

CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements



- Next Week: OpenData Showcase: 28 March, 4:30-6pm (rescheduled due to snow).
- Each lecture includes a survey of computing research and tech in NYC.

*Today: Mitsue Iwata
NYC OpenData Initiative
Mayor's Office*

Frequently Asked Questions

From lecture slips & recitation sections.

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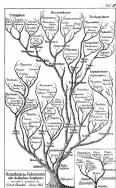
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 - ▶ *Hunter has an ACM Chapter & Women in CS clubs.*
 - ▶ *Tech Meetups: focused on just about everything tech (both via CUNY and city-wide).*
 - ▶ *Internships: <https://jobs.lever.co/cunyinternships>*

Today's Topics

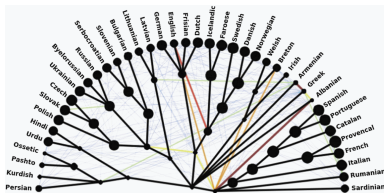


- Recap: Tree-based Networks
- Introduction to Functions
- NYC Open Data

Recap: Tree-Based Networks



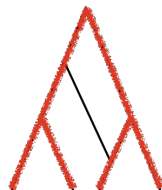
Haeckel



List *et al.*, 2013

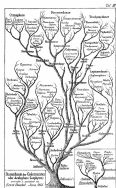


Network

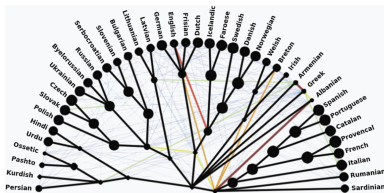


Highlighted Tree

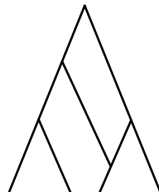
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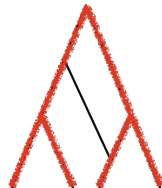
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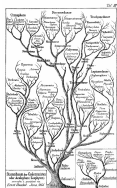
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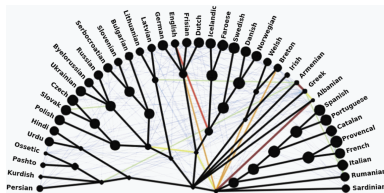
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- Evolutionary history can be represented by a tree.

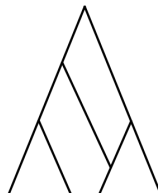
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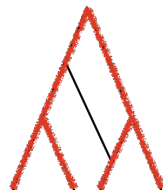
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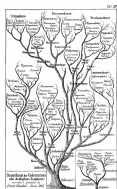
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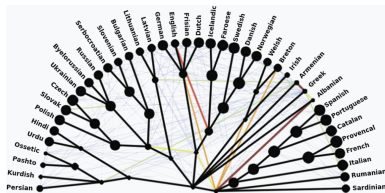
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- Evolutionary history can be represented by a tree.
- Events like hybridization can cause non-tree-like networks.

Recap: Tree-Based Networks



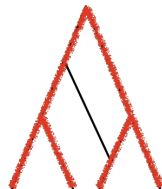
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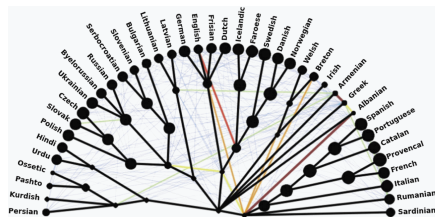


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- Evolutionary history can be represented by a tree.
- Events like hybridization can cause non-tree-like networks.
- Is there a tree on which the network is based?

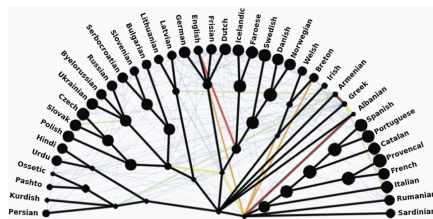
That is, can you start with a tree and only add lines between the original tree edges.

