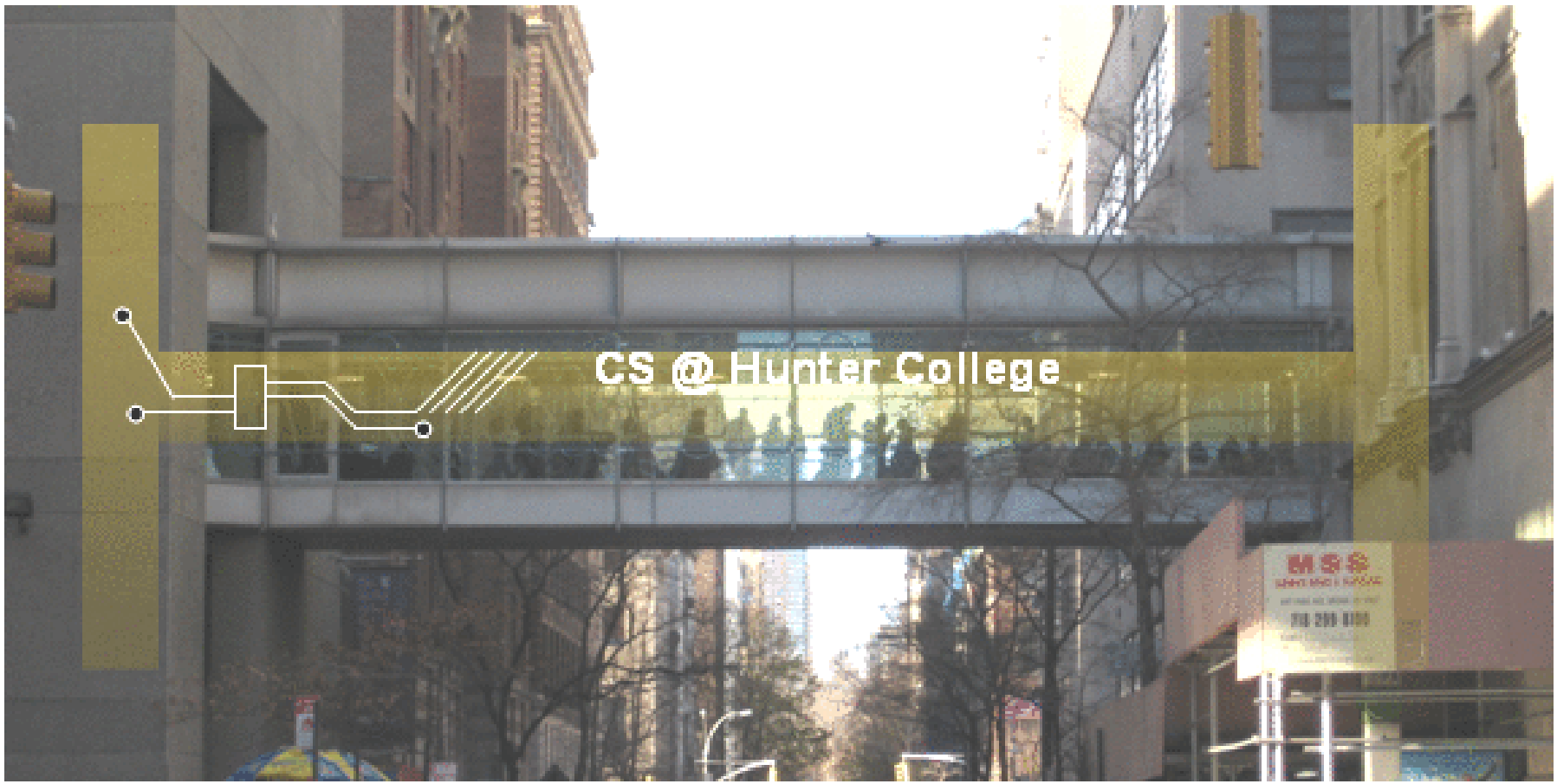
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

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

  Today: Prof. Saad Mneimneh (modeling & algorithms)

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).
- Is it okay to work ahead?
  Yes! It's great to try things before lecture/lab (builds a "mental scaffold" to hold new material covered).
  All the labs are up for the rest of the semester, and programs open on gradescope 4 weeks before the deadline.

Today's Topics

- Recap: Logical Expressions & Circuits
- Design: Cropping Images
- Accessing Formatted Data
- CS Survey: Computational Biology

Recap: Logical Operators

and

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

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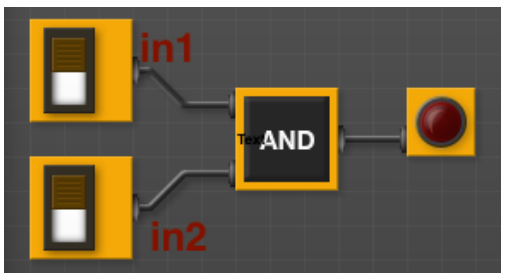
not

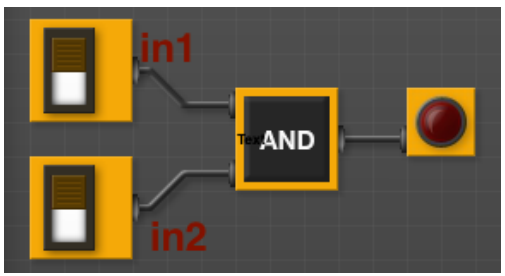
	in1	*returns:*
`not`	`False`	`True`
`not`	`True`	`False`

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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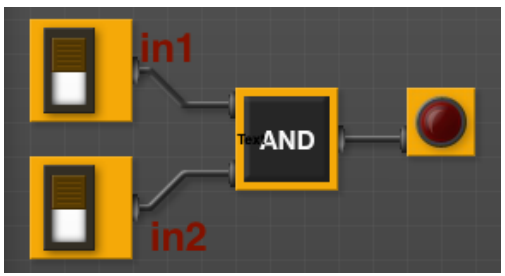
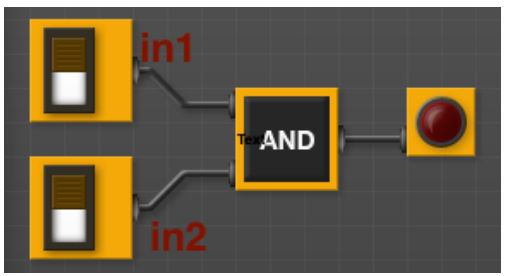


- Each logical operator (`and`, `or`, & `not`) can be used to join together expressions.

