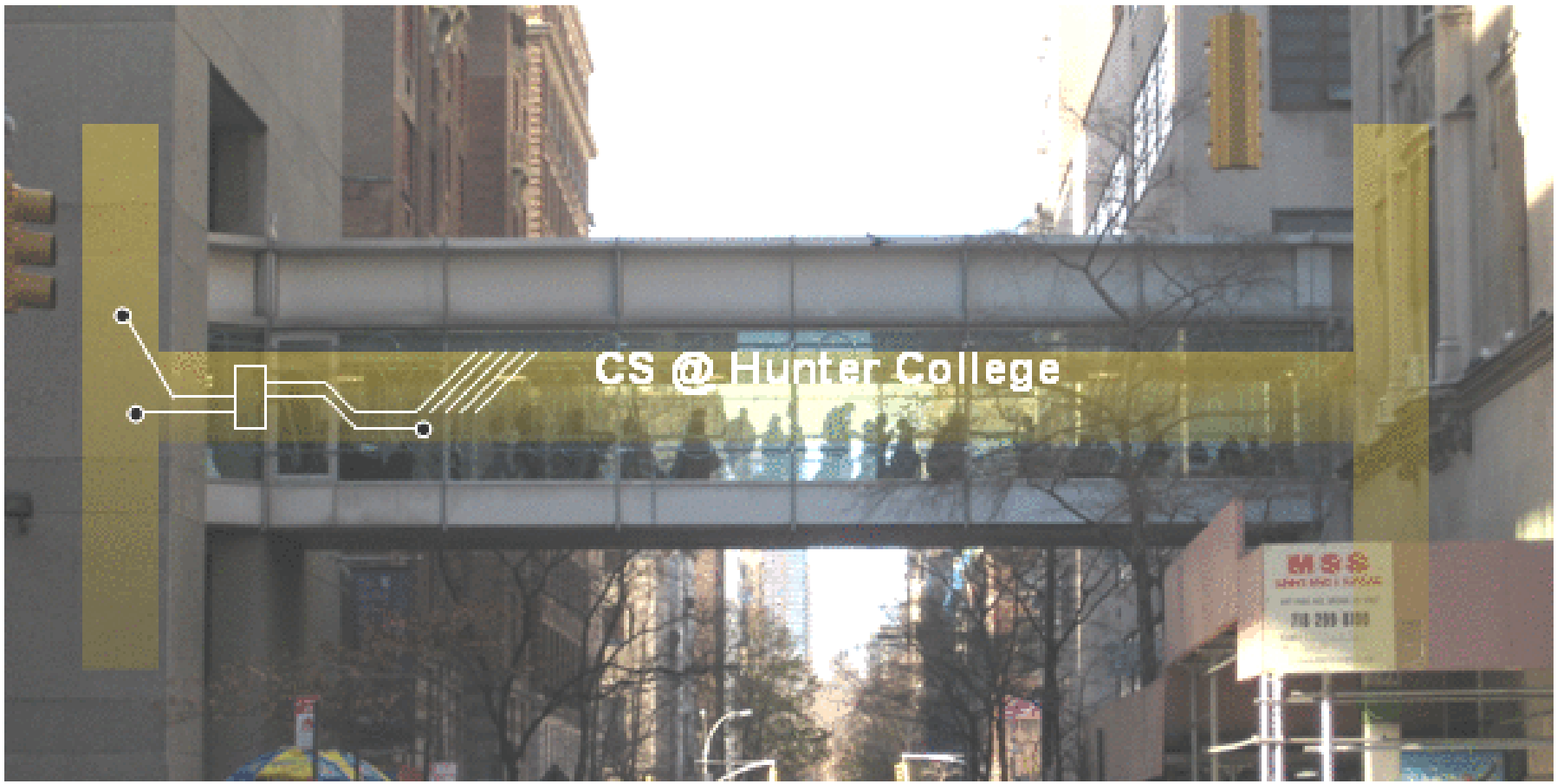
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

- Each lecture includes a survey of computing research and tech in NYC.

  Today: Prof. Kelle Cruz (Astrophysics)

Frequently Asked Questions

From lecture slips & recitation sections.

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  1) it's fundamental, and
  2) the same ideas are used for accessing formatted data (today's topic).

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- Should I have received email for this course?
  Absolutely!!! We often send important communication by email. If you have not been receiving email from us weekly, please check your spam folder.

Today's Topics

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

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Recap: Logical Operators

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

in1		in2	*returns:*
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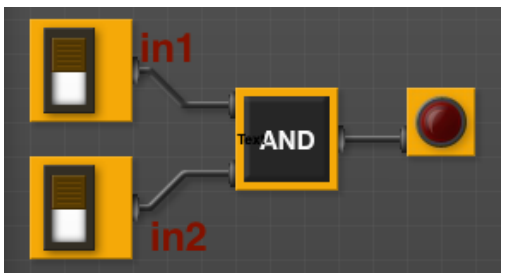
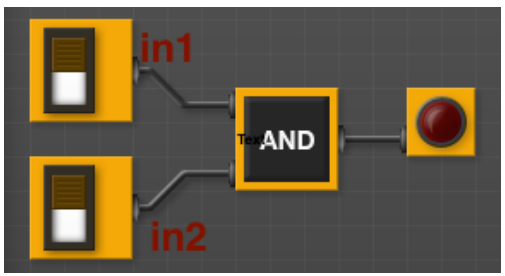
Logical Operators & Circuits



- 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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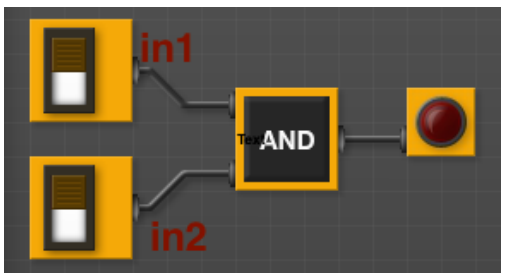

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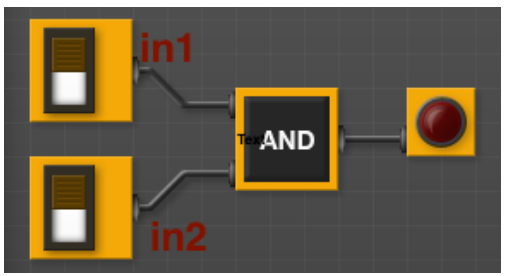
  Example: `in1 and in2`
- Each logical operator (`and`, `or`, & `not`) has a corresponding logical circuit that can be used to join together inputs.