Tree-based Networks: Lecture Slip



List et al., 2013

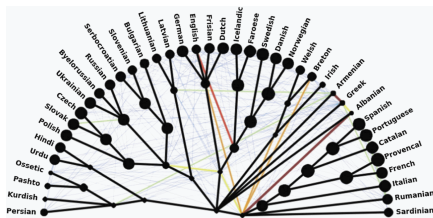
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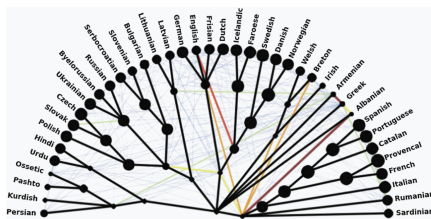
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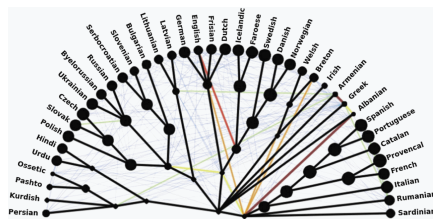
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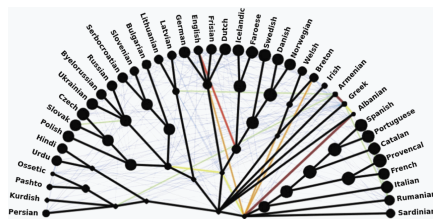
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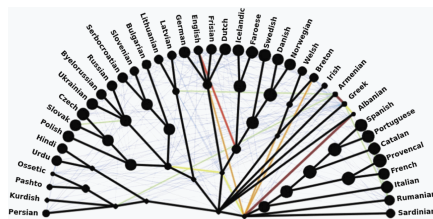
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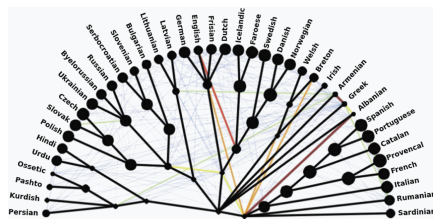
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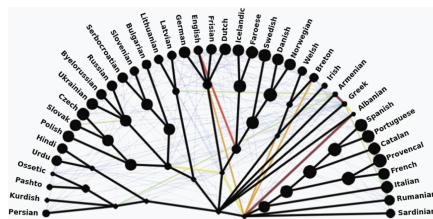
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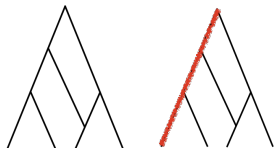
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 - ▶ What's left: a bunch of choices on which edge to include in the tree
 - ▶ Becomes a logic puzzle: a logical expression that can be solved.

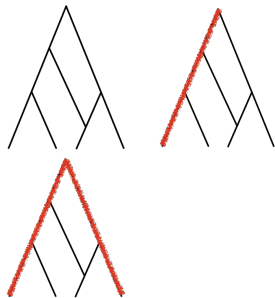
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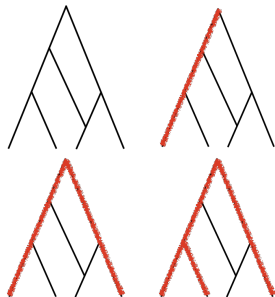
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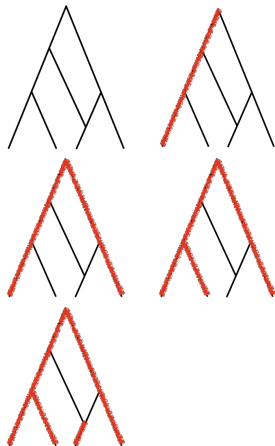
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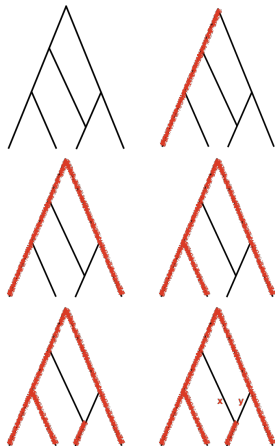
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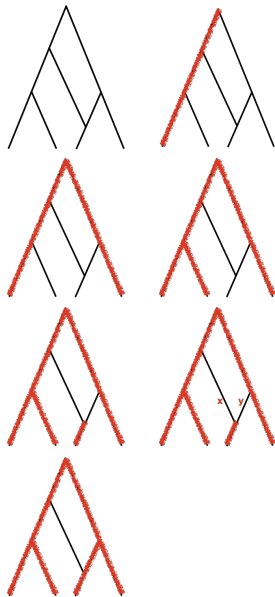
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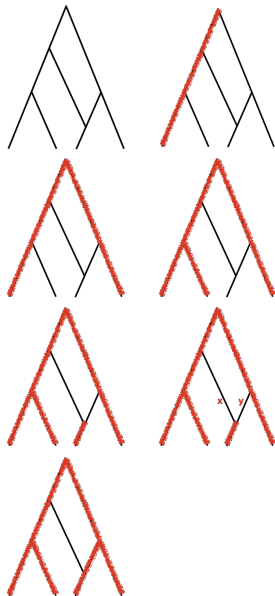
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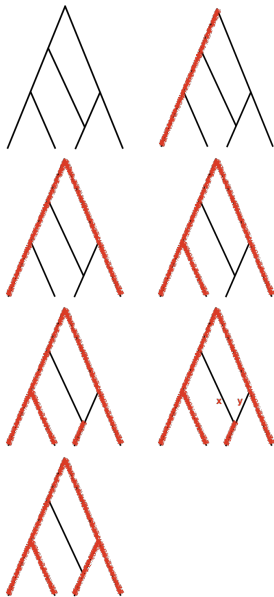