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

Logical Operators & Circuits



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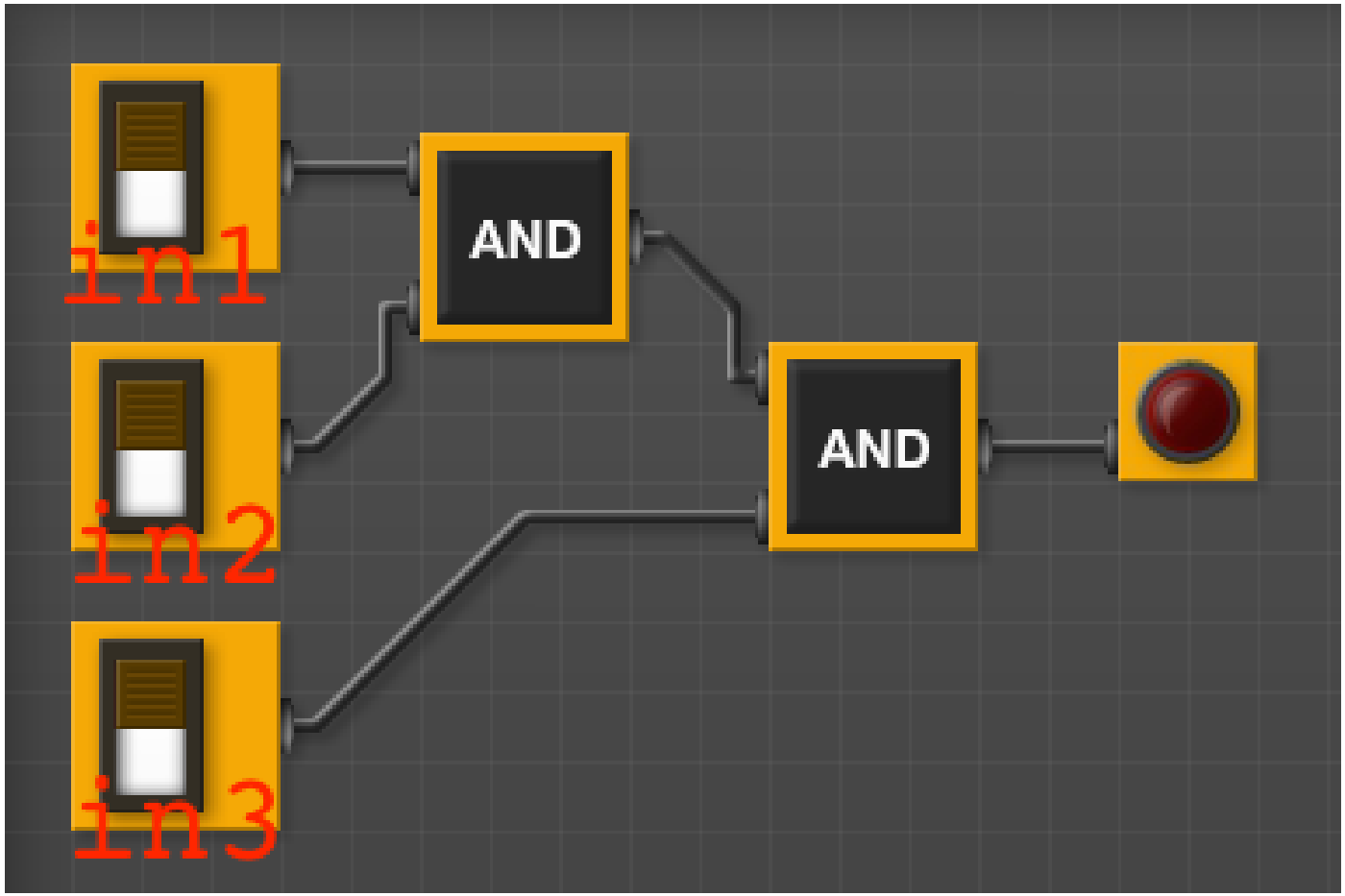
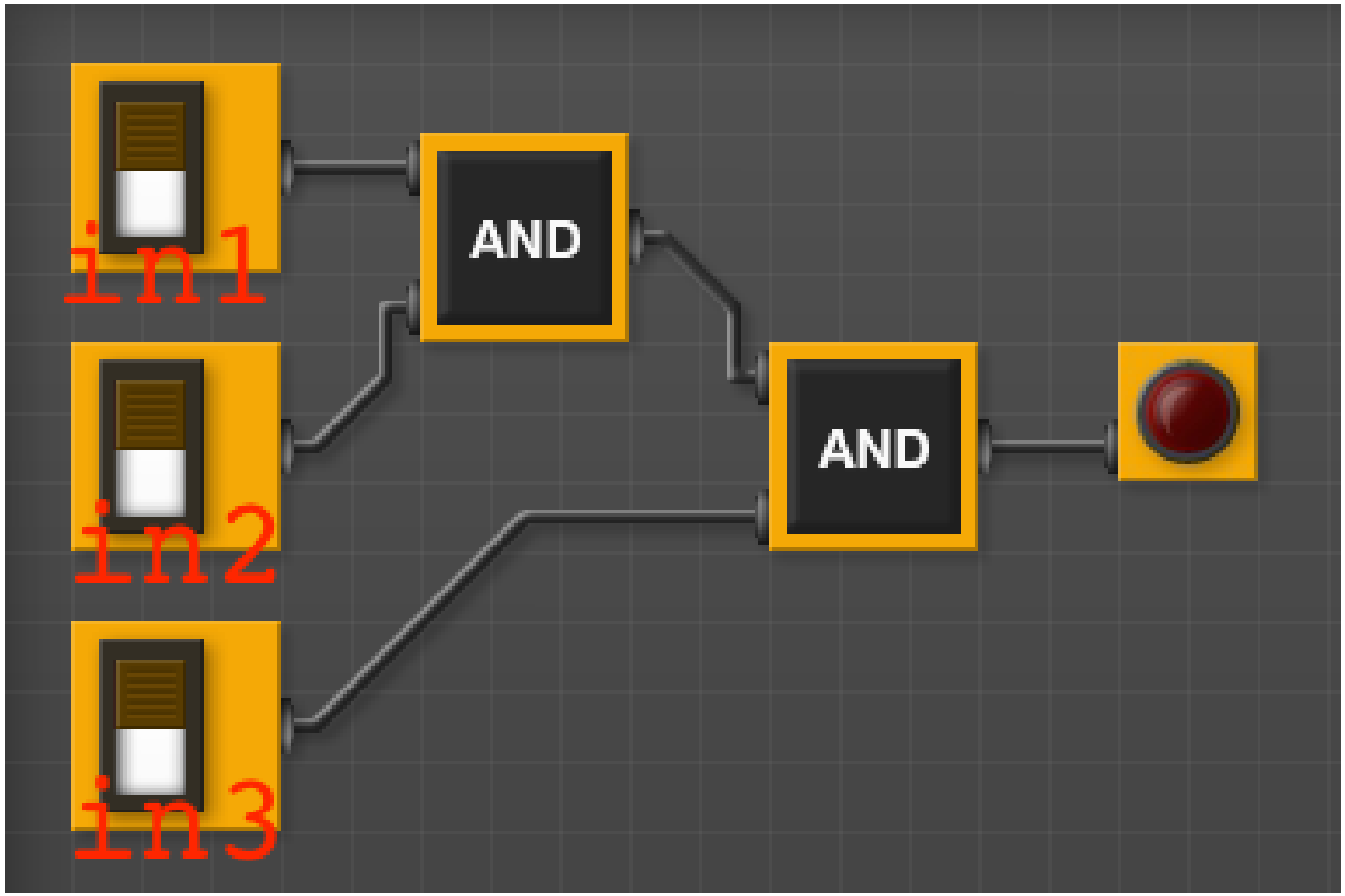
  Example: `in1 and in2`
- Each logical operator (`and`, `or`, & `not`) has a corresponding logical circuit that can be used to join together inputs.

Examples: Logical Circuit



Examples: Logical Circuit



`(in1 and in2) and in3`

Examples: Logical Expressions

Examples from last lecture:

```
origin = "Indian Ocean"
winds = 100
if (winds > 74):
    print("Major storm, called a ", end="")
    if origin == "Indian Ocean" or origin == "South Pacific":
        print("cyclone.")
    elif origin == "North Pacific":
        print("typhoon.")
    else:
        print("hurricane.")

visibility = 0.2
winds = 40
conditions = "blowing snow"
if (winds > 35) and (visibility < 0.25) and \
      (conditions == "blowing snow" or conditions == "heavy snow"):
    print("Blizzard!")
```

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)

In Pairs or Triples: 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)
```

Structured Data

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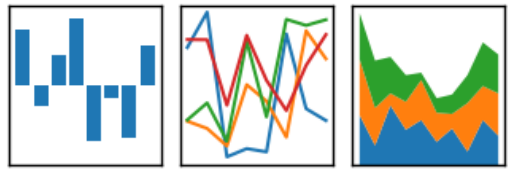
- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

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



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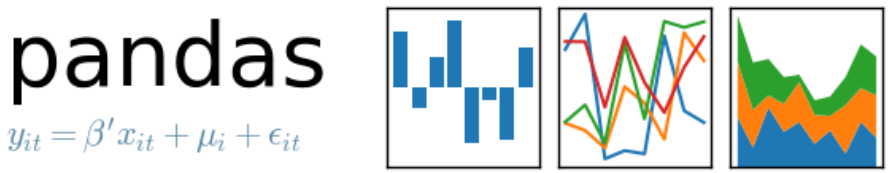
Structured Data



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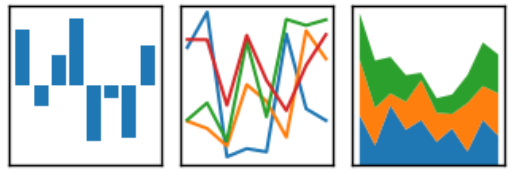
Structured Data

pandas

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



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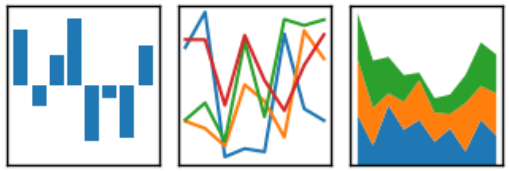

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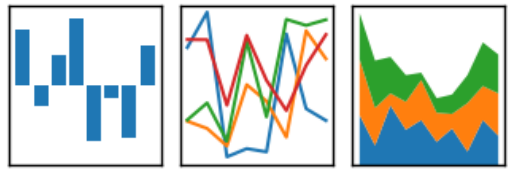

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- To use, add to the top of your file:

```
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
Lehman	6,600	4,720	11,320
Medgar Evers	4,760	2,059	6,819
NYCCT	10,912	6,370	17,282
Queens	11,693	4,633	16,326
Staten Island	9,584	2,948	12,532
York	5,066	3,192	8,258

- Excel .xls files have much extra formatting.

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nycHistPop.csv

Reading in CSV Files

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- 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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import pandas as pd
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`nycHistPop.csv`

In Lab 6

Example: Reading in CSV Files

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```

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nycHistPop.csv

In Lab 6

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nycHistPop.csv

In Lab 6

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

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

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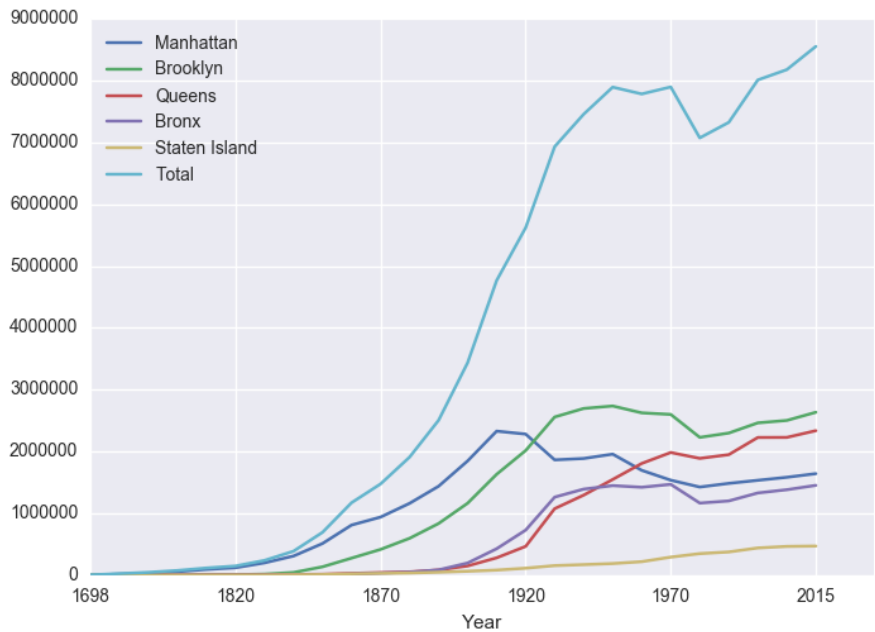
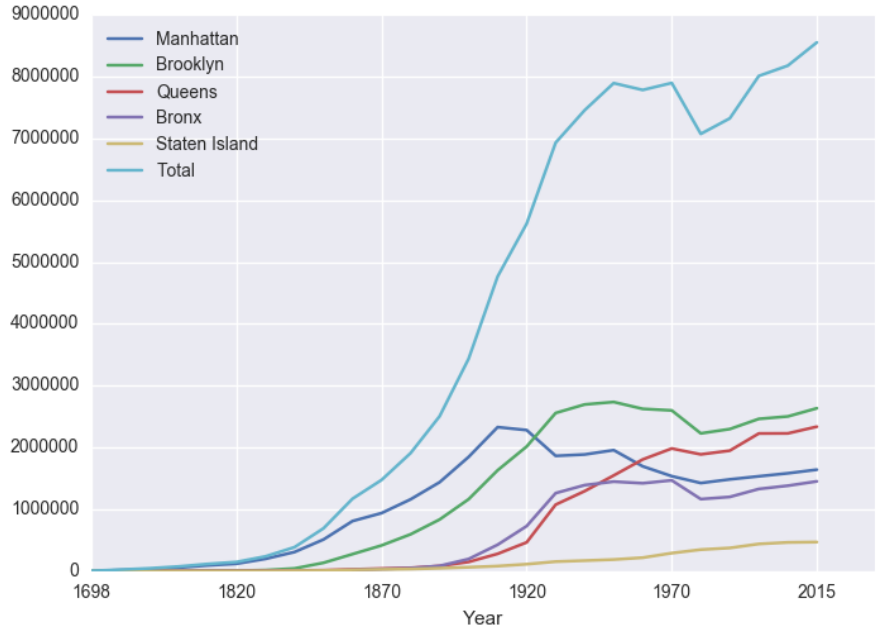
nycHistPop.csv