Logical Operators & Circuits



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  Example: `in1 and in2`
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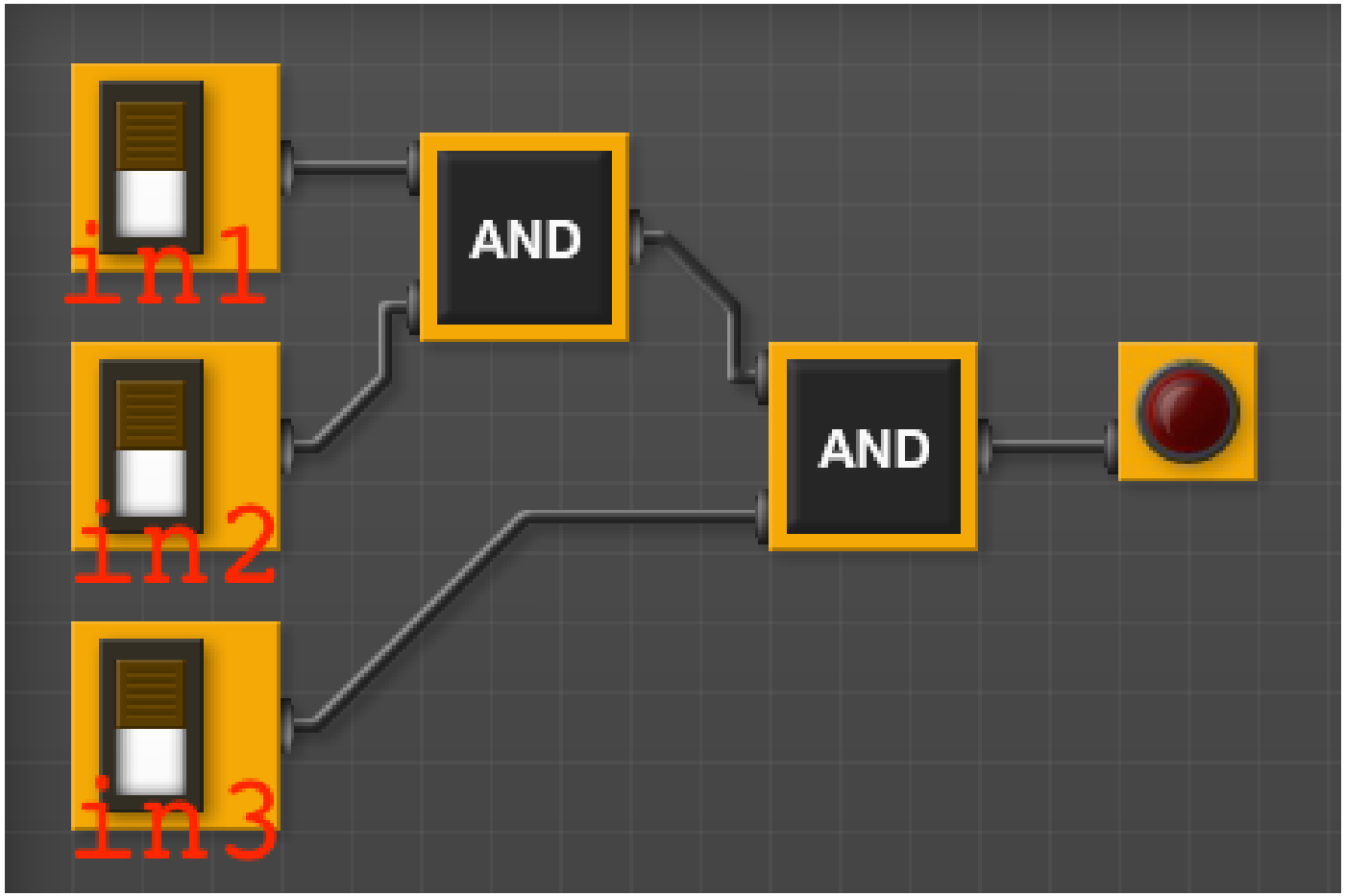
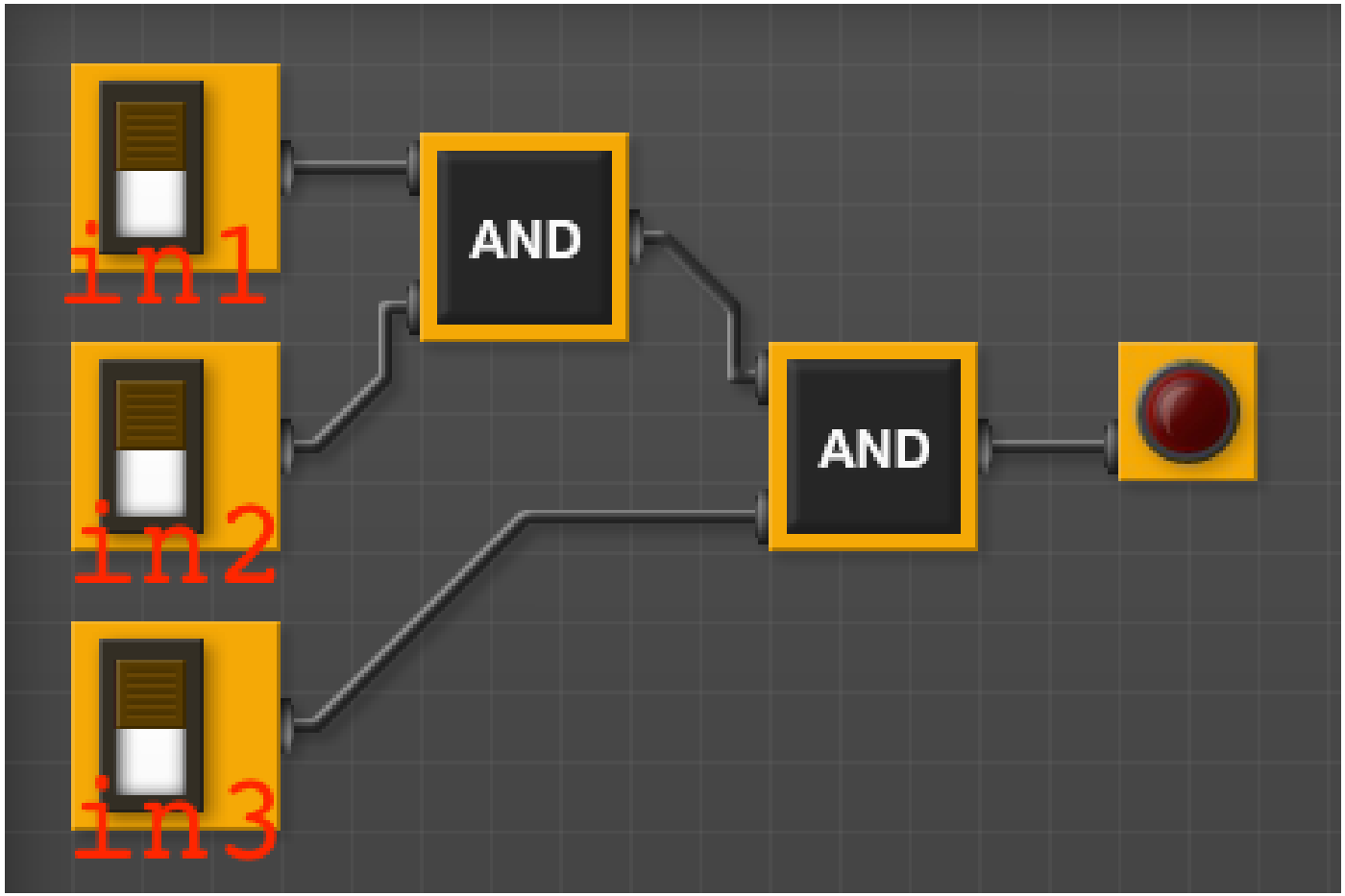
Examples: Logical Circuit



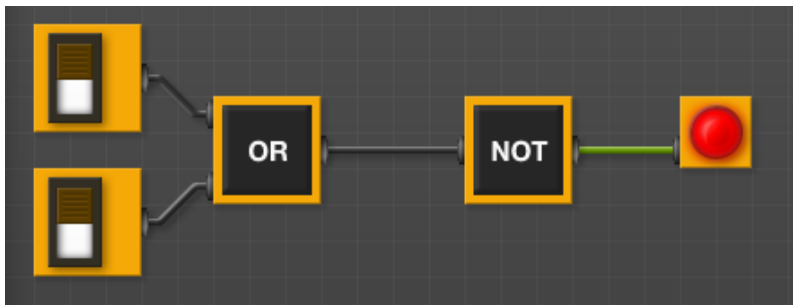
Examples: Logical Circuit

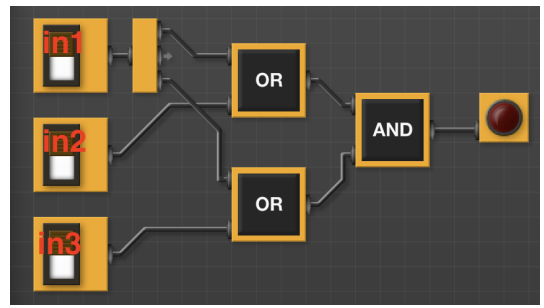


`(in1 and in2) and in3`

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))`

In Pairs or Triples:

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

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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
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

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- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

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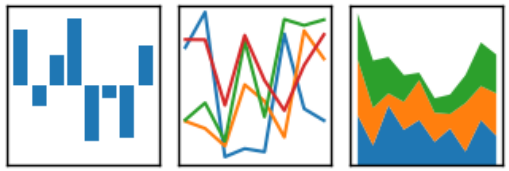

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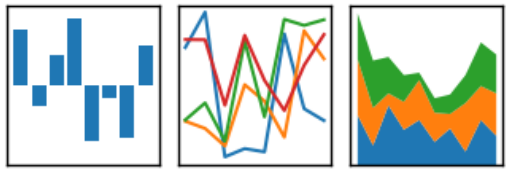

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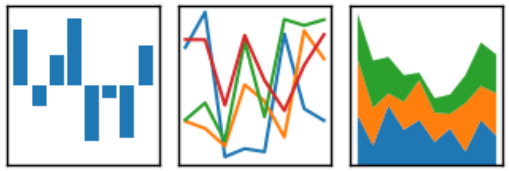
- Open source and freely available (part of anaconda distribution).