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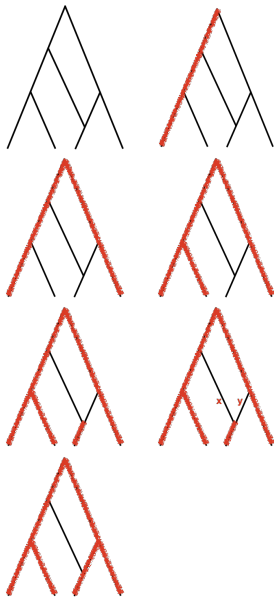
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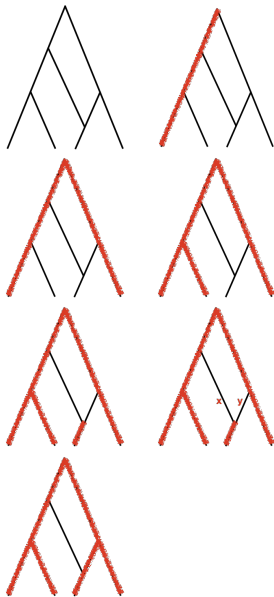
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 $(x \text{ and not } y) \text{ or } (\text{not } x \text{ and } y)$
- Solve the resulting logical puzzle.

Functions

- Functions are a way to break code into pieces, that can be easily reused.

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#Name: your name here
#Date: October 2017
#This program, uses functions,
#    says hello to the world!

def main():
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- Can write, or **define** your own functions, which are stored, until invoked or called.

“Hello, World!” with Functions

```
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Python Tutor

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(Demo with pythonTutor)

In Pairs or Triples:

1. *Predict what the code will do:*

```
def totalWithTax(food,tip):
    total = 0
    tax = 0.0875
    total = food + food * tax
    total = total + tip
    return(total)

lunch = float(input('Enter lunch total: '))
lTip = float(input('Enter lunch tip: '))
lTotal = totalWithTax(lunch, lTip)
print('Lunch total is', lTotal)

dinner= float(input('Enter dinner total: '))
dTip = float(input('Enter dinner tip: '))
dTotal = totalWithTax(dinner, dTip)
print('Dinner total is', dTotal)
```

2. *Fill in the missing code:*

```
def monthString(monthNum):
    """
    Takes as input a number, monthNum, and
    returns the corresponding month name as a string.
    Example: monthString(1) returns "January".
    Assumes that input is an integer ranging from 1 to
    """

    monthString = ""

    #####
    ### FILL IN YOUR CODE HERE      ###
    ### Other than your name above, ###
    ### this is the only section    ###
    ### you change in this program. ###
    #####

    return(monthString)

def main():
    n = int(input('Enter the number of the month: '))
    mString = monthString(n)
    print('The month is', mString)
```

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    return(total)  
  
lunch = float(input('Enter lunch total: '))  
lTip = float(input('Enter lunch tip: '))  
lTotal = totalWithTax(lunch, lTip)  
print('Lunch total is', lTotal)  
  
dinner= float(input('Enter dinner total: '))  
dTip = float(input('Enter dinner tip: '))  
dTotal = totalWithTax(dinner, dTip)  
print('Dinner total is', dTotal)
```

(Demo with pythonTutor)

IDLE

```
def monthString(monthNum):
    """
    Takes as input a number, monthNum, and
    returns the corresponding month name as a string.
    Example: monthString(1) returns "January".
    Assumes that input is an integer ranging from 1 to 12
    """

    monthString = ""

    #####
    ### FILL IN YOUR CODE HERE   ###
    ### Other than your name above, ###
    ### this is the only section  ###
    ### you change in this program. ###
    #####

    return(monthString)

def main():
    n = int(input('Enter the number of the month: '))
    nString = monthString(n)
    print('The month is', nString)
```

(Demo with IDLE)

In Pairs or Triples:

Predict what the code will do:

```
#CSci 127 Teaching Staff
#Triangles two ways...
import turtle
```

```
def setUp(t, dist, col):
    t.penup()
    t.forward(dist)
    t.pendown()
    t.color(col)
```

```
def nestedTriangle(t, side):
    if side > 10:
        for i in range(3):
            t.forward(side)
            t.left(120)
        nestedTriangle(t, side/2)
```

```
def fractalTriangle(t, side):
    if side > 10:
        for i in range(3):
            t.forward(side)
            t.left(120)
        fractalTriangle(t, side/2)
```

```
def main():
    nessa = turtle.Turtle()
    setUp(nessa, 100, "violet")
    nestedTriangle(nessa, 160)

    frank = turtle.Turtle()
    setUp(frank, -100, "red")
    fractalTriangle(frank, 160)

if __name__ == "__main__":
    main()
```

