circuits**
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Recap: Logical Operators

and

in1		in2	*returns:*
`False`	`and`	`False`	`False`
`False`	`and`	`True`	`False`
`True`	`and`	`False`	`False`
`True`	`and`	`True`	`True`

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`False`	`and`	`True`	`False`
`True`	`and`	`False`	`False`
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or

in1		in2	*returns:*
`False`	`or`	`False`	`False`
`False`	`or`	`True`	`True`
`True`	`or`	`False`	`True`
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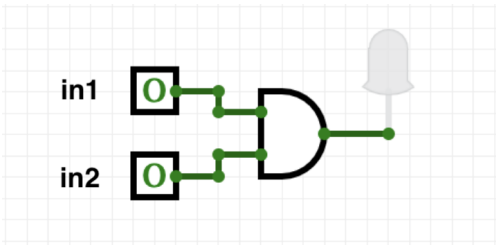
not

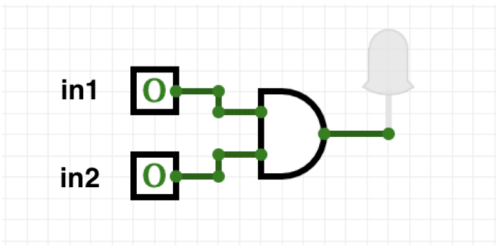
	in1	*returns:*
`not`	`False`	`True`
`not`	`True`	`False`

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`

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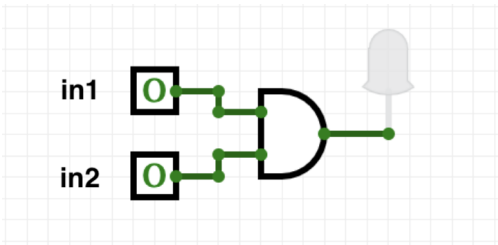
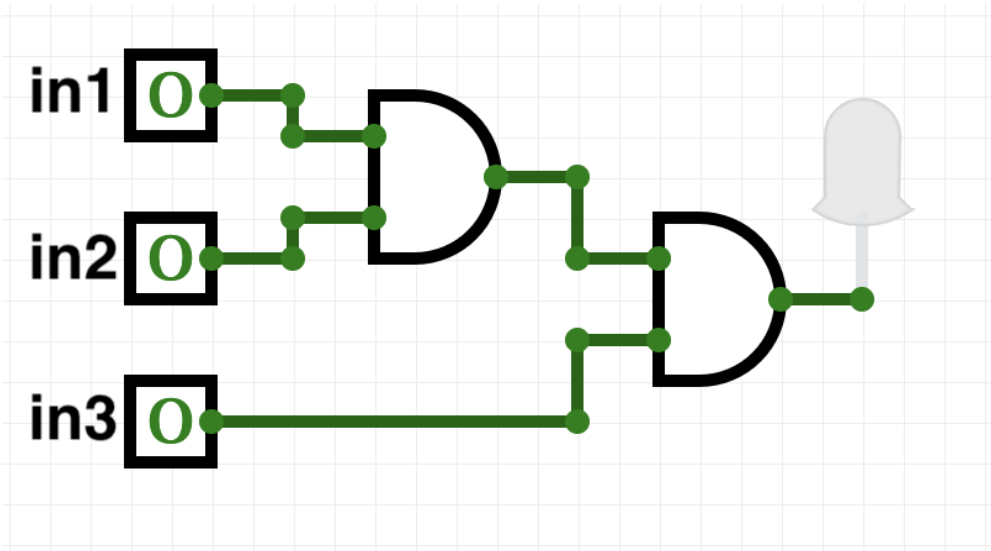


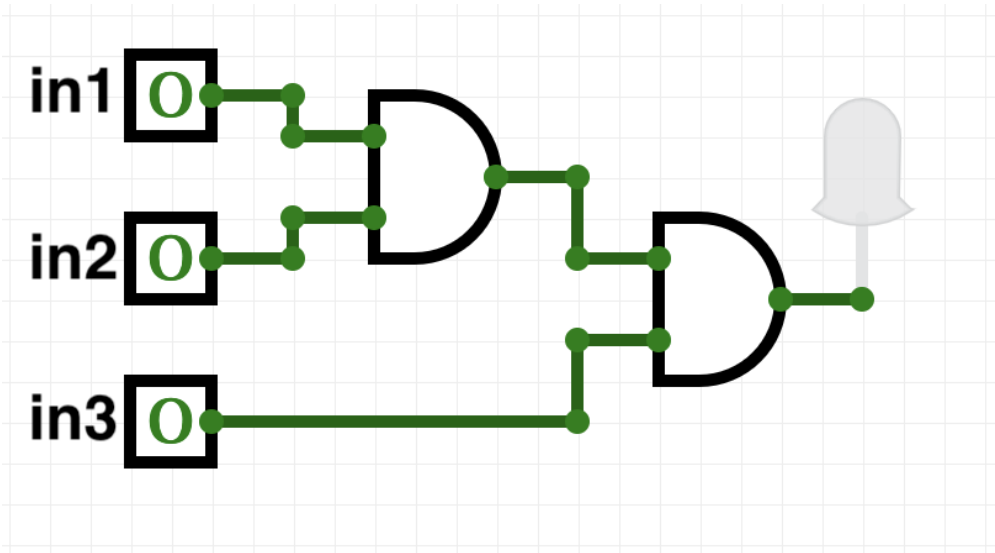
- Each logical operator (`and`, `or`, & `not`) can be used to join together expressions.