In Lab 6

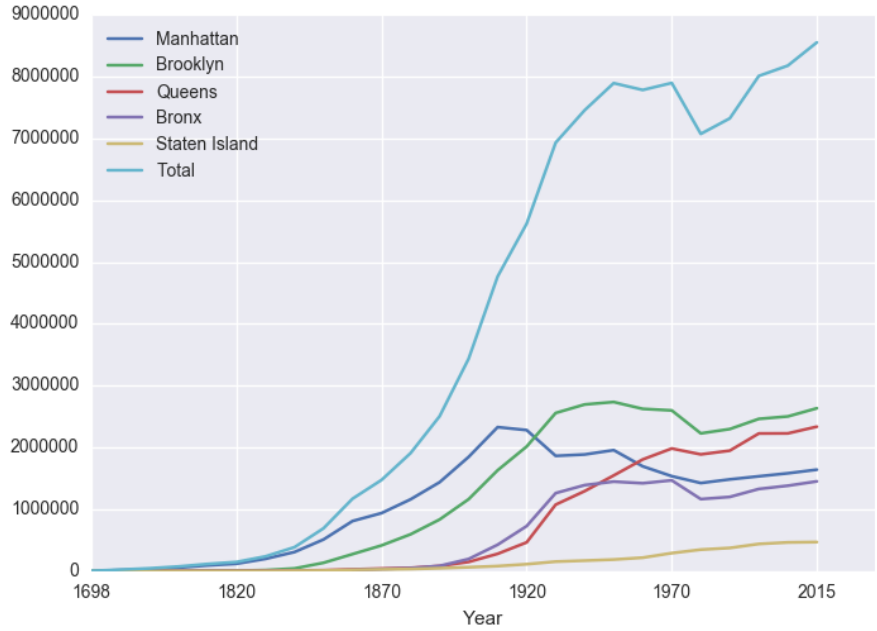


Series in Pandas



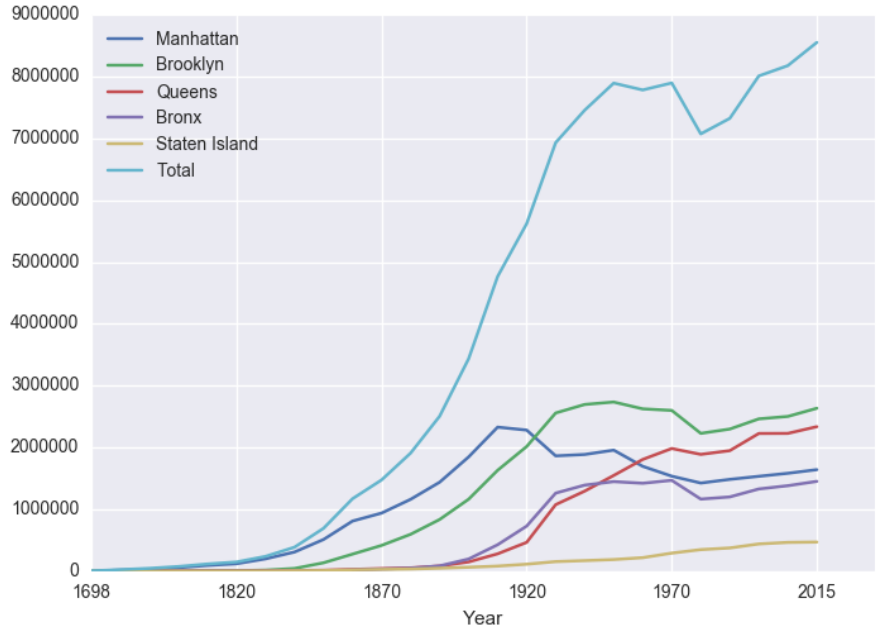
- Series can store a column or row of a DataFrame.