IDLE

```
#CSci 127 Teaching Staff
#Triangles two ways...
import turtle

def setUp(t, dist, col):
    t.penup()
    t.forward(dist)
    t.pendown()
    t.color(col)

def nestedTriangle(t, side):
    if side > 10:
        for i in range(3):
            t.forward(side)
            t.left(120)
            nestedTriangle(t, side/2)

def fractalTriangle(t, side):
    if side > 10:
        for i in range(3):
            t.forward(side)
            t.left(120)
            fractalTriangle(t, side/2)
```

(Demo with IDLE)

Recap: Functions

```
#Name: your name here
#Date: October 2017
#This program, uses functions,
#    says hello to the world!

def main():
    print("Hello, World!")

if __name__ == "__main__":
    main()
```

- Functions are a way to break code into pieces, that can be easily reused.

Recap: Functions

```
#Name: your name here
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#This program, uses functions,
#    says hello to the world!

def main():
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if __name__ == "__main__":
    main()
```

- Functions are a way to break code into pieces, that can be easily reused.
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:

Recap: Functions

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- Functions are a way to break code into pieces, that can be easily reused.
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:
Example: `print("Hello", "World")`

Recap: Functions

```
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#This program, uses functions,
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def main():
    print("Hello, World!")

if __name__ == "__main__":
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```

- Functions are a way to break code into pieces, that can be easily reused.
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:
Example: `print("Hello", "World")`
- Can write, or **define** your own functions,

Recap: Functions

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#Name: your name here
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#This program, uses functions,
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- Functions are a way to break code into pieces, that can be easily reused.
- You **call** or **invoke** a function by typing its name, followed by any inputs, surrounded by parenthesis:
Example: `print("Hello", "World")`
- Can write, or **define** your own functions, which are stored, until invoked or called.

In Pairs or Triples:

Predict what the code will do:

```
motto = "Mihi Cura Futuri"  
l = len(motto)  
for i in range(l):  
    print(motto[i])  
for j in range(l-1,-1,-1):  
    print(motto[j])
```

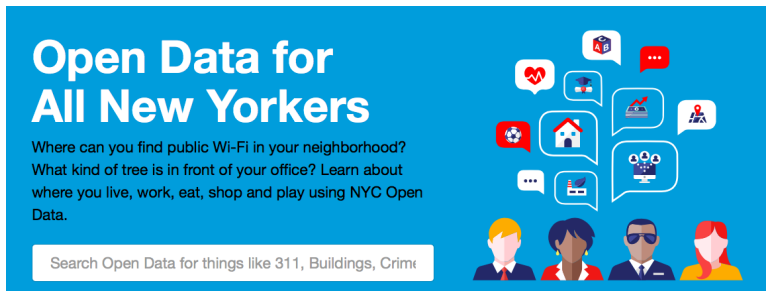
```
import matplotlib.pyplot as plt  
import numpy as np  
img = plt.imread('csBridge.png')  
plt.imshow(img)  
plt.show()  
height = img.shape[0]  
width = img.shape[1]  
img2 = img[:height/2, :width/2]  
plt.imshow(img2)  
plt.show()
```

Python Tutor