  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



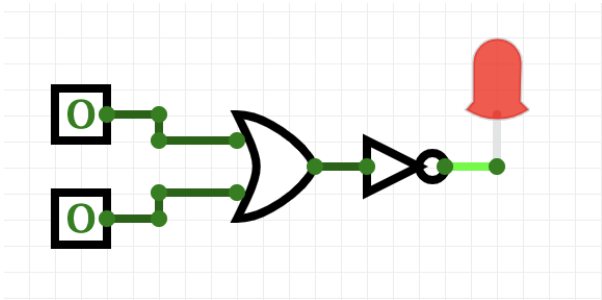
Examples: Logical Circuit

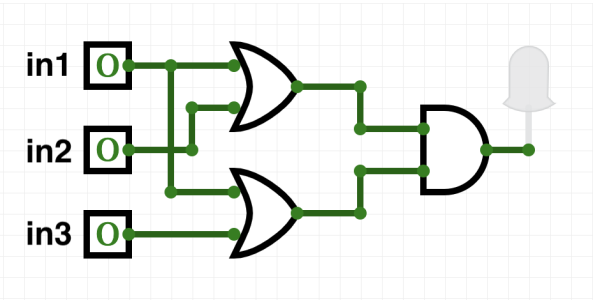


`(in1 and in2) and in3`

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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(Demo with pythonTutor)

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- **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.

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

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

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Structured Data

	Undergraduate		
College	Full-time	Part-time	Total
Baruch	11,288	3,922	15,210
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Hunter	12,223	4,500	16,723
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- Python has several ways to read in such data.
- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

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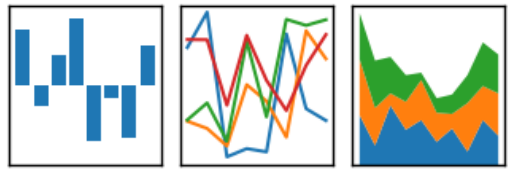

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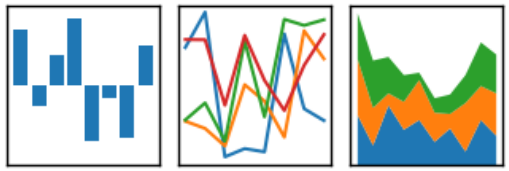

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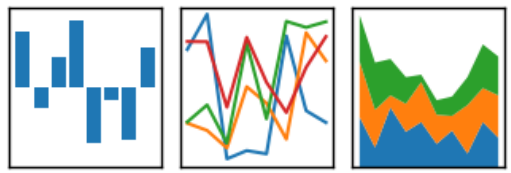

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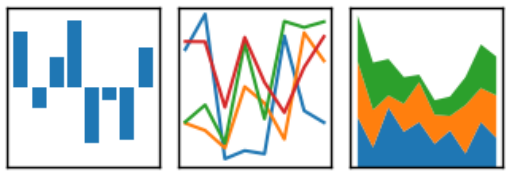

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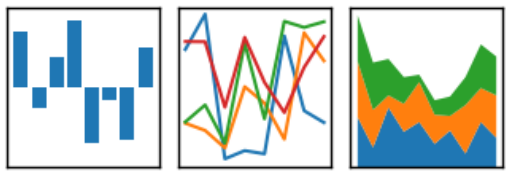

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- To use, add to the top of your program:

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CSV Files

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- Excel .xls files have much extra formatting.

CSV Files

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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
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nycHistPop.csv

Reading in CSV Files

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- It also has **Series**, that is perfect for holding a row or column of data.