Structured Data

pandas

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



- We will use the popular Python Data Analysis Library (**Pandas**).
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Structured Data

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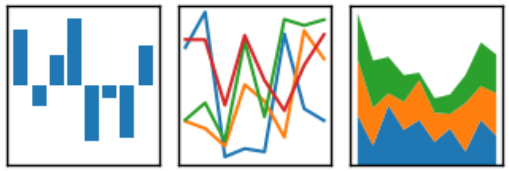

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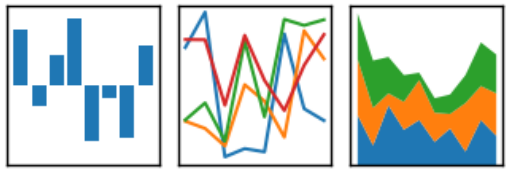

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- To use, add to the top of your file:

```
import pandas as pd
```

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
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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

- Excel .xls files have much extra formatting.

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- Columns are separated by commas on each line.

CSV Files

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1698,4937,2017,,,727,7681
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nycHistPop.csv

Reading in CSV Files

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

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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

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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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`nycHistPop.csv`

In Lab 6

Example: Reading in CSV Files

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import pandas as pd

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pop.plot(x="Year")
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nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

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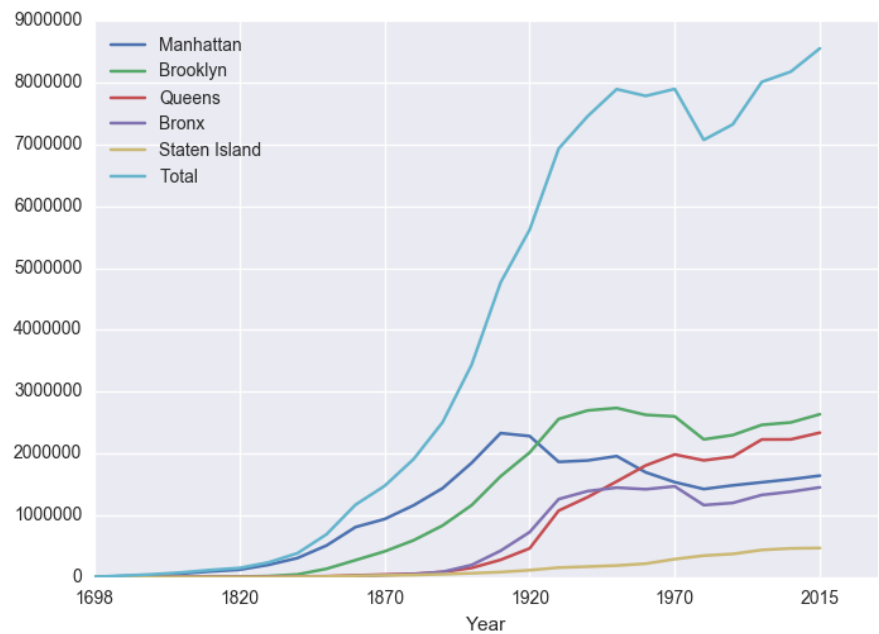
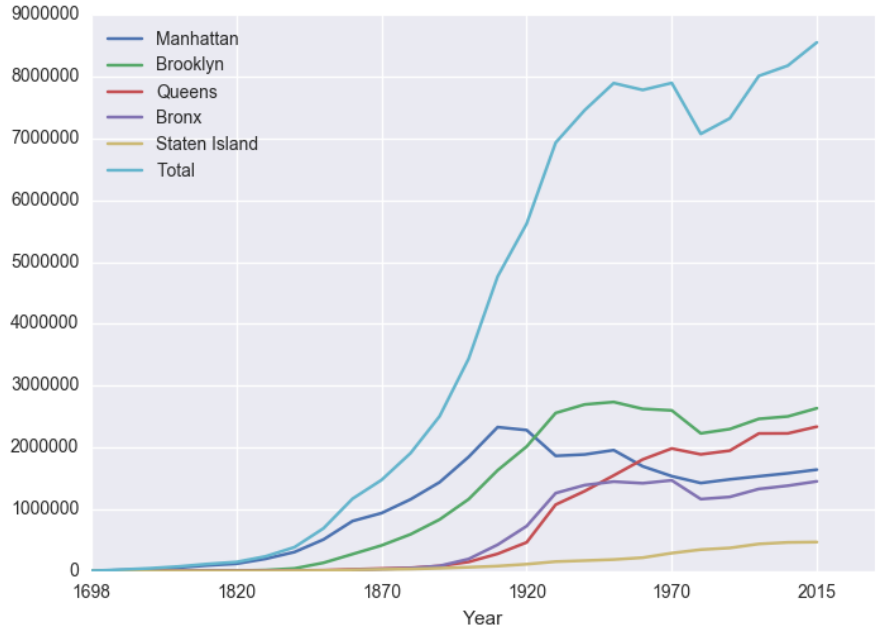
nycHistPop.csv