Series in Pandas



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

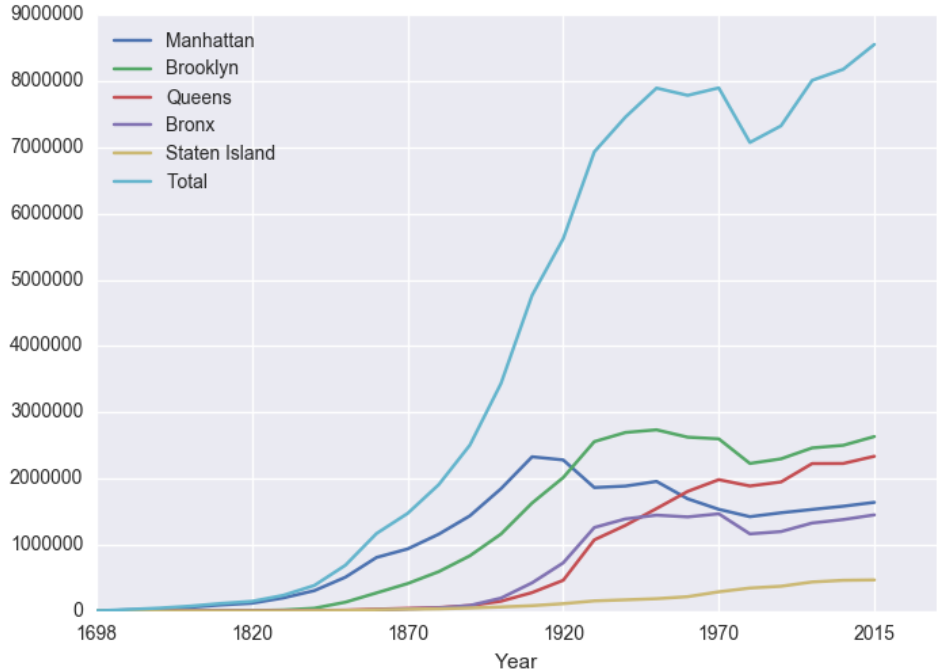
Series in Pandas



- 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())
```

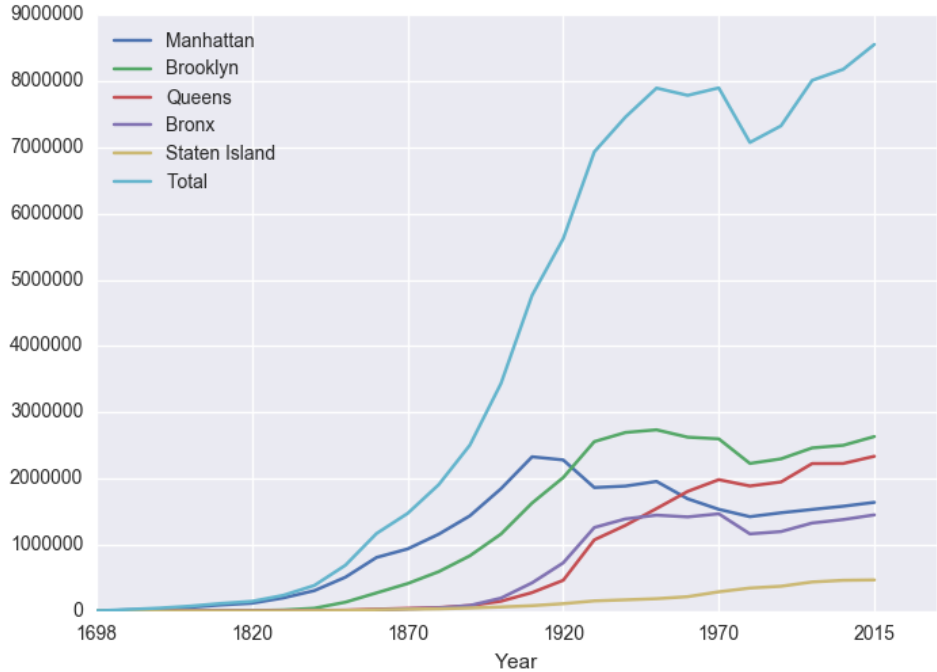
In Pairs or Triples



Predict what the following will do:

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

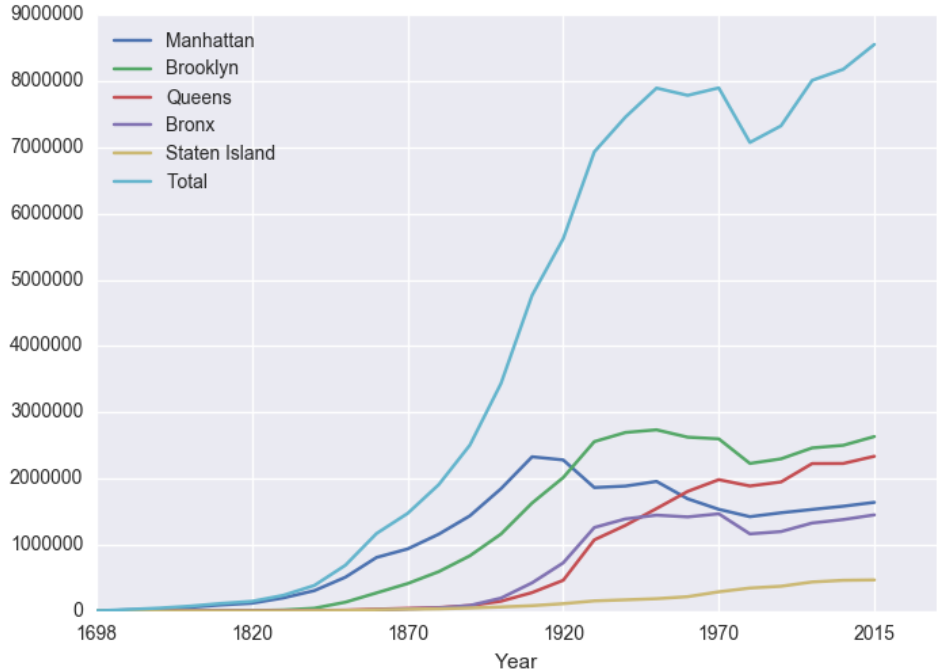
In Pairs or Triples



Predict what the following will do:

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

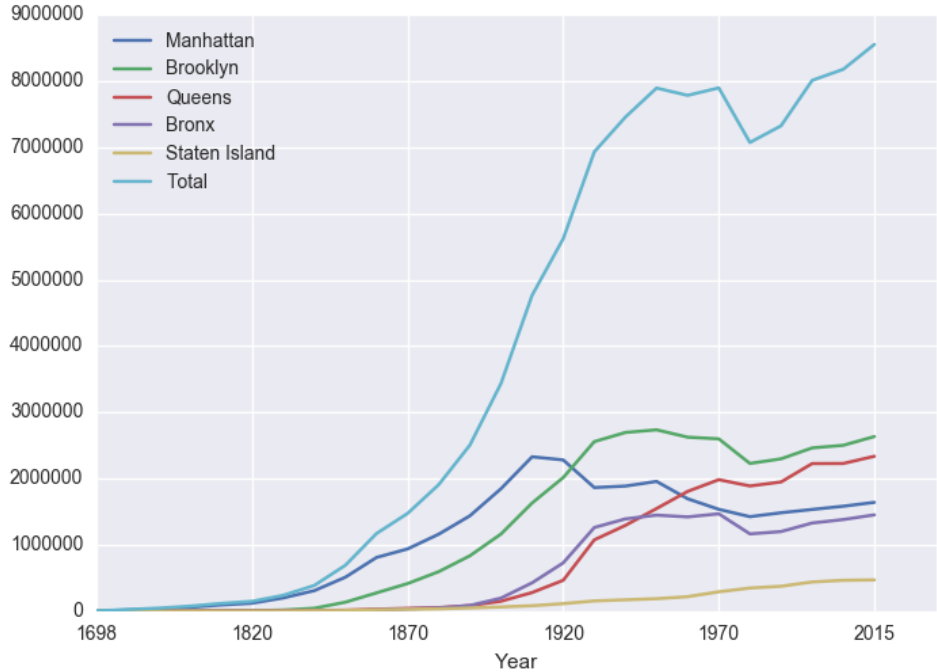
In Pairs or Triples



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())`

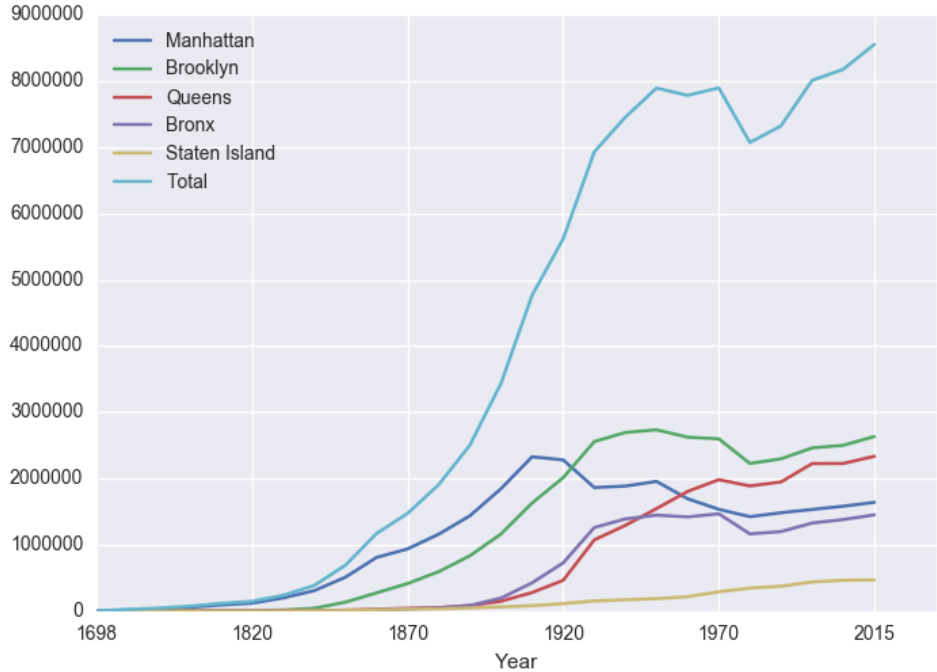
In Pairs or Triples



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")`

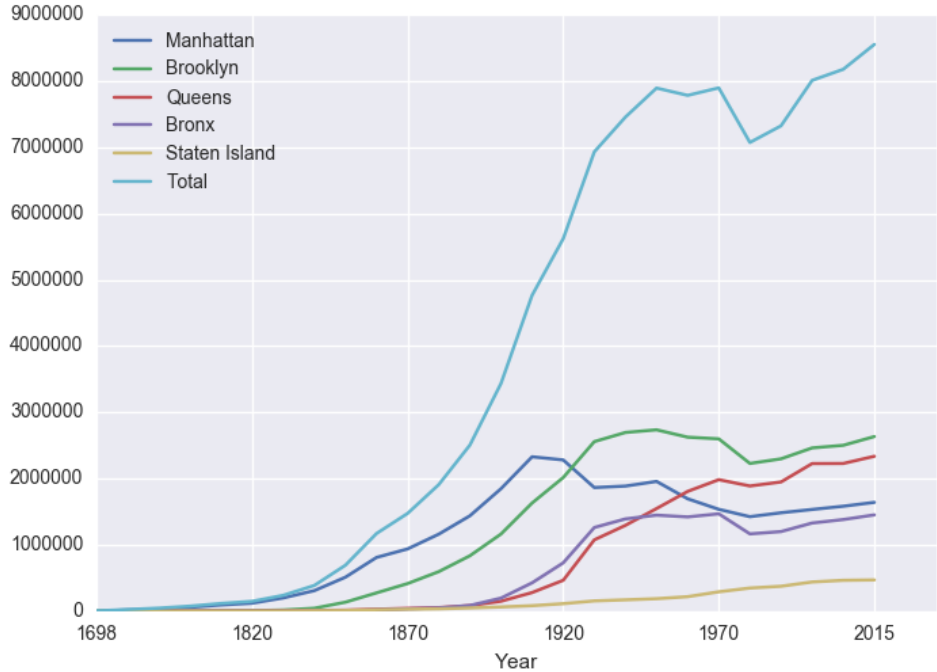
In Pairs or Triples



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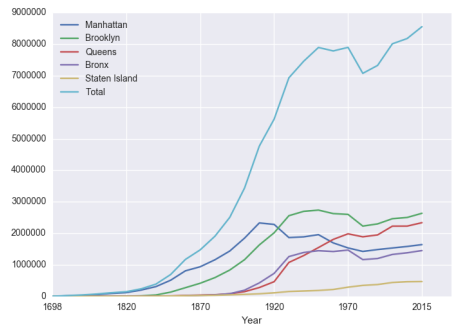
- `print("S I:", pop["Staten Island"].std())`
- `pop.plot.bar(x="Year")`
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
- `pop["Fraction"] = pop["Bronx"]/pop["Total"]`

Solutions

Predict what the following will do:

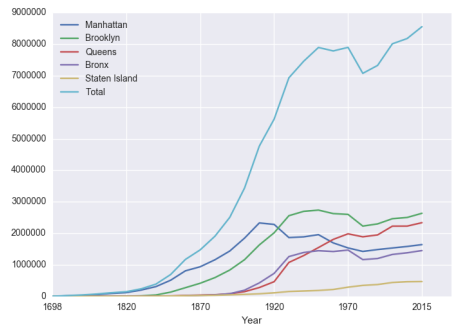
- `print("Queens:", pop["Queens"].min())`



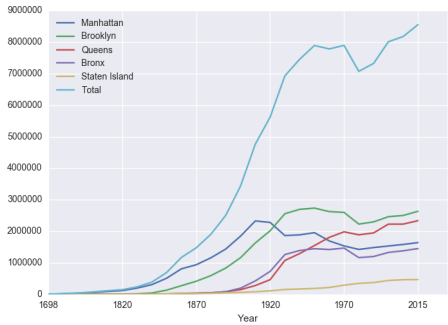
Solutions

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:

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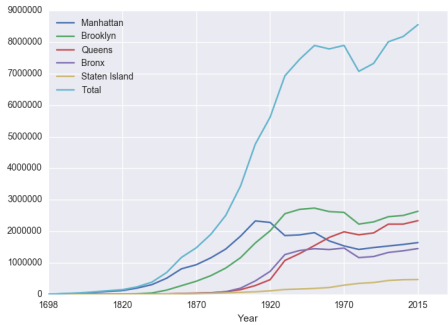
  Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`

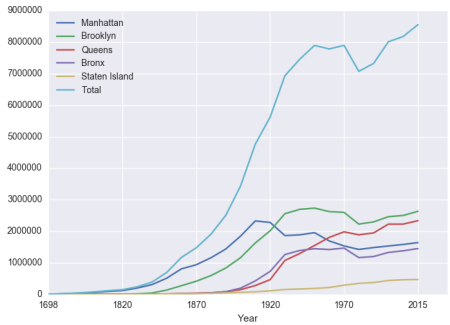
Solutions



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