Example: Reading in CSV Files

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`nycHistPop.csv`

In Lab 6

Example: Reading in CSV Files

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`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)
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In Lab 6

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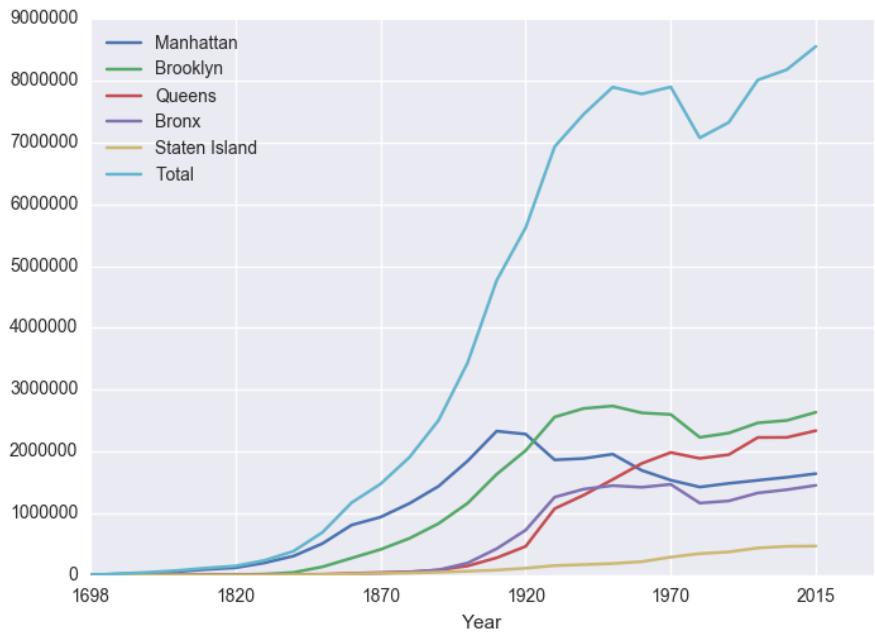
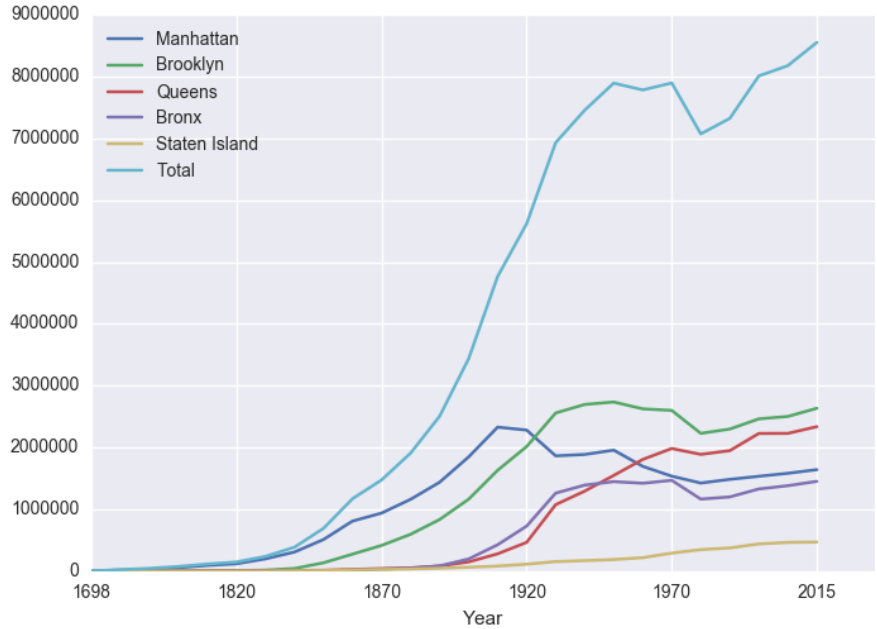
nycHistPop.csv

In Lab 6

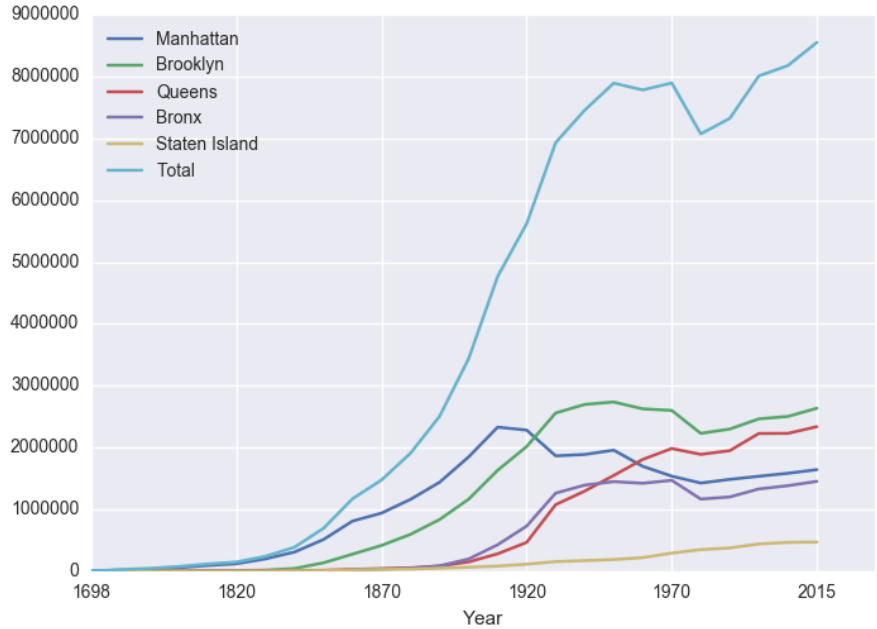


Series in Pandas



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

Series in Pandas



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- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.