In Lab 6

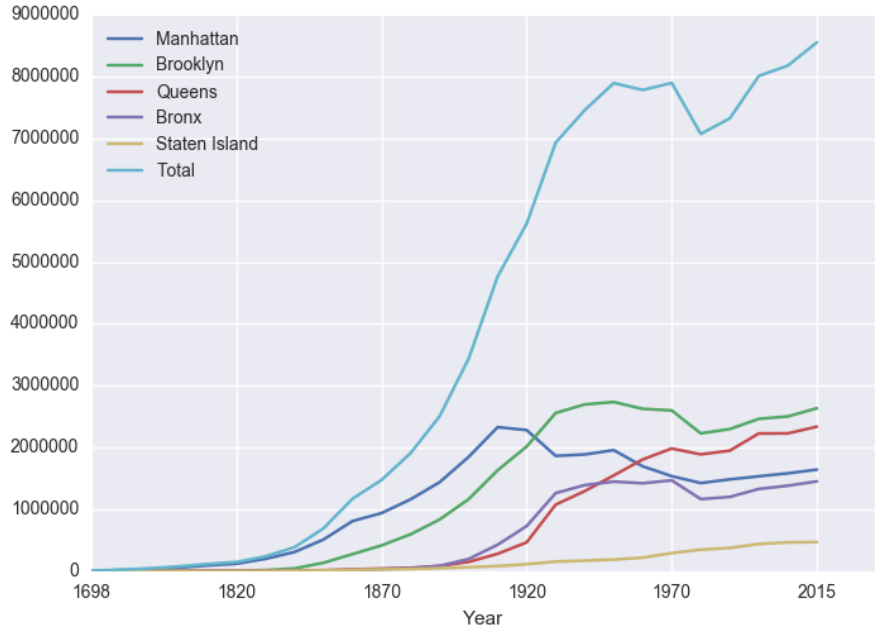


Series in Pandas



- 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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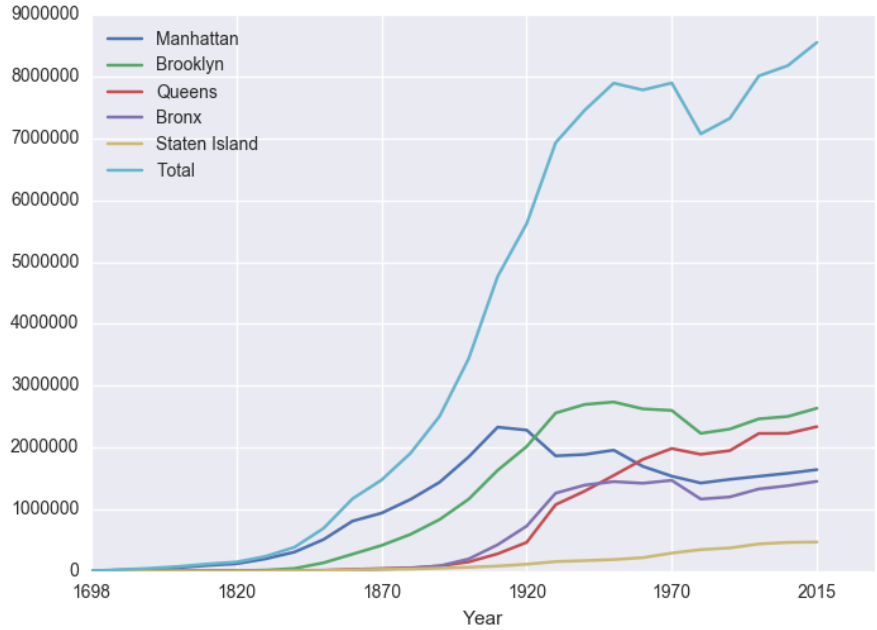
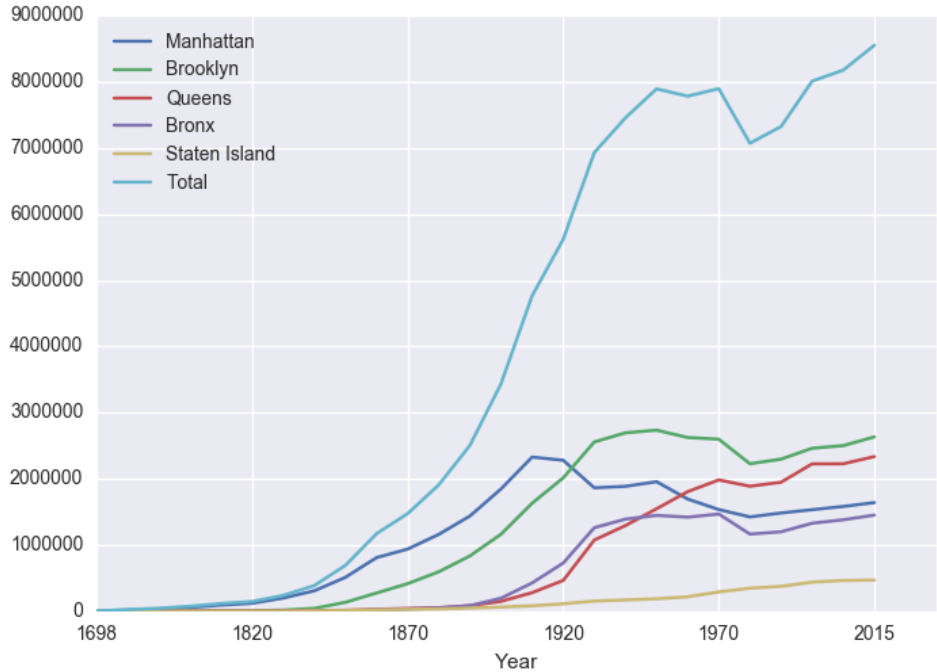


- Series can store a column or row of a DataFrame.
- Example: `pop["Manhattan"]` is the Series corresponding to the column of Manhattan data.
- Example:

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

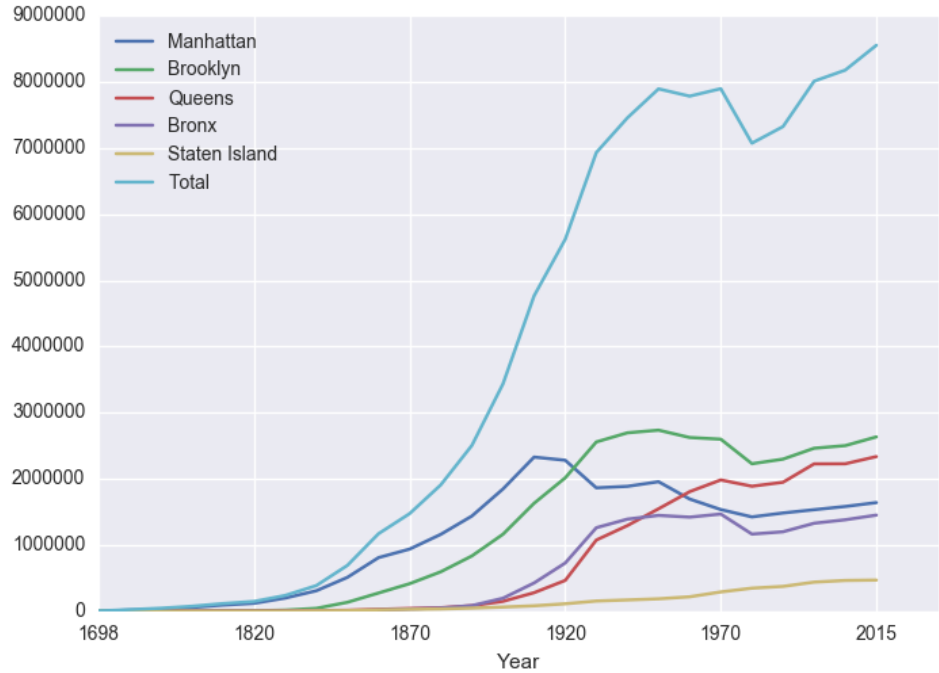
In Pairs or Triples



Predict what the following will do:

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

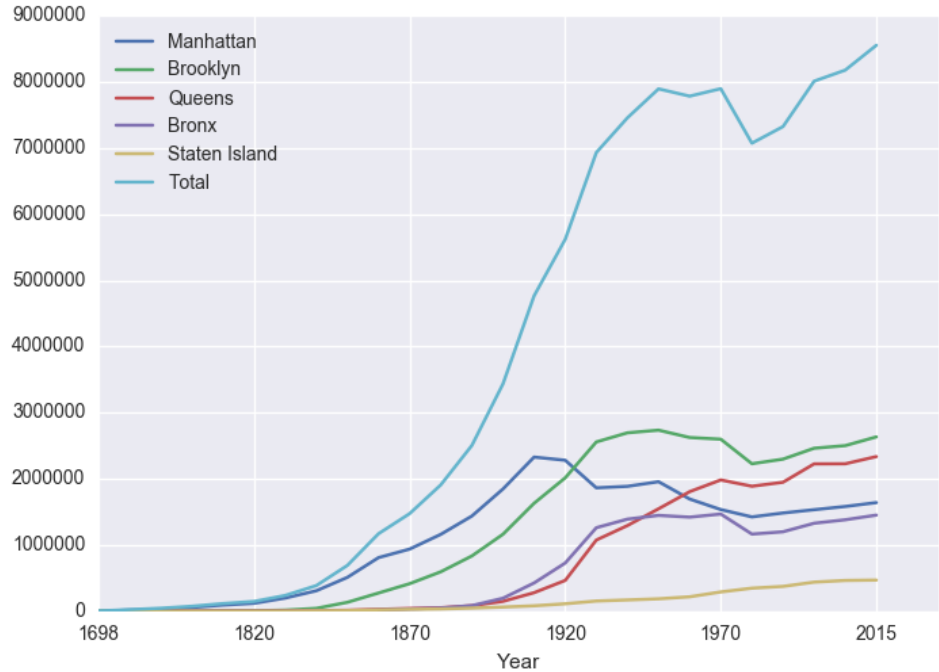
In Pairs or Triples



Predict what the following will do:

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

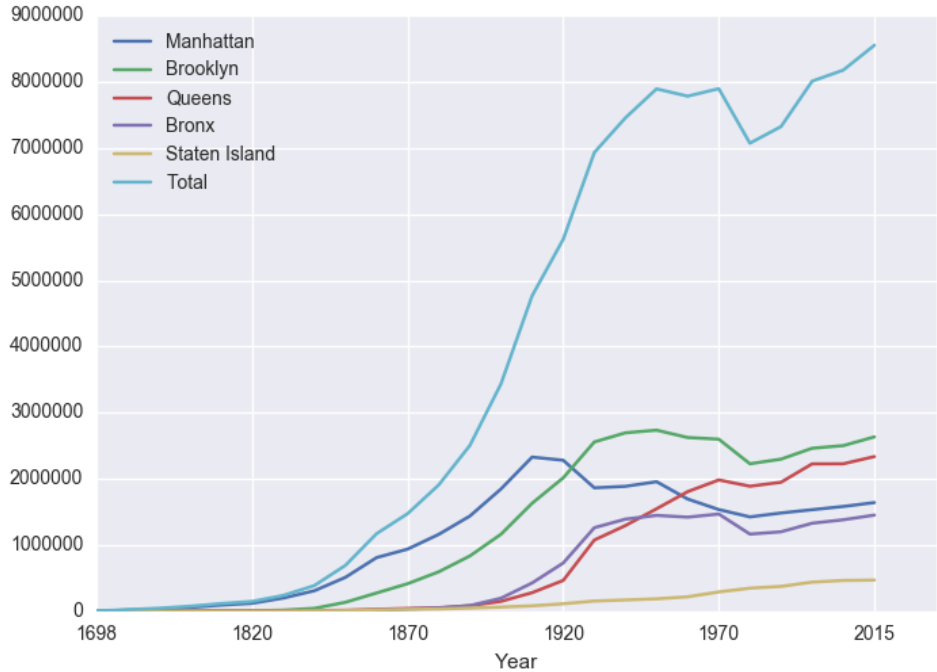
In Pairs or Triples



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())`

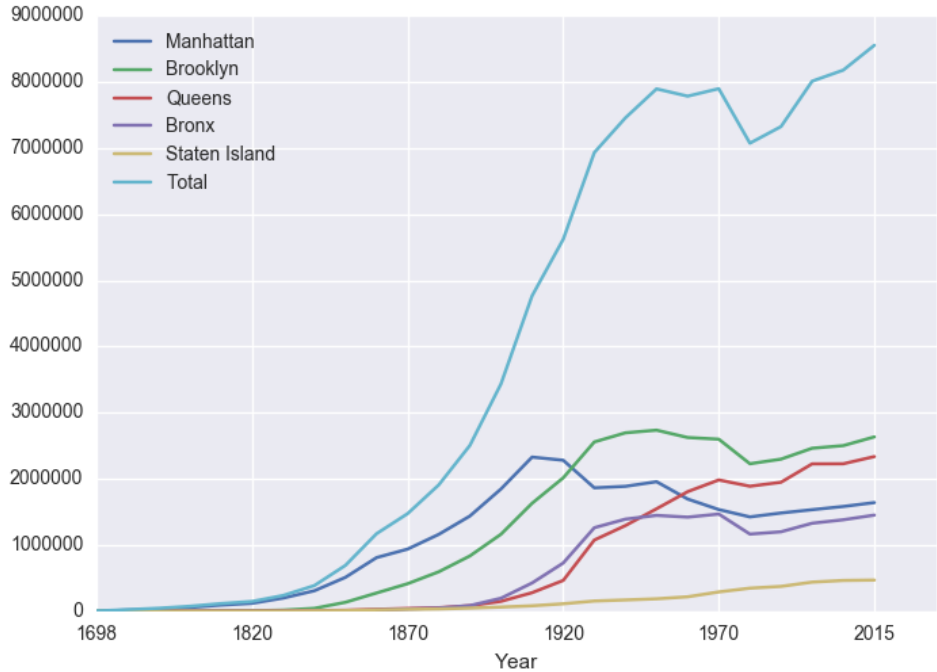
In Pairs or Triples



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")`

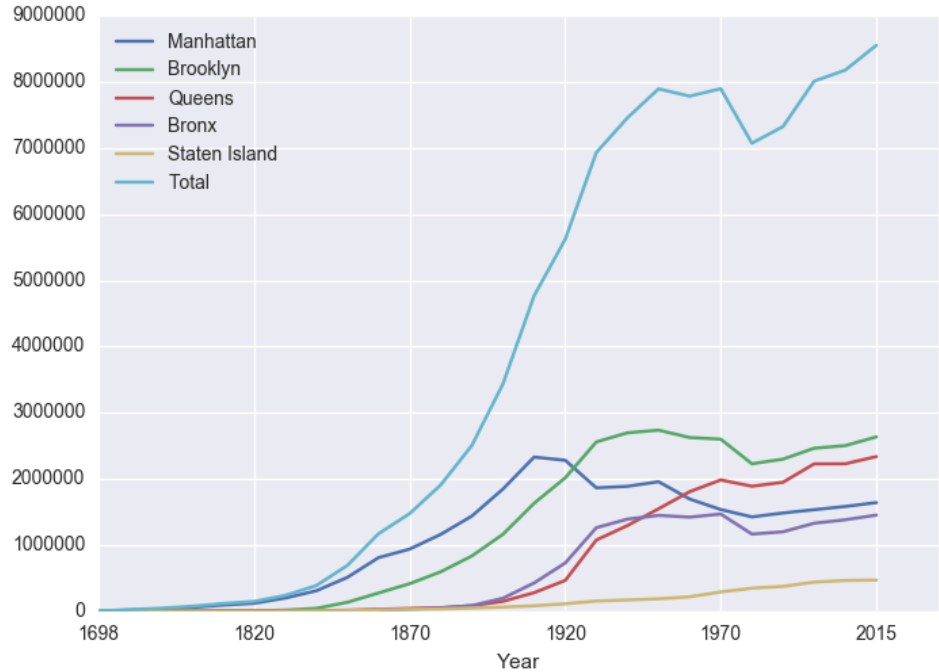
In Pairs or Triples



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")`

In Pairs or Triples



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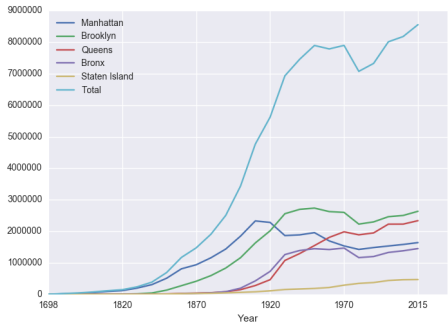
- `print("Queens:", pop["Queens"].min())`
- `print("S I:", pop["Staten Island"].mean())`
- `print("S I:", pop["Staten Island"].std())`
- `pop.plot.bar(x="Year")`
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`

Solutions

Predict what the following will do:

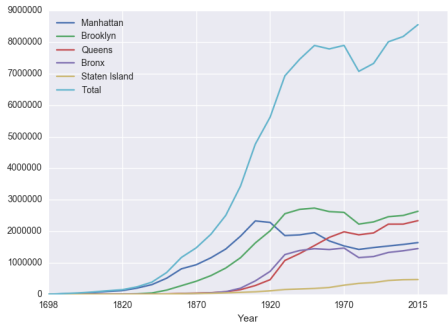
- `print("Queens:", pop["Queens"].min())`



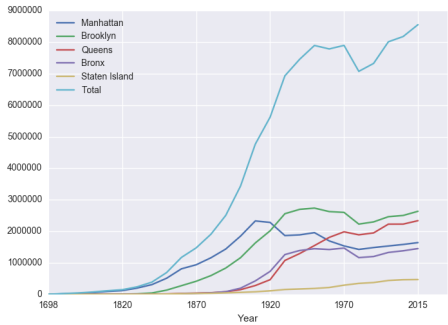
Solutions

Predict what the following will do:

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



Solutions



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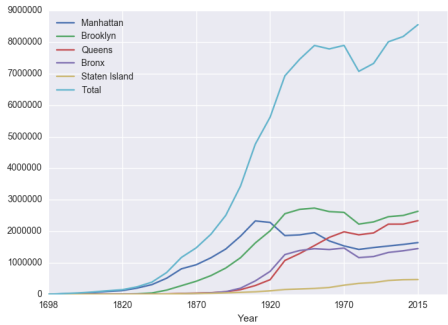
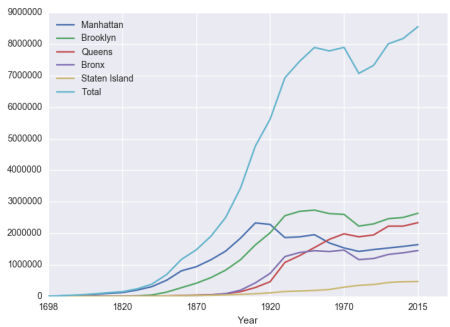
Solutions



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



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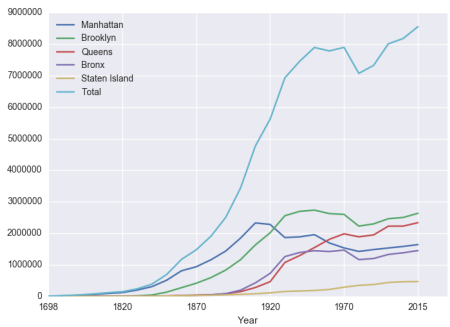
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`

Solutions



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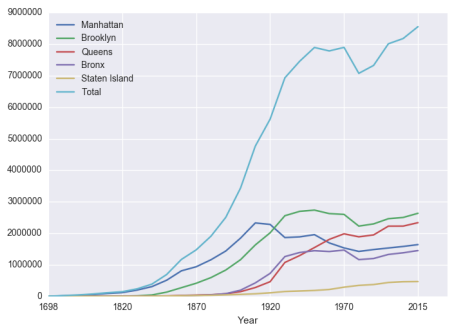
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".

Solutions



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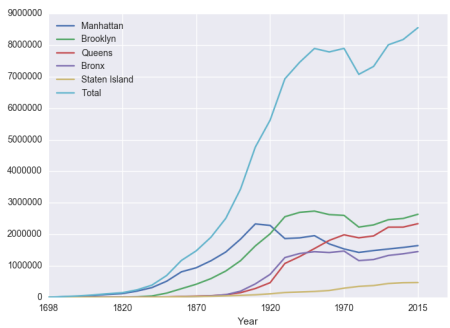
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`

Solutions



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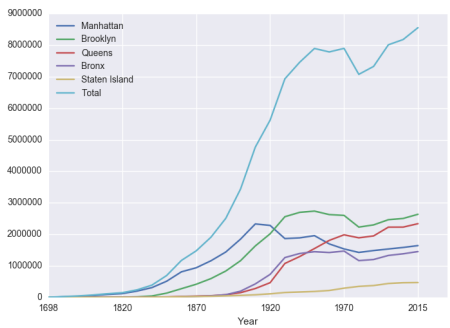
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".

Solutions



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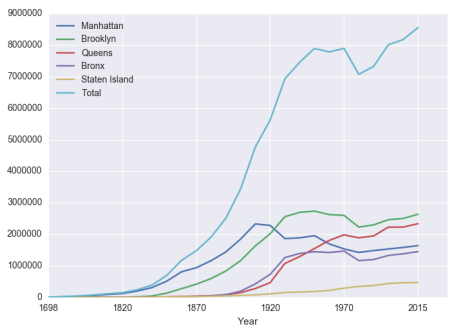
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`

Solutions



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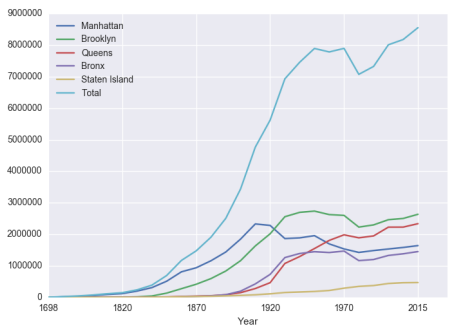
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
  Scatter plot of Brooklyn versus Total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

Solutions



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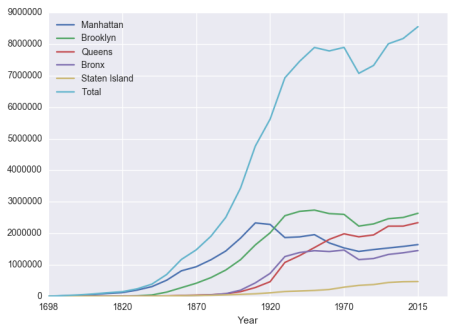
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
  Scatter plot of Brooklyn versus Total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

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".
- `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.

In Pairs or Triples

	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

`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.

In Pairs or Triples

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Solution:

1. *Include pandas & pyplot libraries.*

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

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```
pop=pd.read_csv('cunyF2016.csv',skiprows=1)
```
3. *Set up a scatter 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.*

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pop.plot.scatter(x="Full-time",y="Part-time")
```
4. *Display plot.*
```
plt.show()
```

groupby()

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`AustraliaRain.csv`

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4. *Print the average rainfall at each location.*
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   print(groupAvg['Rainfall'])
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`AustraliaRain.csv`

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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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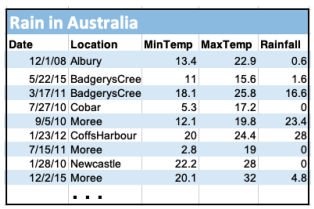

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   ```
   MoreeAvg =
   rain.groupby(['Location']).get_group('Moree').mean()
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groupby()

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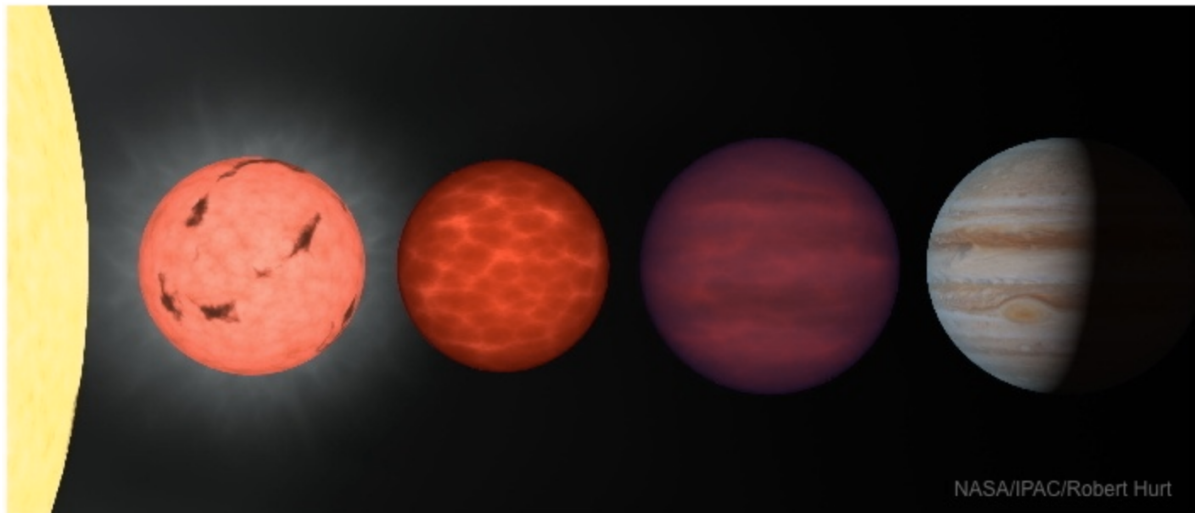
Today's Topics

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

CS Survey: Prof. Cruz, Astrophysics



Hunter College - Department of Physics and Astronomy
American History Museum - Department of Astrophysics
`http://www.hunter.cuny.edu/physics/faculty/cruz/kelle-cruz`

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
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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
3628	0.0055	0.393	10.48	Red Dwarf	Red	M
3749	550000	1648	-8.05	Hypergiant	Orange	M

On your Lecture Slip, design an algorithm that:

- Prints the luminosity of the brightest star.
- Prints the temperature in Kelvin (K) of the coldest star.
- Prints the temperature in Fahrenheit of the coldest star. **New:** `astropy.units` **will seamlessly convert!!!**
- Prints the average radius of a Hypergiant

Design Challenge - Solution

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

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  - **groupby 'Star Type'** and take **averages**, then print **max of 'Radius'** column

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  - **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 and astropy

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print(stars['Luminosity(L/Lo)'].max())
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minTempK = stars['Temperature (K)'].min()
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  - **groupby 'Star Type'** and take **averages**, then print **max of 'Radius'** column

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

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print(KUnit.to(u.imperial.deg_F, equivalencies = \
u.temperature()))
```

Design Challenge - Code

- **Libraries:** pandas and astropy

```
import pandas as pd
import astropy.units as u
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

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

  - Use **astropy to convert** temp variable to Fahrenheit and print

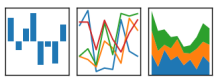
```
KUnit = minTempK * u.K
print(KUnit.to(u.imperial.deg_F, equivalencies = \
u.temperature()))
```

  - 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

- On lecture slip, write down a topic you wish we had spent more time (and why).