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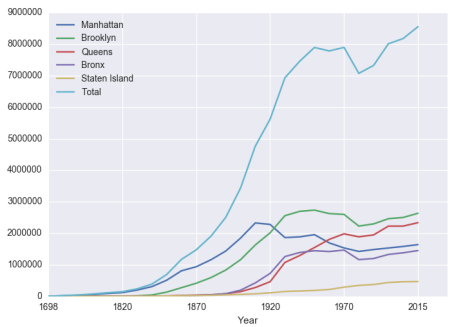
- `print("Queens:", pop["Queens"].min())`
  Minimum value in the column with label "Queens".
- `print("S I:", pop["Staten Island"].mean())`
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`

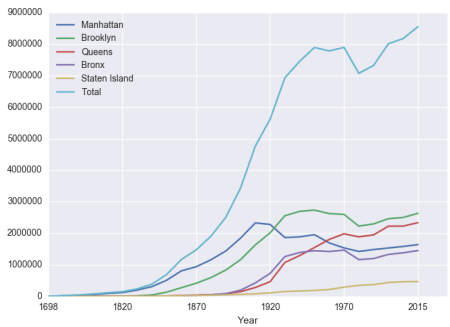
Solutions



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



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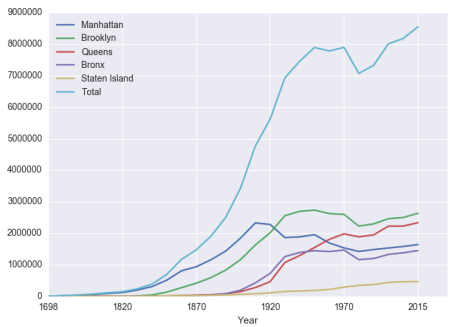
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`

Solutions



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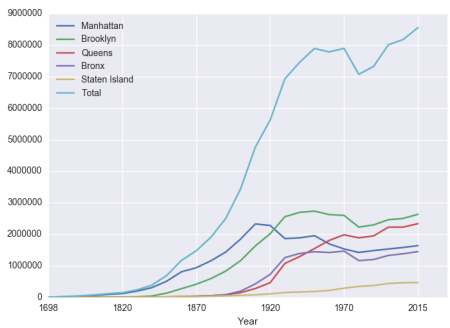
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".

Solutions



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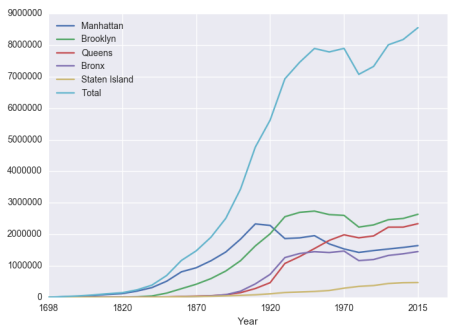
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`

Solutions



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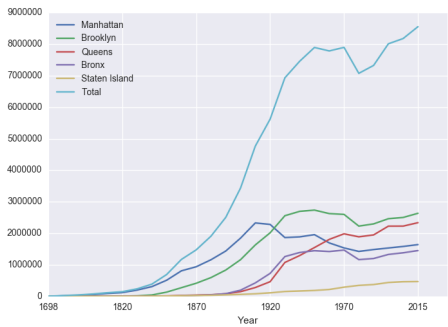
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
  Scatter plot of Brooklyn versus Total values.

Solutions



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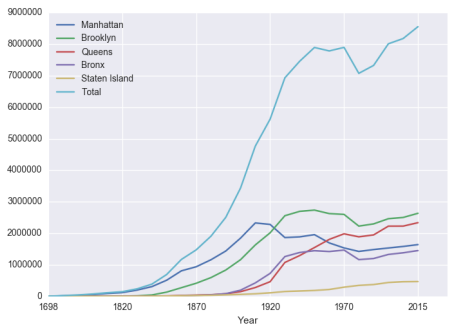
  Average of values in the column "Staten Island".
- `print("S I :", pop["Staten Island"].std())`
  Standard deviation of values in the column "Staten Island".
- `pop.plot.bar(x="Year")`
  Bar chart with x-axis "Year".
- `pop.plot.scatter(x="Brooklyn", y= "Total")`
  Scatter plot of Brooklyn versus Total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

Solutions



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- `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.