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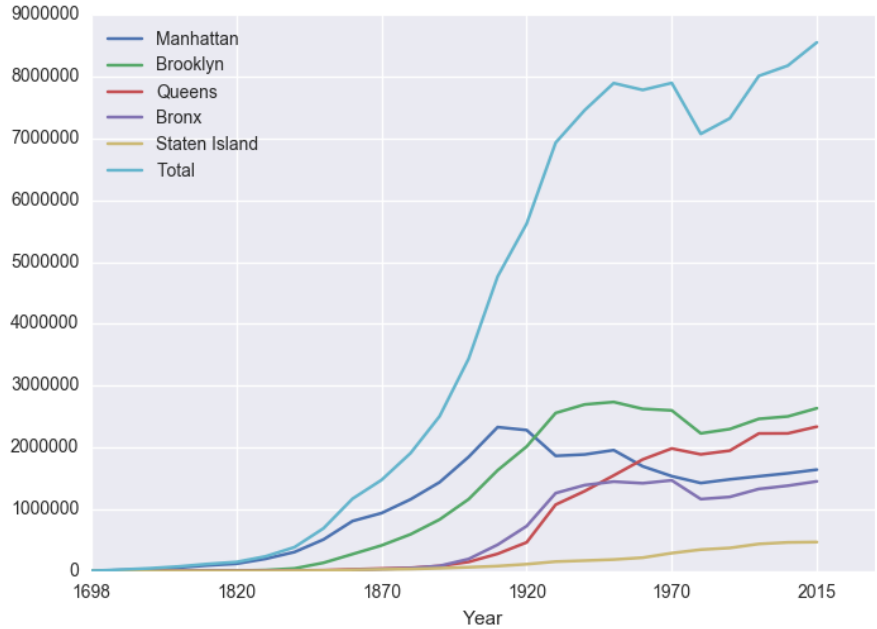
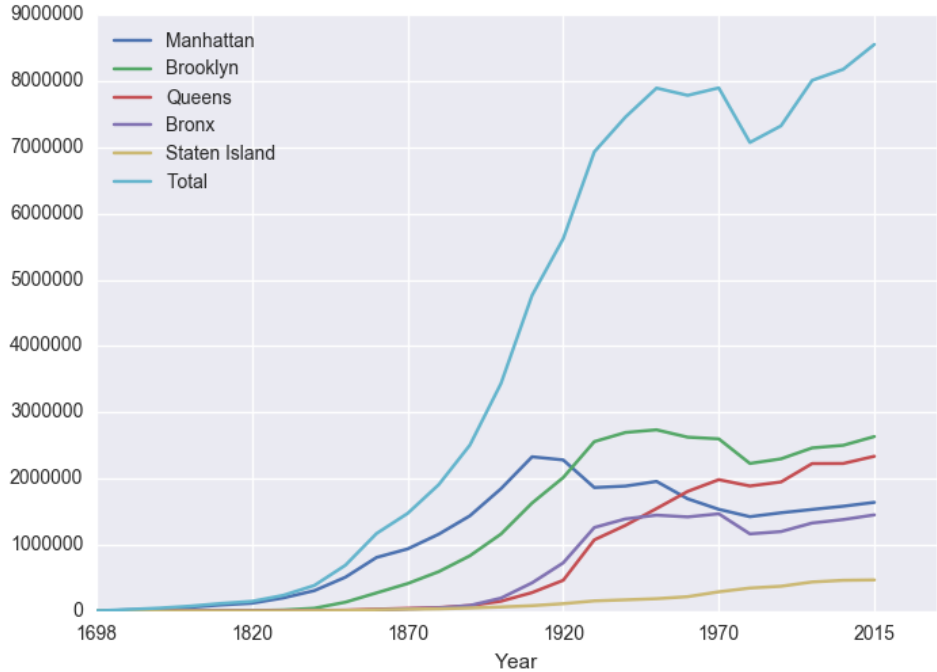


- Series can store a column or row of a DataFrame.
- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.
- Example:

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

Challenge:



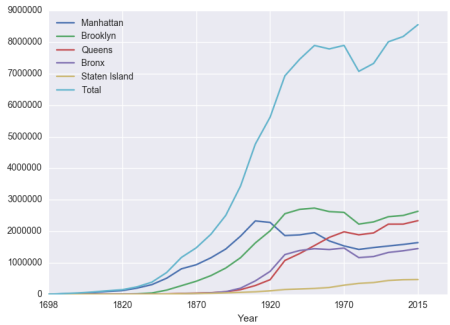
Predict what the following will do:

- `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:

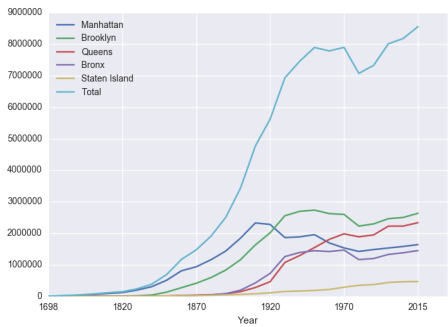
- `print("Queens:", pop["Queens"].min())`



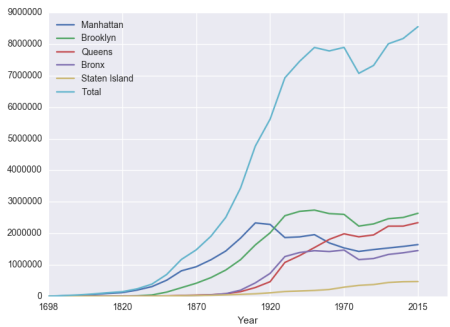
Solutions

Predict what the following will do:

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



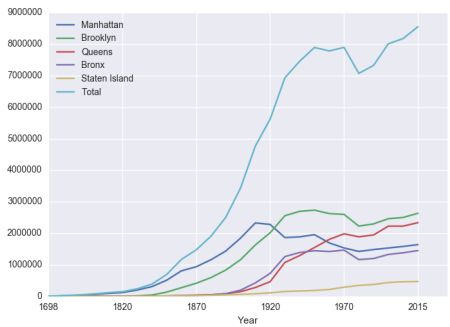
Solutions



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())`

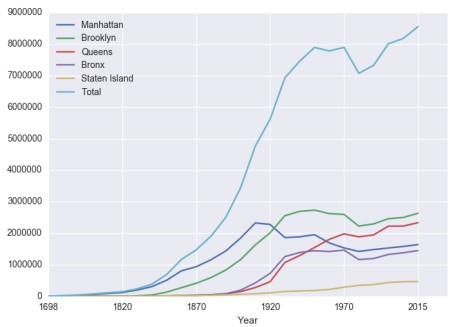
Solutions



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".

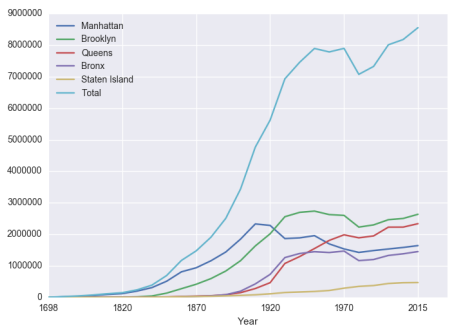
Solutions



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



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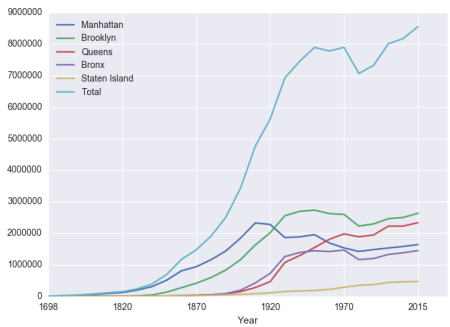
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".

Solutions



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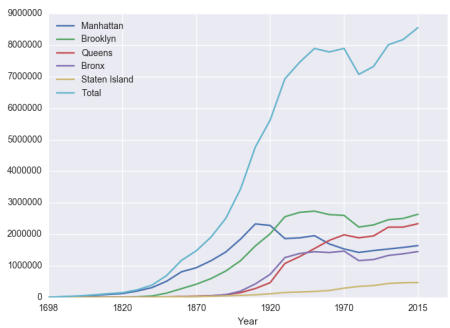
  Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`

Solutions



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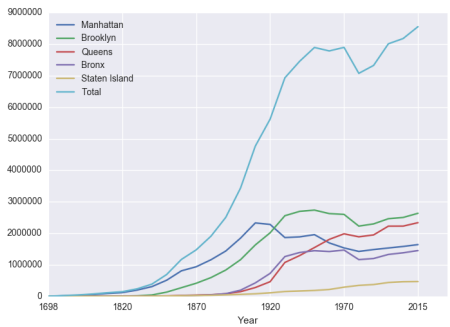
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".