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

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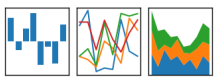
- Recap: Logical Expressions & Circuits

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

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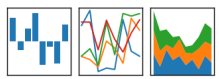
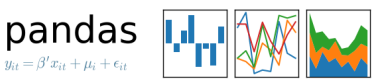
pandas 

Recap



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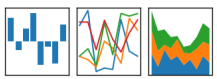
pandas 

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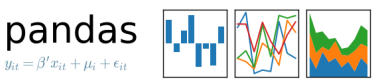

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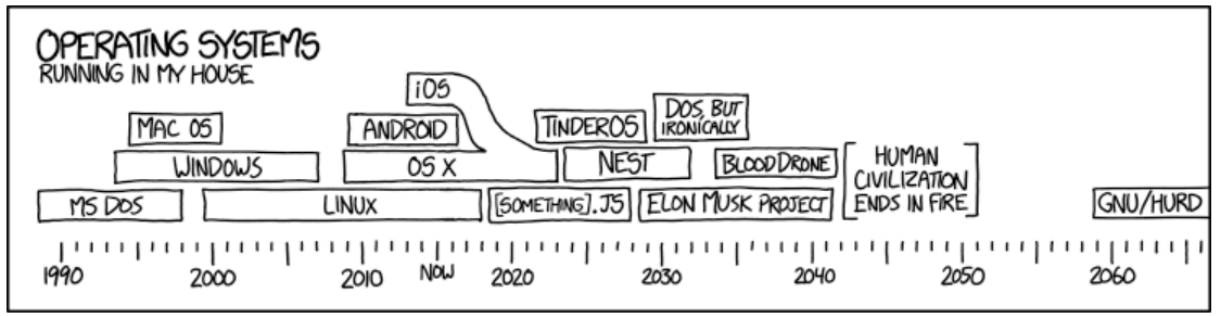
- Pass your lecture slips to the aisles for the UTAs to collect.

Practice Quiz & Final Questions



xkcd #1508

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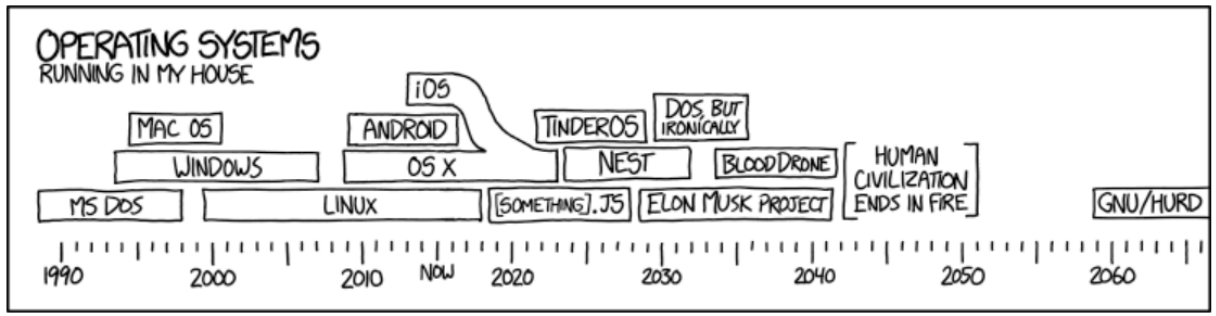

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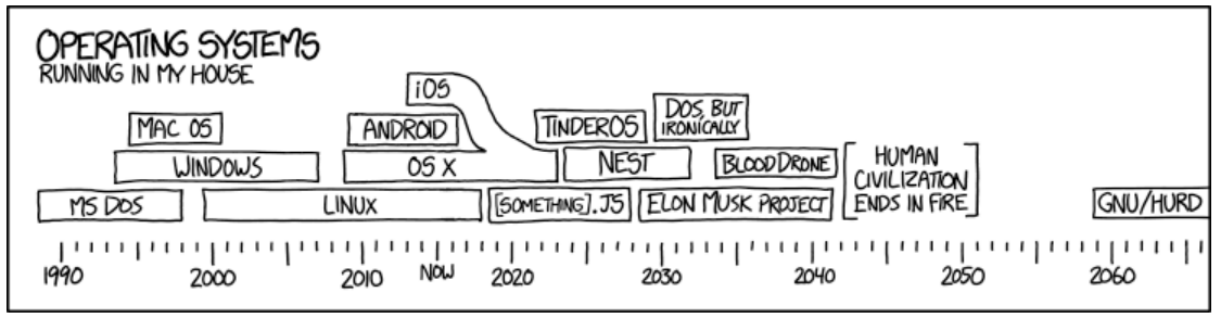

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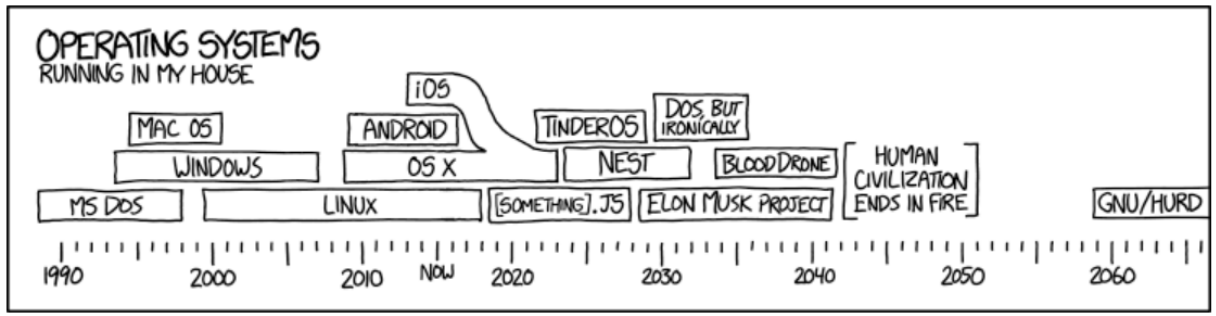

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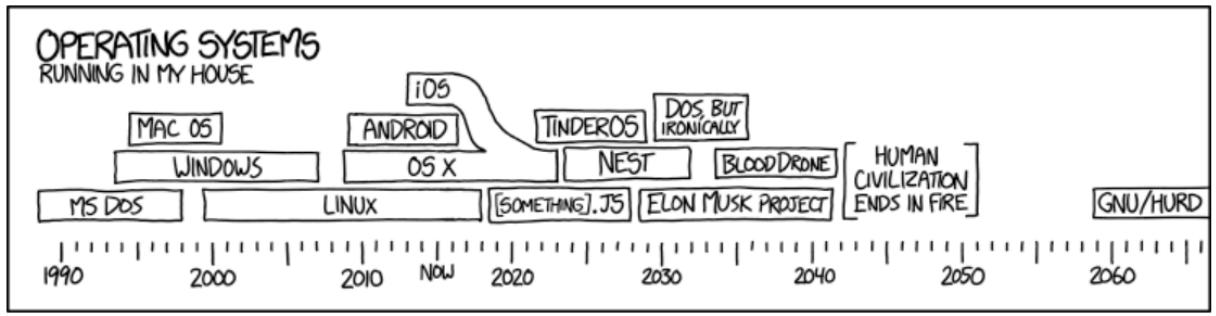

