STATISTICAL THINKING IN PYTHON I

Introduction to Exploratory Data Analysis

Exploratory data analysis

- The process of organizing, plotting, and summarizing a data set

“Exploratory data analysis can never be the whole story, but nothing else can serve as the foundation stone.”

—John Tukey

2008 US swing state election results

2008_swing_states.csv

```
state,county,total_votes,dem_votes,rep_votes,dem_share
PA,Erie County,127691,75775,50351,60.08
PA,Bradford County,25787,10306,15057,40.64
PA,Tioga County,17984,6390,11326,36.07
PA,McKean County,15947,6465,9224,41.21
PA,Potter County,7507,2300,5109,31.04
PA,Wayne County,22835,9892,12702,43.78
PA,Susquehanna County,19286,8381,10633,44.08
PA,Warren County,18517,8537,9685,46.85
OH,Ashtabula County,44874,25027,18949,56.94
OH,Lake County,121335,60155,59142,50.46
PA,Crawford County,38134,16780,20750,44.71
OH,Lucas County,219830,142852,73706,65.99
OH,Fulton County,21973,9900,11689,45.88
OH,Geauga County,51102,21250,29096,42.23
OH,Williams County,18397,8174,9880,45.26
PA,Wyoming County,13138,5985,6983,46.15
PA,Lackawanna County,107876,67520,39488,63.10
PA,Elk County,14271,7290,6676,52.20
PA,Forest County,2444,1038,1366,43.18
PA,Venango County,23307,9238,13718,40.24
OH,Erie County,41229,23148,17432,57.01
```

Data retrieved from Data.gov (https://www.data.gov/)

2008 US swing state election results

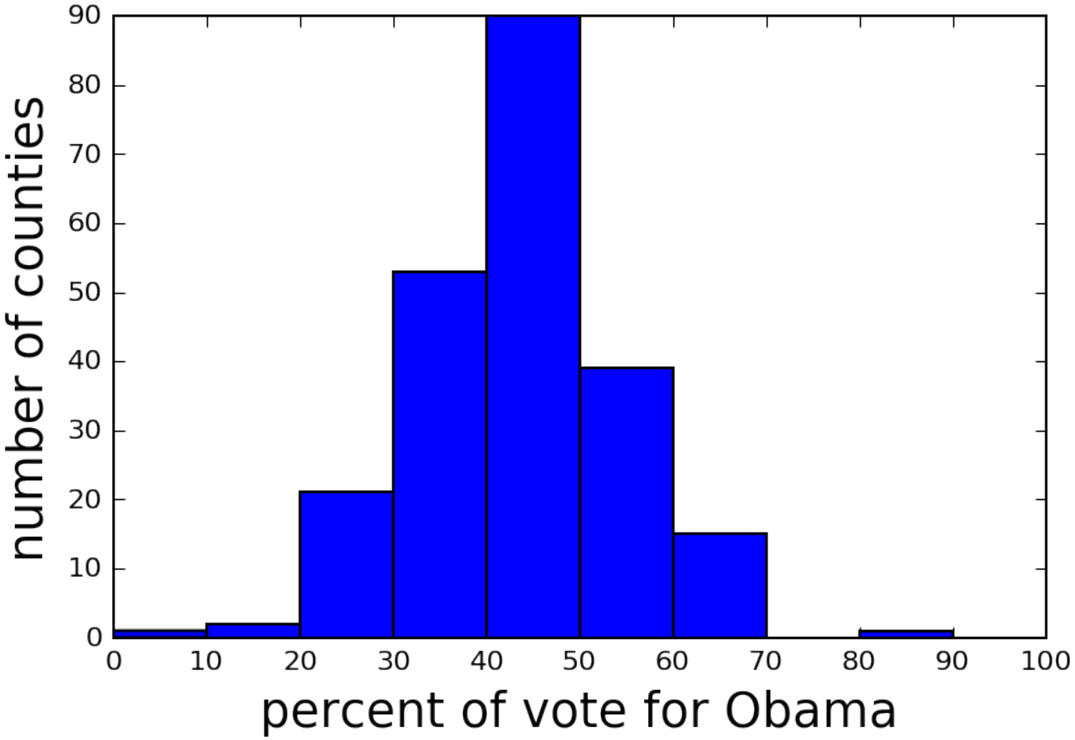
```
In [1]: import pandas as pd

In [2]: df_swing = pd.read_csv('2008_swing_states.csv')

In [3]: df_swing[['state', 'county', 'dem_share']]
Out[3]:
    state              county  dem_share
0      PA          Erie County      60.08
1      PA     Bradford County      40.64
2      PA        Tioga County      36.07
3      PA       McKean County      41.21
4      PA       Potter County      31.04
5      PA        Wayne County      43.78
6      PA  Susquehanna County      44.08
7      PA       Warren County      46.85
8      OH    Ashtabula County      56.94
```