Solutions



Predict what the following will do:

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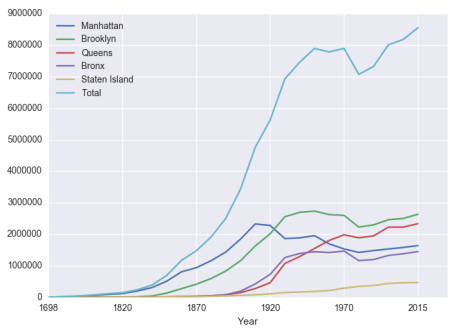
- `print("S I:", pop["Staten Island"].mean())`
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y=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

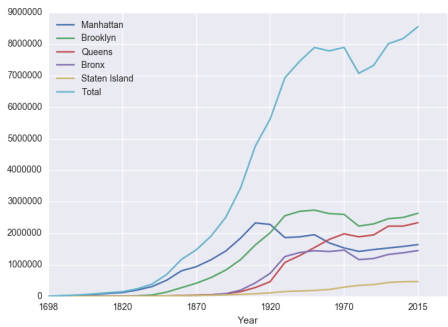
Solutions



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.

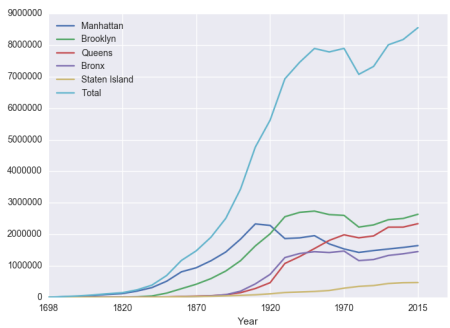
Solutions



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:

	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
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Staten Island	9,584	2,948	12,532
York	5,066	3,192	8,258

`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.

Challenge:

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1. *Include pandas & pyplot libraries.*

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Solution:

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

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Solution:

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

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

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

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2. *Read in the CSV file.*
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pop.plot.scatter(x="Full-time",y="Part-time")
```
4. *Display plot.*

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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")
```
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
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1/23/12	CoffsHarbour	20	24.4	28
7/15/11	Moree	2.8	19	0
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	...			

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

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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)
   ```

Rain in Australia				
Date	Location	MinTemp	MaxTemp	Rainfall
12/1/08	Albury	13.4	22.9	0.6
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	...			

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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')`**

Rain in Australia				
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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`

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**:

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

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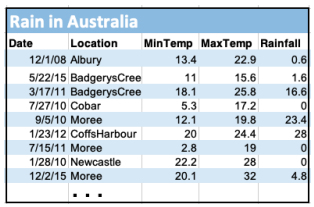
For example, to **find the average rainfall at one location, e.g. Albury***:*



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   ```
   AlburyAvg =
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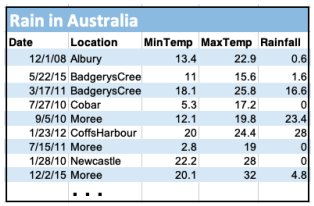

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AustraliaRain.csv