```
motto = "Mihi Cura Futuri"  
l = len(motto)  
for i in range(l):  
    print(motto[i])  
for j in range(l-1,-1,-1):  
    print(motto[j])
```

(Demo with pythonTutor)

Accessing Structured Data: NYC Open Data



Open Data for All New Yorkers

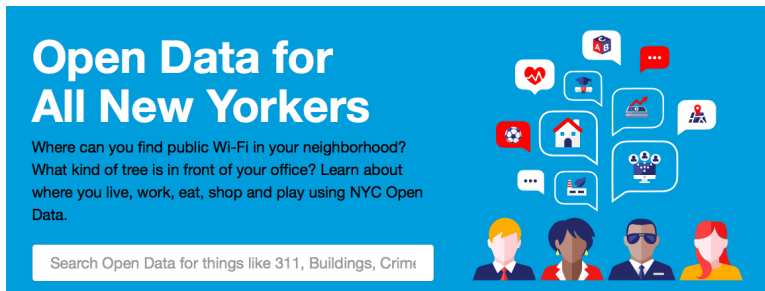
Where can you find public Wi-Fi in your neighborhood?
What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

Search Open Data for things like 311, Buildings, Crime

The graphic features a blue background with white text. Below the title, there are two lines of text asking questions about public Wi-Fi and trees. Below that is a search bar with the text "Search Open Data for things like 311, Buildings, Crime". To the right of the text, there are several speech bubbles containing icons: a heart with a pulse line, a graduation cap, a house, a soccer ball, a bar chart with an upward arrow, a location pin, a person with a magnifying glass, and a group of people. At the bottom right, there are four stylized human figures in different colors (yellow, blue, black, and red) wearing various accessories like sunglasses and a hat.

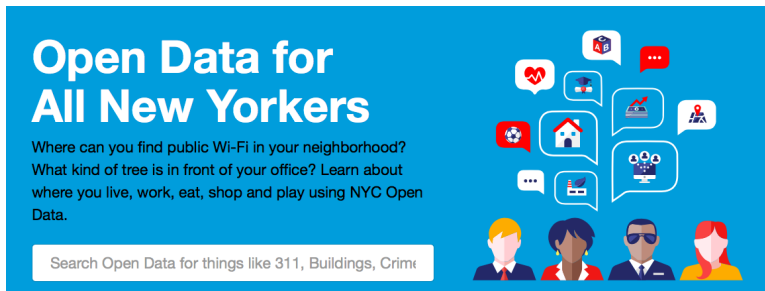
- Freely available source of data.

Accessing Structured Data: NYC Open Data

A blue banner for NYC Open Data. On the left, the text "Open Data for All New Yorkers" is in large white font. Below it, a paragraph asks: "Where can you find public Wi-Fi in your neighborhood? What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data." At the bottom left is a white search bar with the placeholder text "Search Open Data for things like 311, Buildings, Crime". On the right, there are several white speech bubbles containing icons: a heart with a pulse line, a graduation cap, a red location pin, a soccer ball, a house, a bar chart with an upward arrow, a person with a magnifying glass, and a group of people. Below the speech bubbles are four stylized human avatars with different skin tones and hairstyles.

- Freely available source of data.
- Maintained by the NYC data analytics team.

Accessing Structured Data: NYC Open Data



Open Data for All New Yorkers

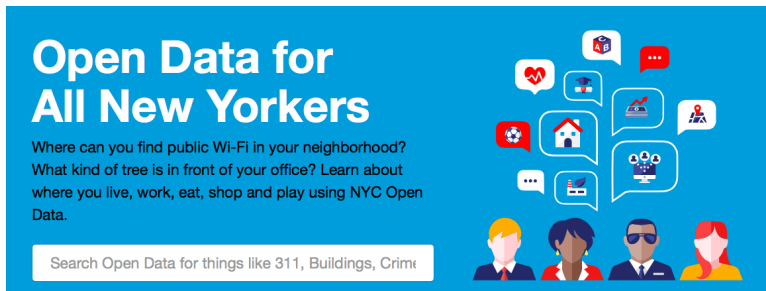
Where can you find public Wi-Fi in your neighborhood?
What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

Search Open Data for things like 311, Buildings, Crime

The banner features a blue background with white text. On the right side, there are several speech bubbles containing icons: a heart with a pulse line, a graduation cap, a bar chart with an upward arrow, a location pin, a house, a soccer ball, a factory, and a group of people. Below the speech bubbles are four stylized human figures with different skin tones and hairstyles.

- Freely available source of data.
- Maintained by the NYC data analytics team.
- We will use several different ones for this class.

Accessing Structured Data: NYC Open Data



Open Data for All New Yorkers

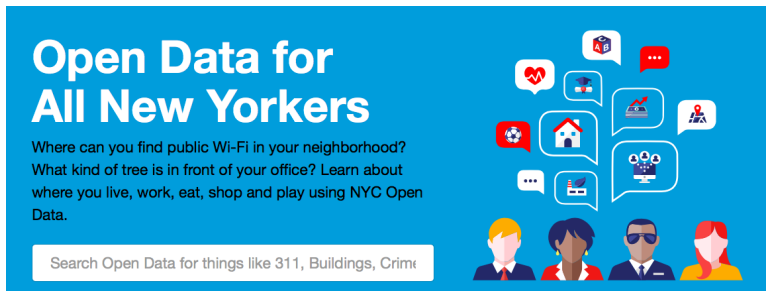
Where can you find public Wi-Fi in your neighborhood?
What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

Search Open Data for things like 311, Buildings, Crime

The banner features a blue background with white text. On the right side, there are several speech bubbles containing icons representing various data categories: a heart with a pulse line, a graduation cap, a bar chart with an upward arrow, a location pin, a house, a soccer ball, a factory, and a group of people. Below the speech bubbles are four stylized human figures with different hair colors and outfits.

- Freely available source of data.
- Maintained by the NYC data analytics team.
- We will use several different ones for this class.
- Will use pandas, pyplot & folium libraries to analyze, visualize and map the data.

Accessing Structured Data: NYC Open Data



Open Data for All New Yorkers

Where can you find public Wi-Fi in your neighborhood?
What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

Search Open Data for things like 311, Buildings, Crime

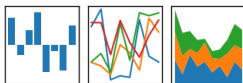
The graphic features a blue background with white text. Below the title, there are two lines of text asking questions about finding public Wi-Fi and learning about the neighborhood. Below this is a search bar with the text "Search Open Data for things like 311, Buildings, Crime". To the right of the search bar, there are several speech bubbles containing icons representing different data categories: a heart with a pulse line, a graduation cap, a bar chart with an upward arrow, a location pin, a house, a soccer ball, a factory, and a group of people. At the bottom right, there are four stylized human figures in different colors (yellow, blue, black, and red) representing diverse New Yorkers.

- Freely available source of data.
- Maintained by the NYC data analytics team.
- We will use several different ones for this class.
- Will use pandas, pyplot & folium libraries to analyze, visualize and map the data.
- Lab 7 covers accessing and downloading NYC OpenData datasets.

Structured Data

pandas

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

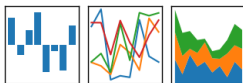


- Common to have data structured in a spread sheet.

Structured Data

pandas

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

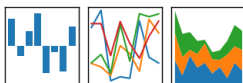


- Common to have data structured in a spread sheet.
- The text file version is called **CSV** for comma separated values.

Structured Data

pandas

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

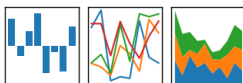


- Common to have data structured in a spread sheet.
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- Each row is a line; columns are separated by commas.

Structured Data

pandas

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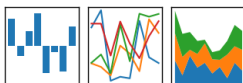


- Common to have data structured in a spread sheet.
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- We will use the popular Python Data Analysis Library (**Pandas**).

Structured Data

pandas

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



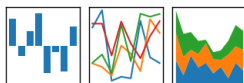
- Common to have data structured in a spread sheet.
- The text file version is called **CSV** for comma separated values.
- Each row is a line; columns are separated by commas.
- We will use the popular Python Data Analysis Library (**Pandas**).
- To use, add to the top of your file:

```
import pandas as pd
```

Structured Data

pandas

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



- Common to have data structured in a spread sheet.
- The text file version is called **CSV** for comma separated values.
- Each row is a line; columns are separated by commas.
- We will use the popular Python Data Analysis Library (**Pandas**).
- To use, add to the top of your file:

```
import pandas as pd
```

- To read in a CSV file:

```
myVar = pd.read_csv("myFile.csv")
```

Example: Reading in CSV Files

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island,Total
1698,4937,2017,,,727,7681
1771,21883,3623,,,2847,28423
1790,33131,45049,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,40203,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419801,45468,37393,33829,1470183
1880,1164673,599495,56559,51980,38991,1911690
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018264,469042,732034,116531,5420048
1930,1867312,2560461,1079129,1266558,159346,6906446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738075,1500849,1452277,191555,78931957
1960,1698281,2627319,1809578,1424815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7094862
1980,1428285,2230936,1801325,1168872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8006278
2010,1494873,2504760,2230722,1385108,448730,8175123
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

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

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,45449,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,40203,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419921,45468,37393,33829,1470193
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,3437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018264,469042,732018,116511,3420048
1930,1867312,2560461,1079129,1262558,159346,6930446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738275,1550849,1452277,291555,78991957
1960,1698281,2627319,1809578,1424815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1891325,1168872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8006278
2010,1494873,2504760,2230722,1385108,448730,8175123
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

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

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

```
Source: https://en.wikipedia.org/wiki/Demographics_of_New_York_City,,,,,
All population figures are consistent with present-day boundaries,,,,,,
First census after the consolidation of the five boroughs,,,,,,
,,,,,
,,,,,
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
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1771,21863,3623,,,2847,28423
1790,33131,45049,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,40203,7444,2267,5347,139734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419801,45468,37393,33829,1470183
1880,1164673,599495,56559,51980,38991,1911690
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018256,469042,732016,116511,5620048
1930,1867312,2560461,1079129,1265258,159346,6506446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738075,1500849,1451277,191555,78991957
1960,1698281,2627319,1809578,1624815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1801325,1168872,352121,7071639
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1648473,2504700,2230722,1385108,448730,81751523
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