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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:

1. *Include pandas & pyplot libraries.*

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

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

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`cunyF2016.csv`

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

Solution:

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

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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

`cunyF2016.csv`

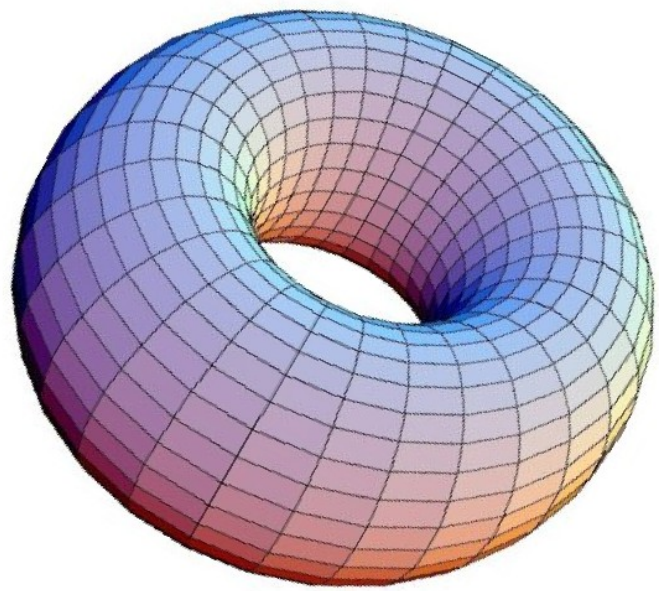
Write a complete Python program that reads in the file, `cunyF2016.csv`, and produces a scatter plot of full-time versus part-time enrollment.

Solution:

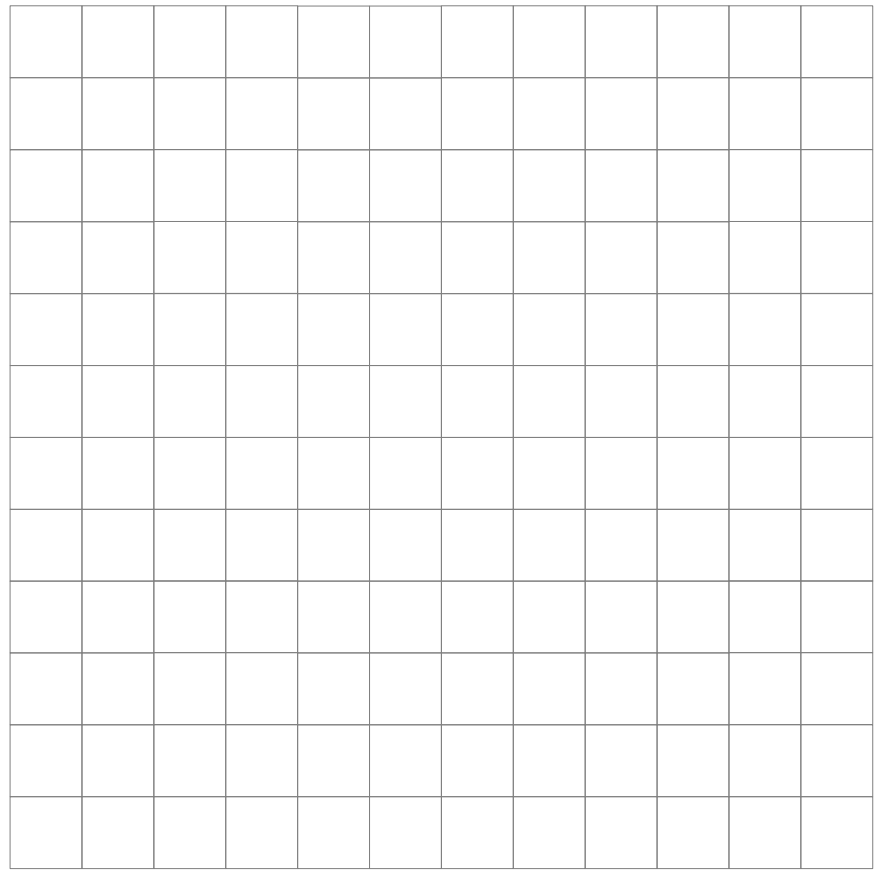
1. *Include pandas & pyplot libraries.*
```
import matplotlib.pyplot as plt
import pandas as pd
```
2. *Read in the CSV file.*
```
pop=pd.read_csv('cunyF2016.csv',skiprows=1)
```
3. *Set up a scatter plot.*
```
pop.plot(x="Full-time",y="Part-time")
```
4. *Display plot.*
```
plt.show()
```

Living on a random torus

Saad Mneimneh
Hunter College, CUNY

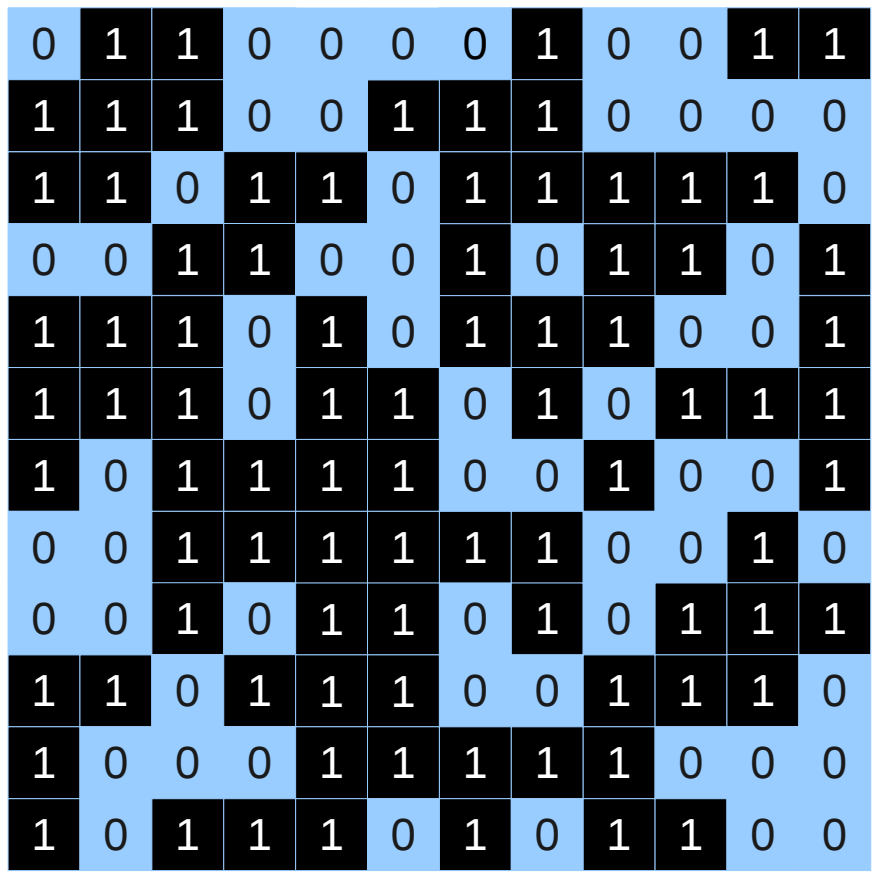


Start with a 2-dimensional mxn array

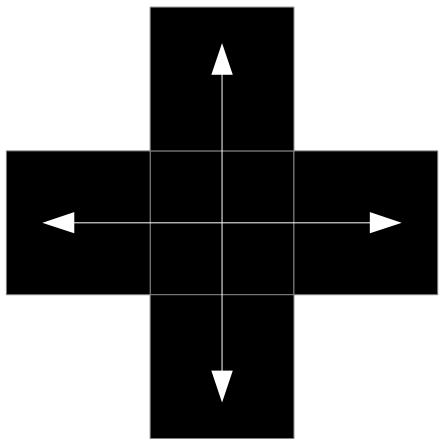


Fill it randomly with 1s and 0s

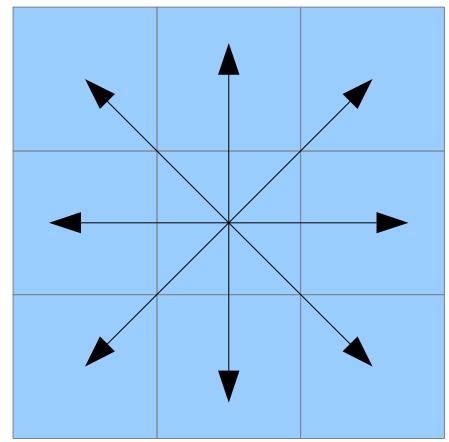
$P(1) = p$, $P(0) = 1 - p$



Islands and pools

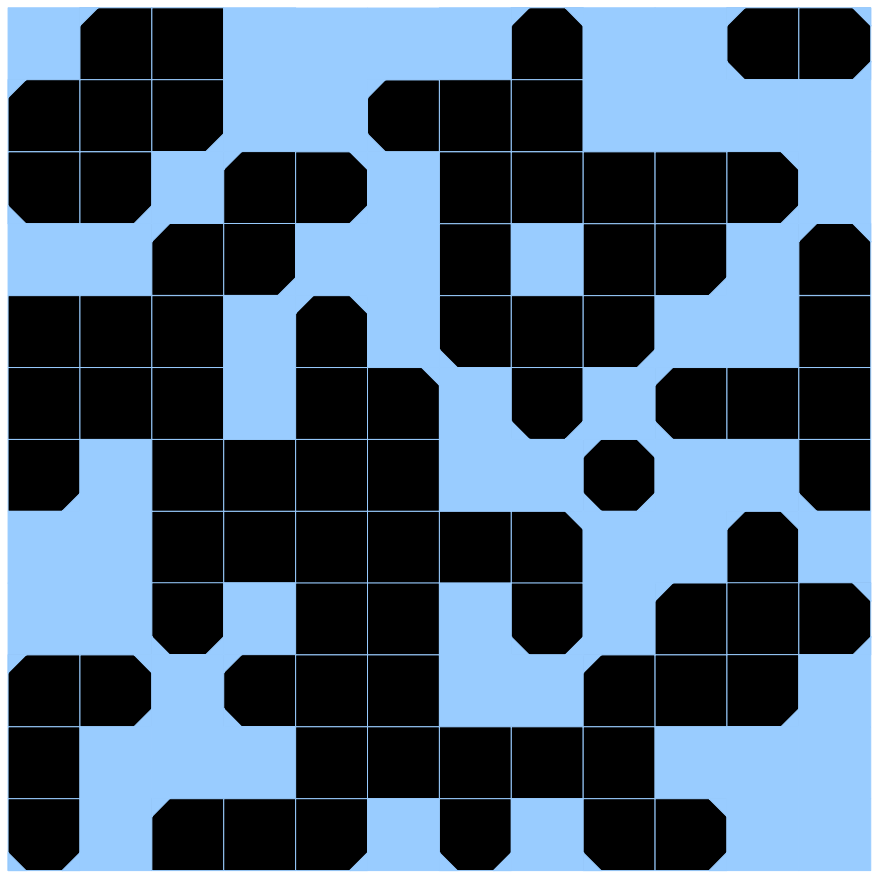


On land, we walk
N, E, S, W

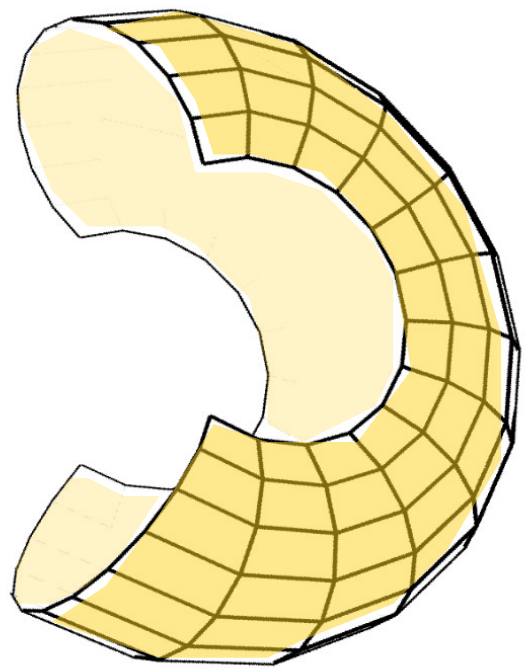


On water, we walk
N, E, S, W
NE, NW, SE, SW

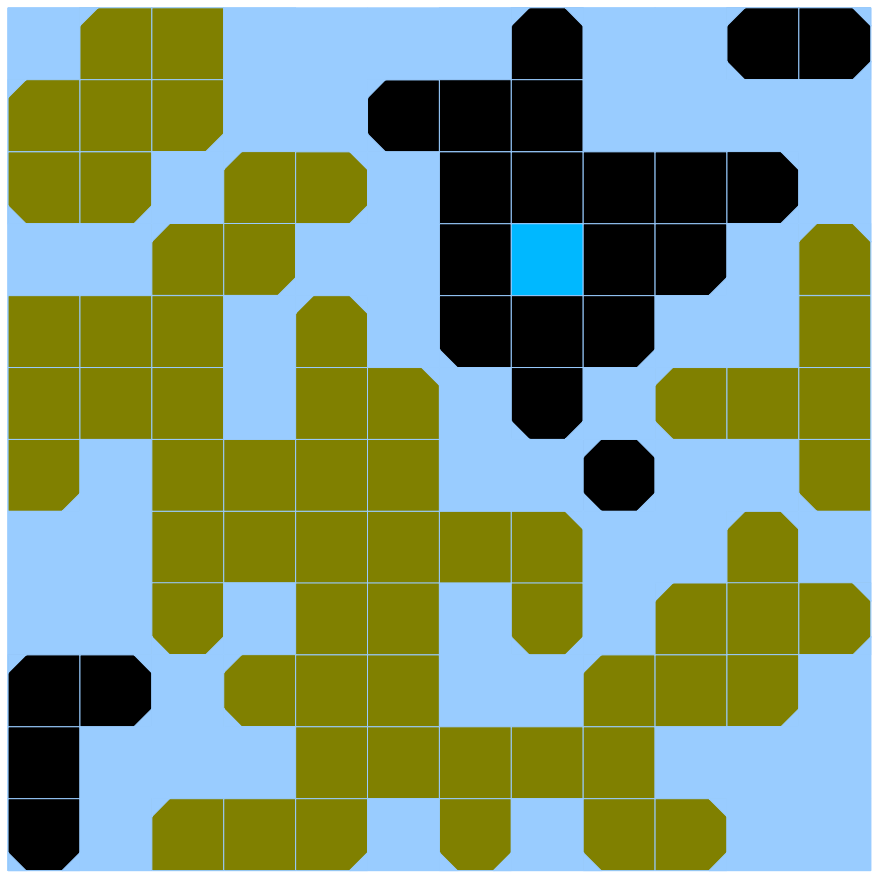