```
1.9257104647275156
```

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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
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- **Libraries:** pandas

Design Challenge - Solution

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

Design Challenge - Solution

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

Design Challenge - Solution

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- **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

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- **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

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```
import pandas as pd
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- **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

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print(stars['Luminosity(L/Lo)'].max())
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  - Prints **min** of **'Temperature'** column and store it in temp variable

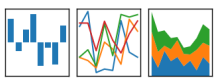
```
print( stars['Temperature (K)'].min())
```

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

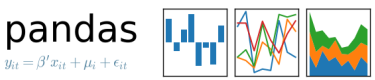
```
print(stars.groupby('Star type')\
.get_group('Hypergiant').mean()['Radius(R/Ro)'])
```

Recap

- Recap: Logical Expressions & Circuits

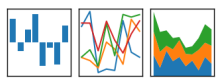
pandas $y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$ 

Recap



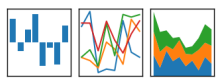
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
  - Pandas library has elegant solutions for accessing & analyzing structured data.

Recap

pandas 

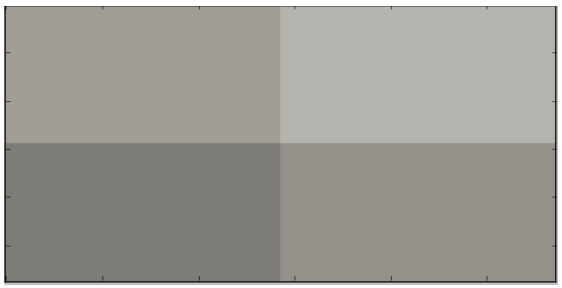
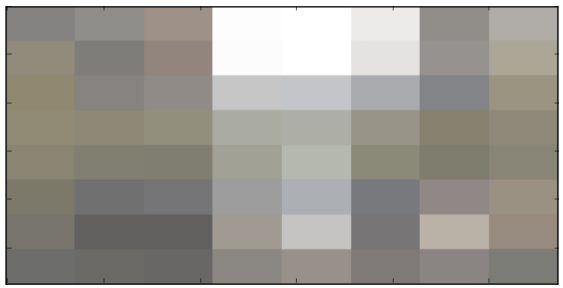