Data retrieved from Data.gov (https://www.data.gov/)

2008 US swing state election results



Data retrieved from Data.gov (https://www.data.gov/)

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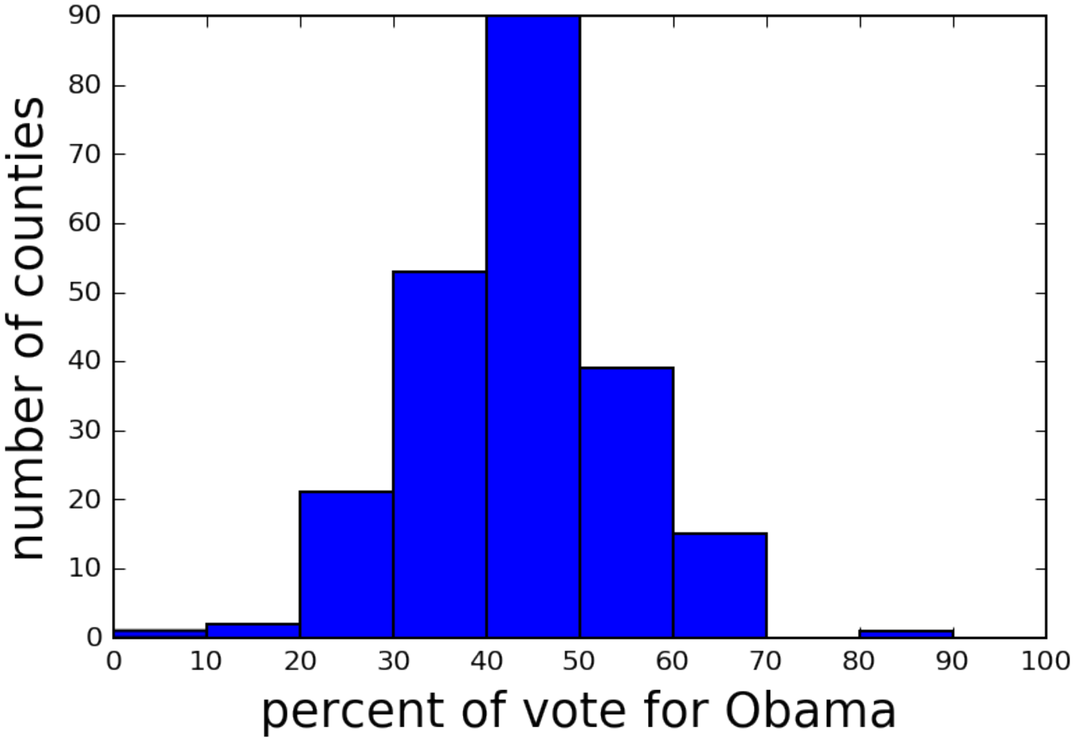
Let’s practice!

STATISTICAL THINKING IN PYTHON I

Plotting a histogram

2008 US swing state election results



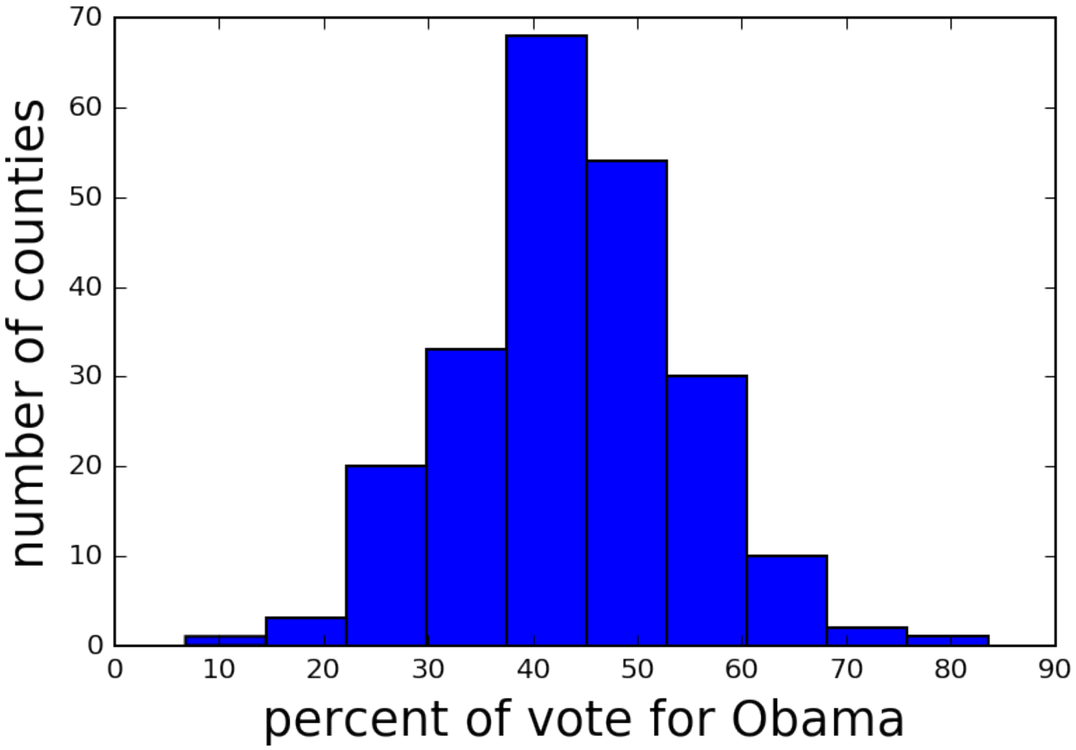
Data retrieved from Data.gov (https://www.data.gov/)