Create islands and pools



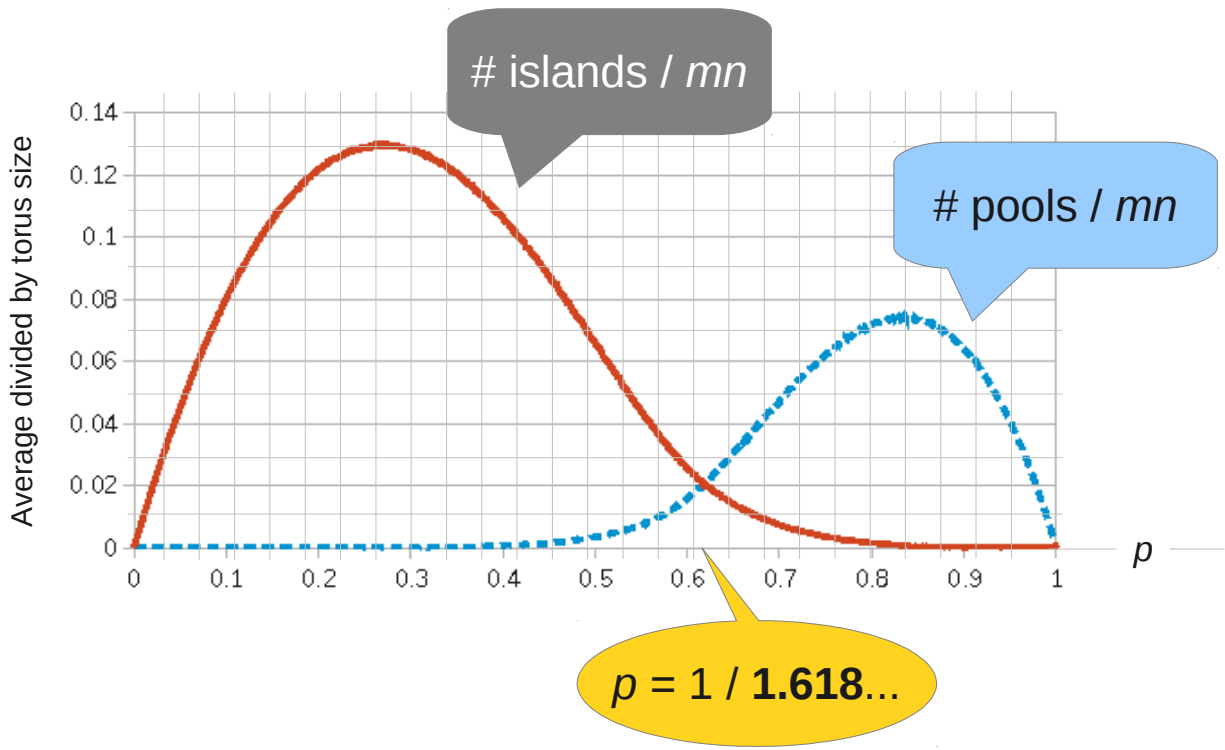
Wrap array around to make a torus



A random torus with 5 islands and 2 pools



The Golden Ratio appears when m and n are large

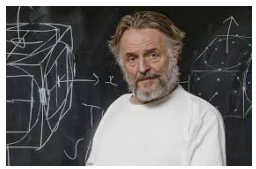


$$\lim_{m,n\to\infty} E[\#\text{islands} - \#\text{pools}] = 0 \text{ when } p = \phi^{-1}$$

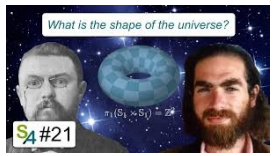
CS Survey: Prof. Saad Mneimneh

Interesting things to look for...

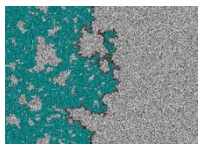
- John Conway's Game of Life



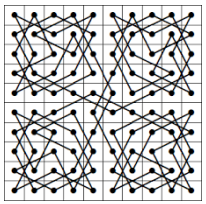
- Poincare's conjecture



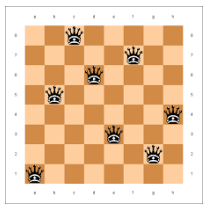
- Percolation theory



- Knight's tour

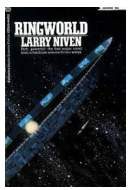


- Eight queens



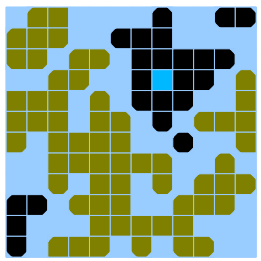
- Golden ratio and Fibonacci numbers

- Ring World (a science fiction novel from the 70s)



Lecture Slip: Living on a Torus

A random torus with
5 islands and 2 pools



- How many pools and how many islands does each version have? (Collect all 5!)

Lecture Slip: Living on a Torus

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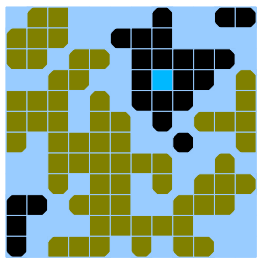
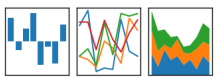


- How many pools and how many islands does each version have? (Collect all 5!)
- Design an algorithm that will count the number of islands.

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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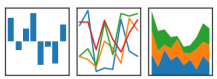
- Recap: Logical Expressions & Circuits

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