Example: Reading in CSV Files

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

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

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

```
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island>Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,30131,4549,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,9303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,3344,10965,391114
1850,515547,138882,18593,8032,15061,696115
1860,813649,279122,32963,23593,25492,1174779
1870,942292,419921,45468,37393,33829,1470183
1880,1164673,599495,56559,51980,38991,1911698
1890,1441216,838547,87050,88908,51692,2507414
1900,1650093,1146582,152899,200507,67021,2437202
1910,2331542,1634351,284041,430980,85969,4766883
1920,2284103,2018256,469042,732016,116511,5620048
1930,1867312,2560461,1079129,1265258,159346,4590446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738075,1550849,1451277,191555,78991957
1960,1698281,2627319,1809578,1624815,221993,7781984
1970,1539233,2602012,1986473,1471701,295443,7894862
1980,1428285,2230936,1801325,1168872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1332650,443728,8008278
2010,1484873,2504700,2230722,1385108,448730,8175133
2015,1644518,2636735,2339150,1455444,476558,8550405
```

nycHistPop.csv

In Lab 6

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

Example: Reading in CSV Files

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

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

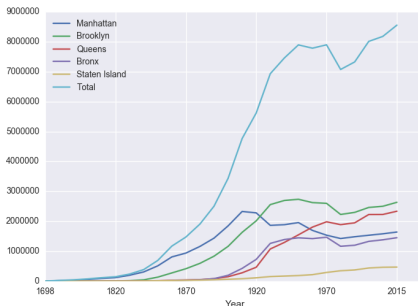
```
pop.plot(x="Year")
plt.show()
```

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

```
Year,Manhattan,Brooklyn,Queens,Bronx,Staten Island,Total
1698,4937,2017,,,727,7681
1771,21863,3623,,,2847,28423
1790,33131,4549,6159,1781,3827,49447
1800,40515,5740,6642,1755,4563,79215
1810,96373,9303,7444,2267,5347,119734
1820,123706,11187,8246,2782,6135,152056
1830,202589,20535,9049,3023,7082,242278
1840,312710,47613,14480,5344,10965,391114
1850,515547,138882,18593,8032,15061,696115
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1890,1441216,838547,87050,88908,51692,2507414
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1910,2331542,1634351,284041,430989,85969,4766883
1920,2284193,2018256,469042,732016,116511,5620048
1930,1867312,2560461,1079129,1265598,159346,6906446
1940,1889924,2698285,1297634,1394711,174441,7454995
1950,1940101,2738275,1505049,1452177,291559,7892957
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1980,1428285,2230936,1801325,1164872,352121,7071439
1990,1487536,2300644,1951598,1203789,378977,7322564
2000,1537195,2465326,2229379,1326450,443728,8006278
2010,1484873,2504760,2230722,1385108,468730,8175133
2015,1644518,2636735,2339155,1455444,476558,8550405
```

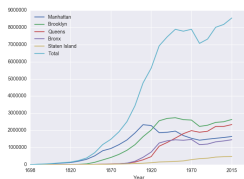
nycHistPop.csv

In Lab 6

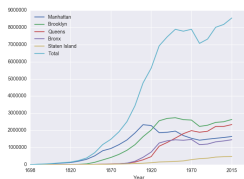


Series in Pandas

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

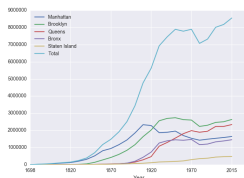


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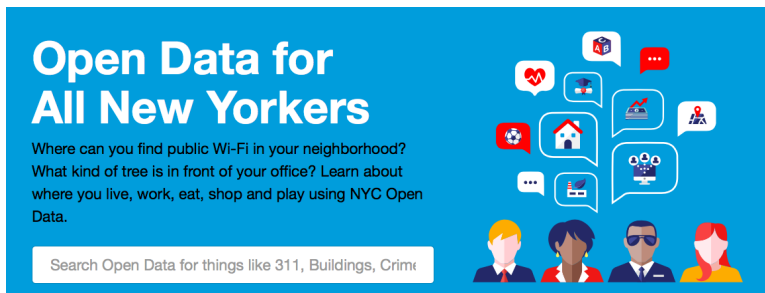
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- Example:

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

CS Survey: Mitsue Iwata, Data Analytics



Open Data for All New Yorkers

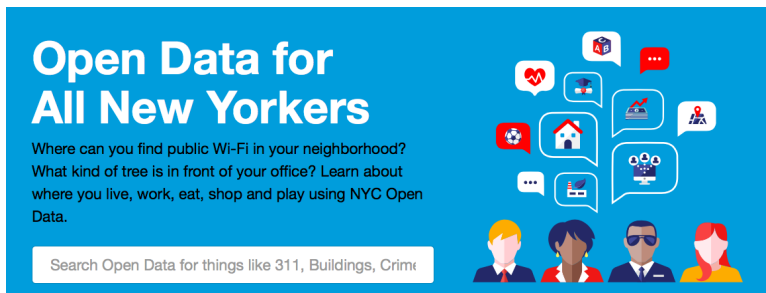
Where can you find public Wi-Fi in your neighborhood?
What kind of tree is in front of your office? Learn about where you live, work, eat, shop and play using NYC Open Data.