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
  - Pandas library has elegant solutions for accessing & analyzing structured data.
  - Can manipulate individual columns or rows ('Series').

Recap

pandas 

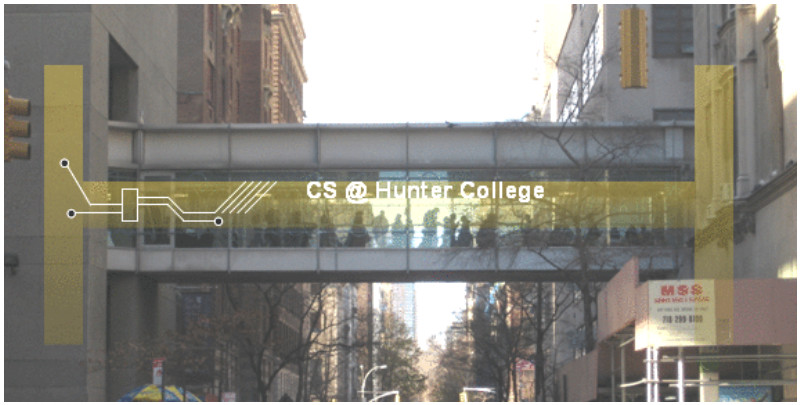
- Recap: Logical Expressions & Circuits
- Accessing Formatted Data:
  - Pandas library has elegant solutions for accessing & analyzing structured data.
  - Can manipulate individual columns or rows ('Series').
  - Has useful functions for the entire sheet ('DataFrame') such as plotting.

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 Fall 2019, Version 2.

Weekly Reminders!



Before next lecture, don't forget to:

- Work on this week's Online Lab

Weekly Reminders!

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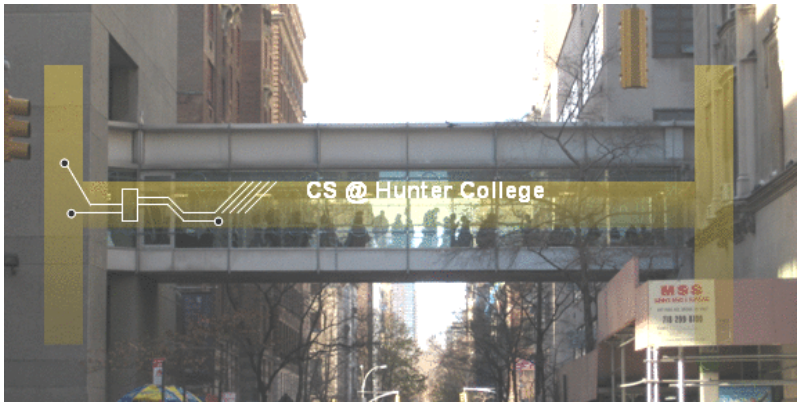
Weekly Reminders!



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- Submit this week's 5 programming assignments **(programs 26-30)**

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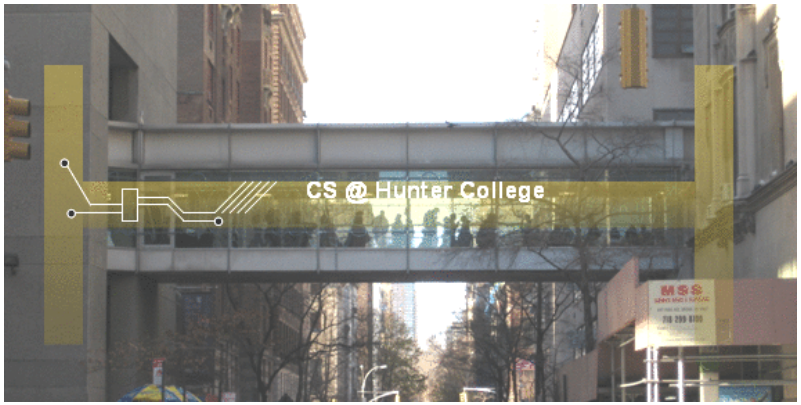

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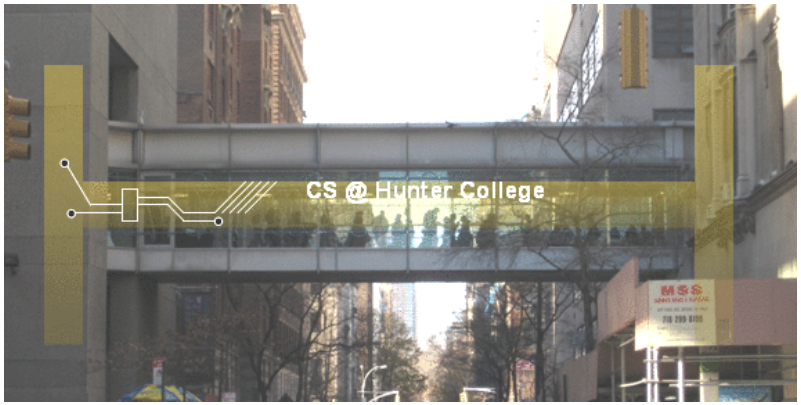
- If you need help, schedule an appointment for Tutoring in lab 1001G 11:30am-5:30pm

Weekly Reminders!



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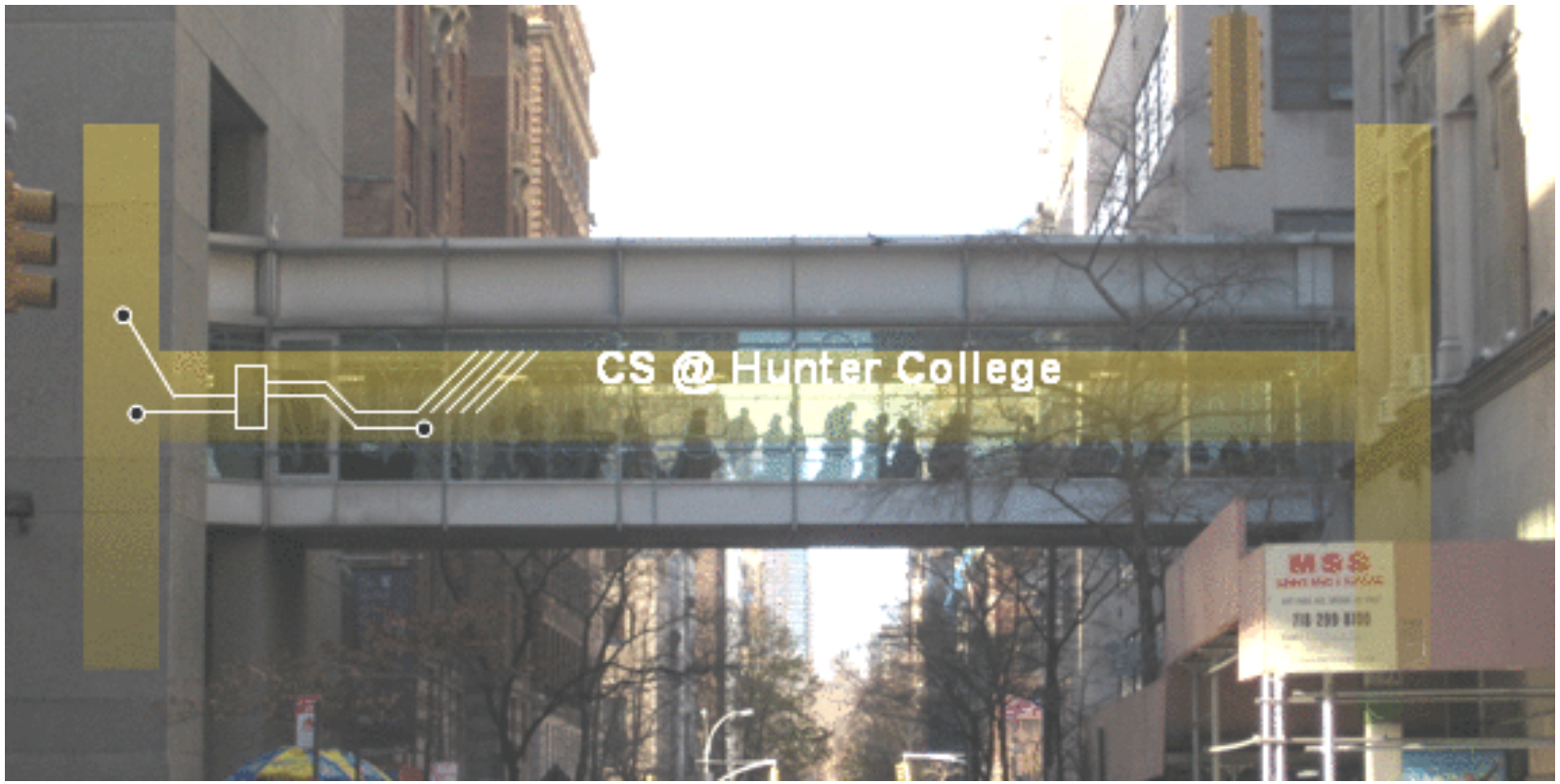
- If you haven't already, schedule an appointment to take the Code Review (**one every two weeks**) in lab 1001G Hunter North
- Submit this week's 5 programming assignments **(programs 26-30)**
- If you need help, schedule an appointment for Tutoring in lab 1001G 11:30am-5:30pm
- Take the Lecture Preview on Blackboard on Monday (or no later than 10am on Tuesday)

Lecture Slips & Writing Boards



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