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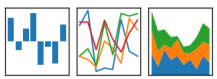
  - Pandas library has elegant solutions for accessing & analyzing structured data.

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

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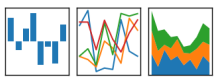
pandas 

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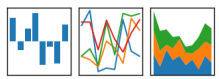
pandas 

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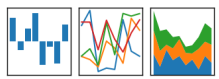
Recap

pandas 

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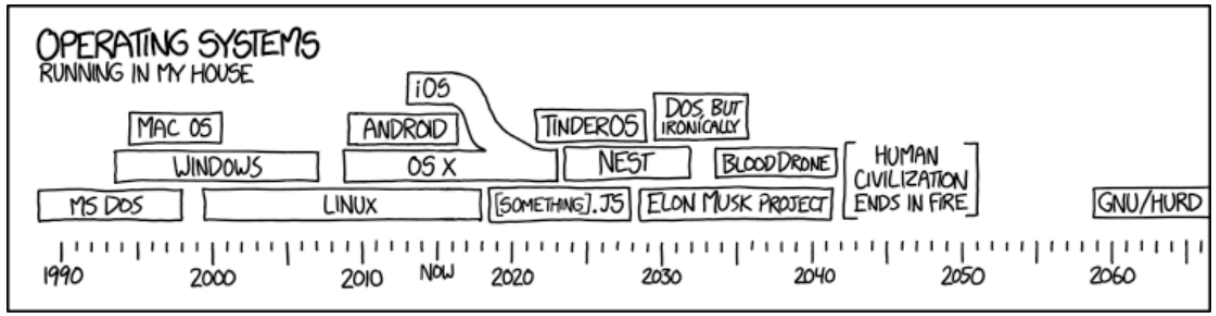
- Pass your lecture slips to the aisles for the UTAs to collect.

Practice Quiz & Final Questions



xkcd #1508

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

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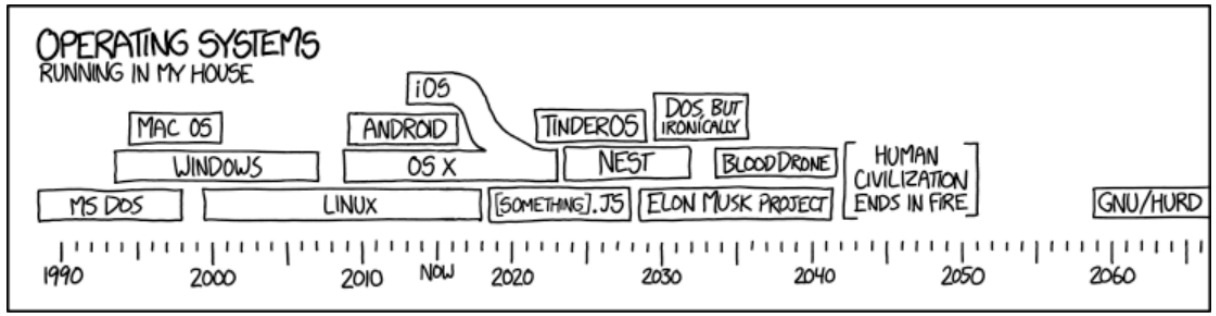

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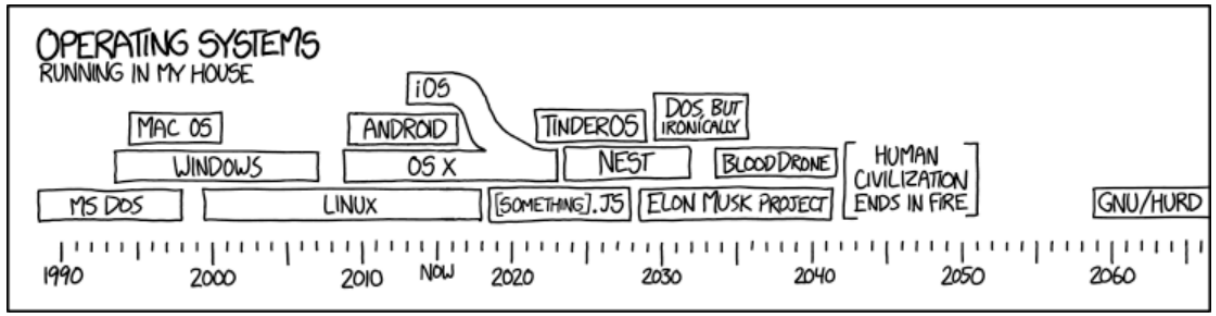

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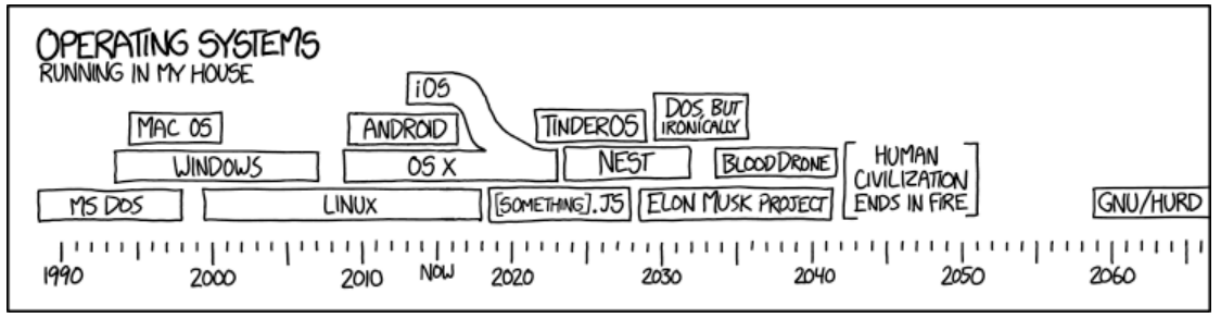

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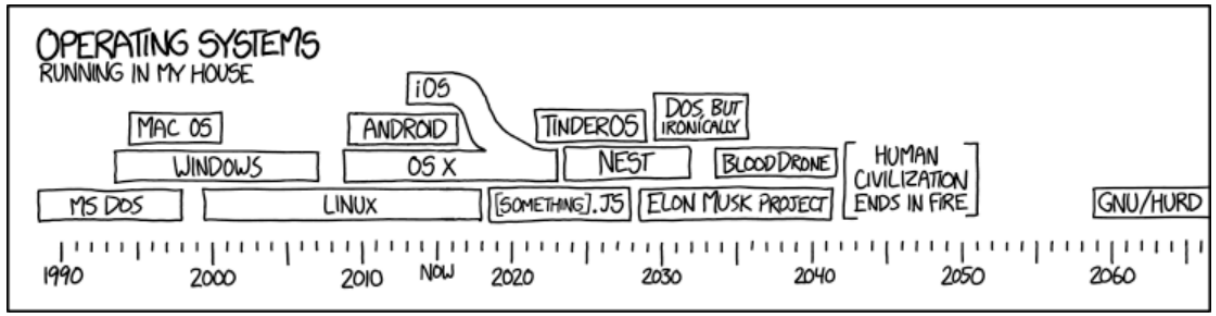

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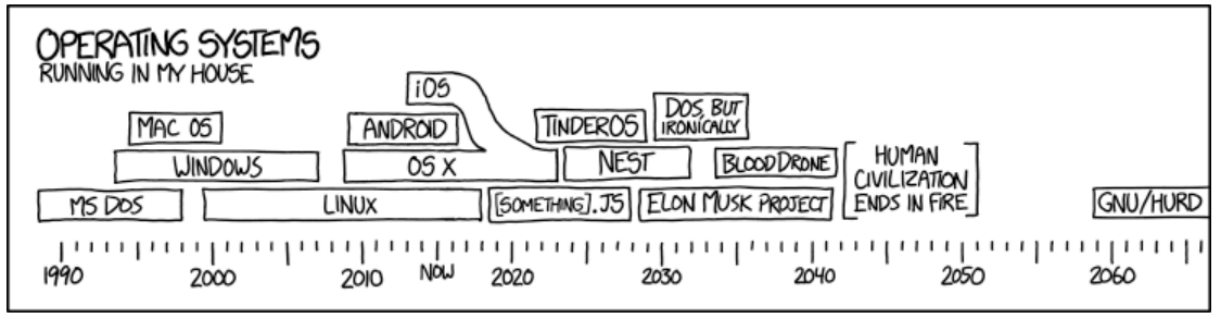

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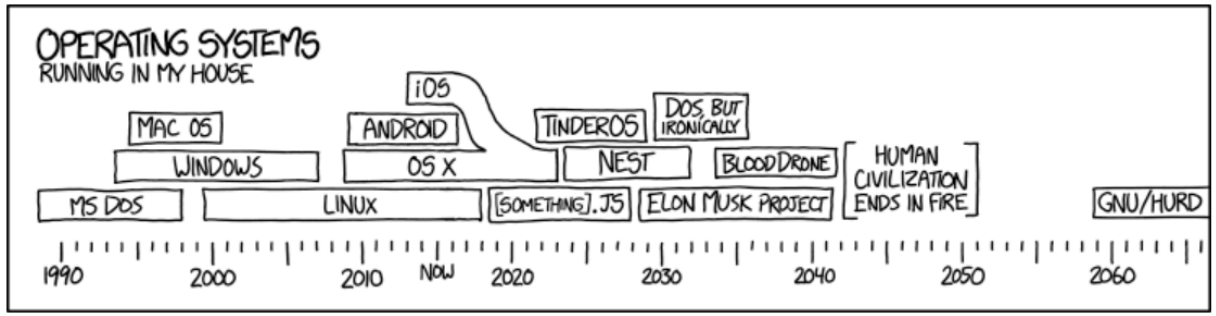

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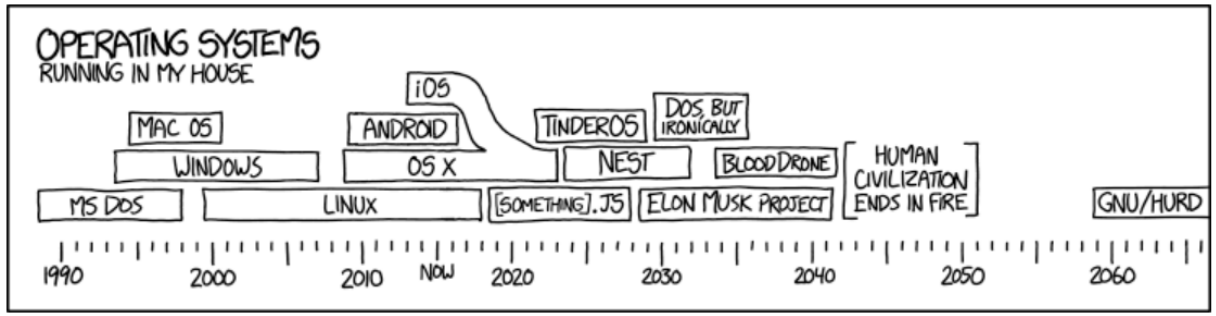

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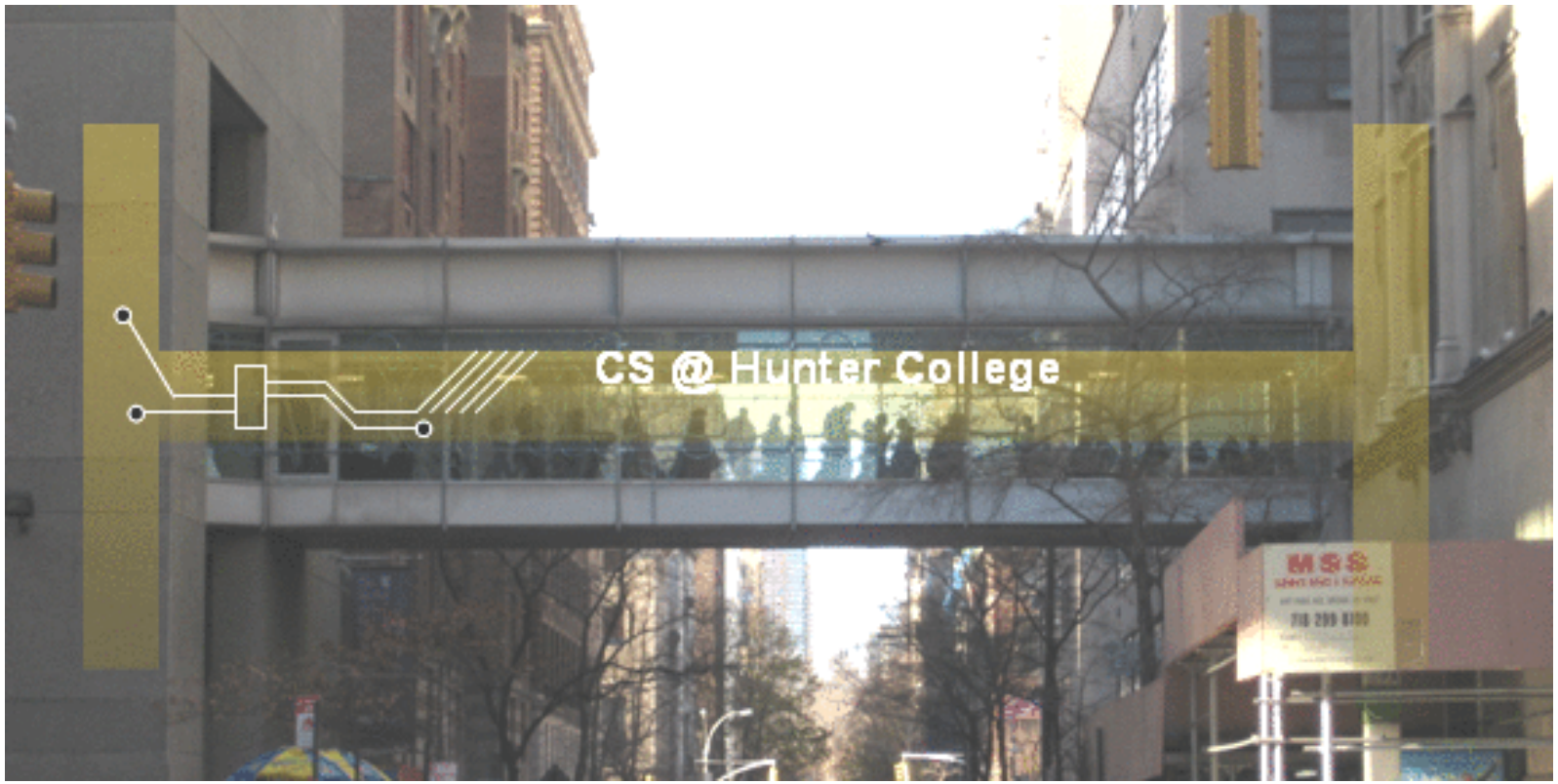
- Theme: Unix commands!

Writing Boards



- Return writing boards as you leave...