Search Open Data for things like 311, Buildings, Crime

The banner features a blue background with white text. On the right side, there are several speech bubbles containing icons: a heart with a pulse line, a graduation cap, a red speech bubble with three dots, a soccer ball, a house, a bar chart with an upward arrow, a location pin, a factory, and a group of people. Below the speech bubbles are four stylized human figures with different hair colors and styles.

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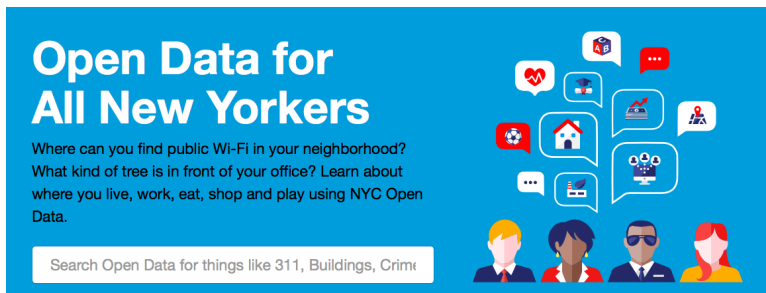
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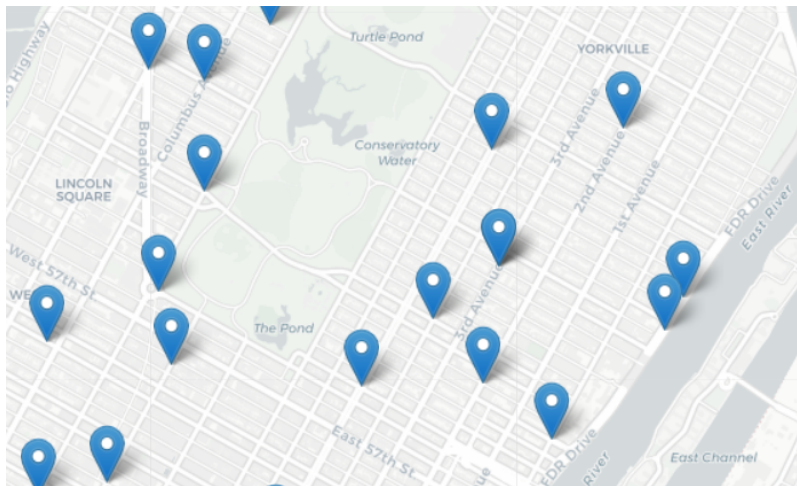
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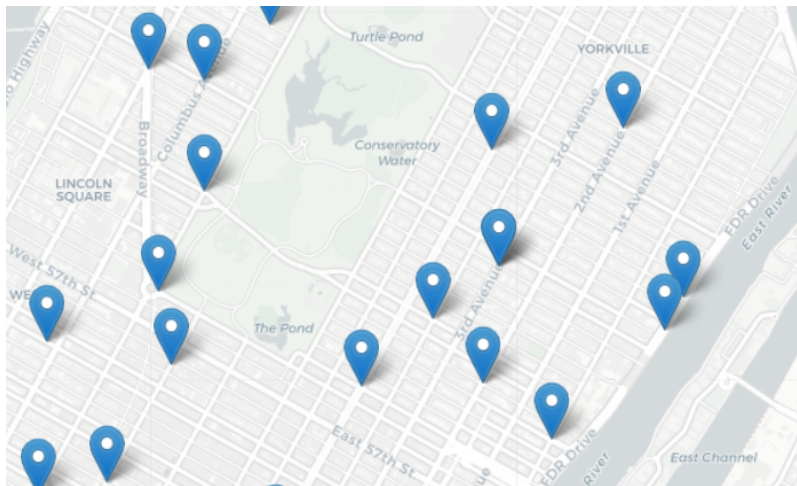
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(Design only the pseudocode.)

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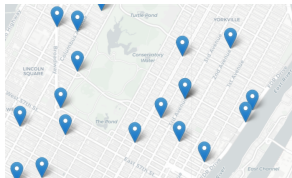
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Recap

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



Recap



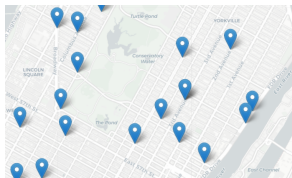
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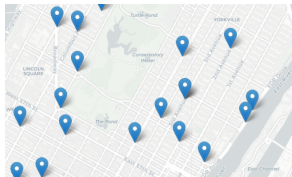
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- Accessing Formatted Data: NYC OpenData