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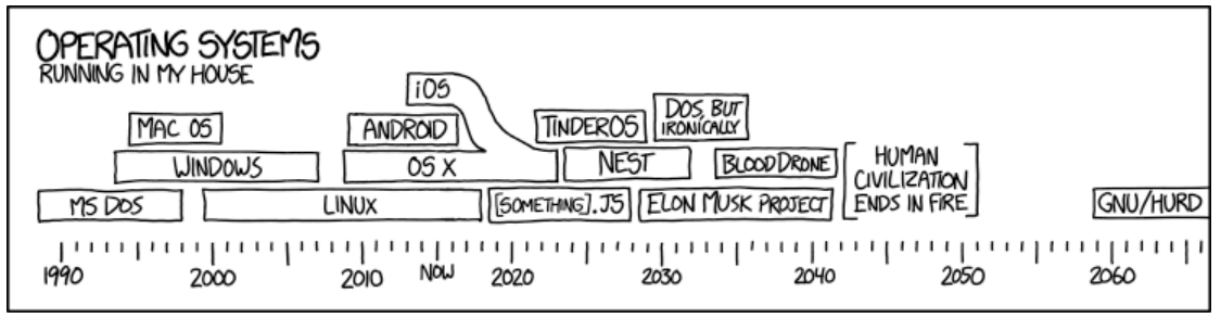

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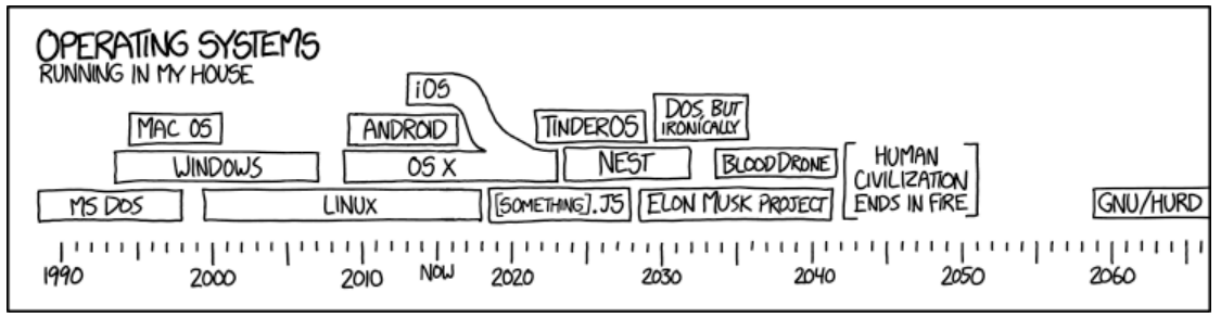

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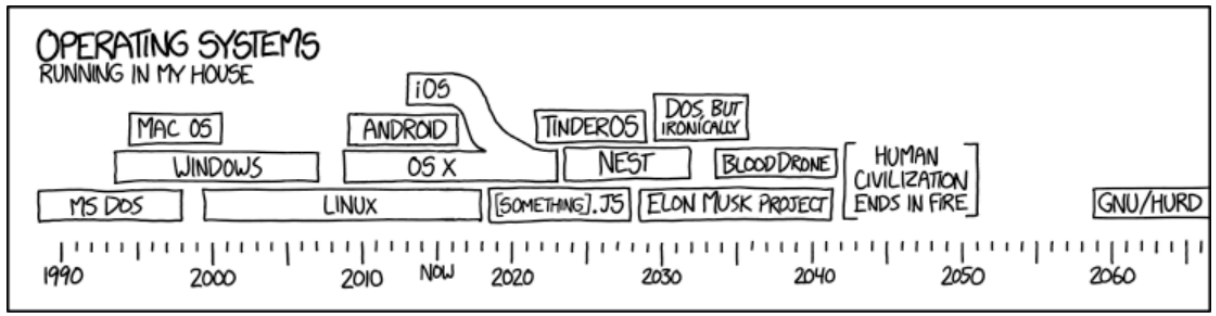

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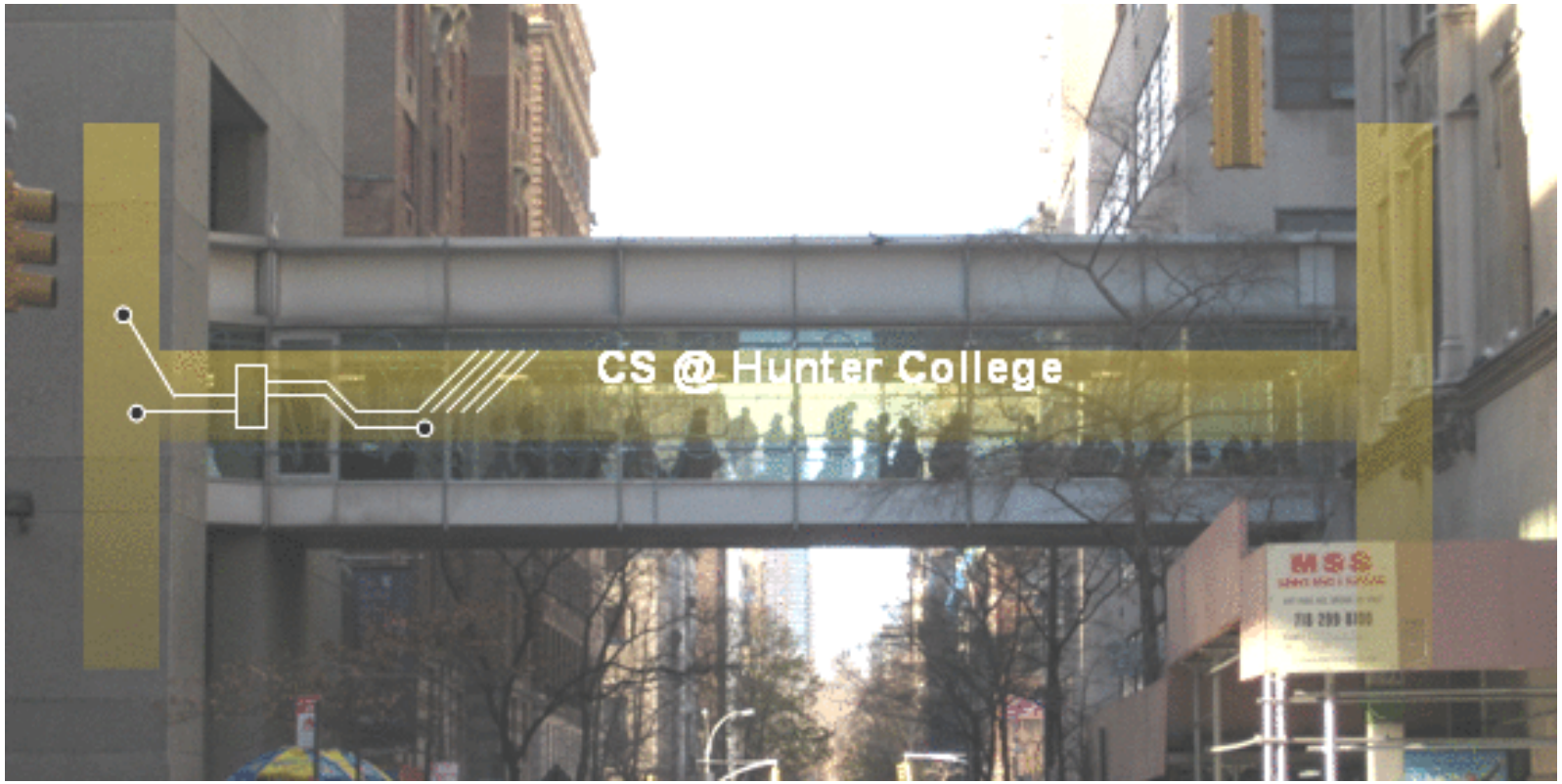
- Theme: Unix commands!

Writing Boards



- Return writing boards as you leave...