Generating a histogram

```
In [1]: import matplotlib.pyplot as plt

In [2]: _ = plt.hist(df_swing['dem_share'])

In [3]: _ = plt.xlabel('percent of vote for Obama')

In [4]: _ = plt.ylabel('number of counties')

In [5]: plt.show()
```

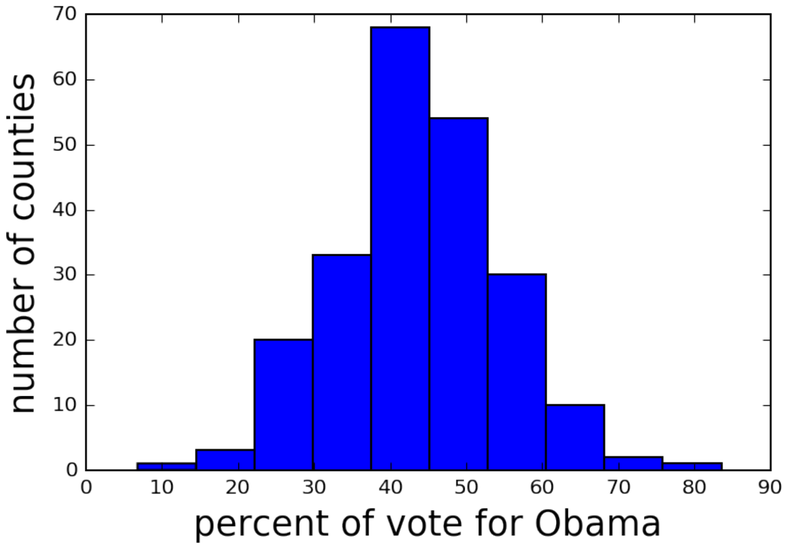
- Always label your axes

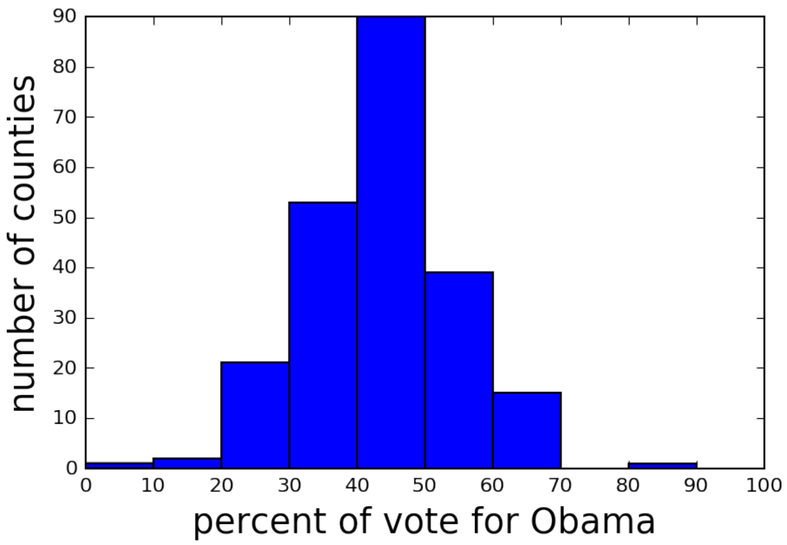
2008 US swing state election results



Data retrieved from Data.gov (https://www.data.gov/)

Histograms with different binning

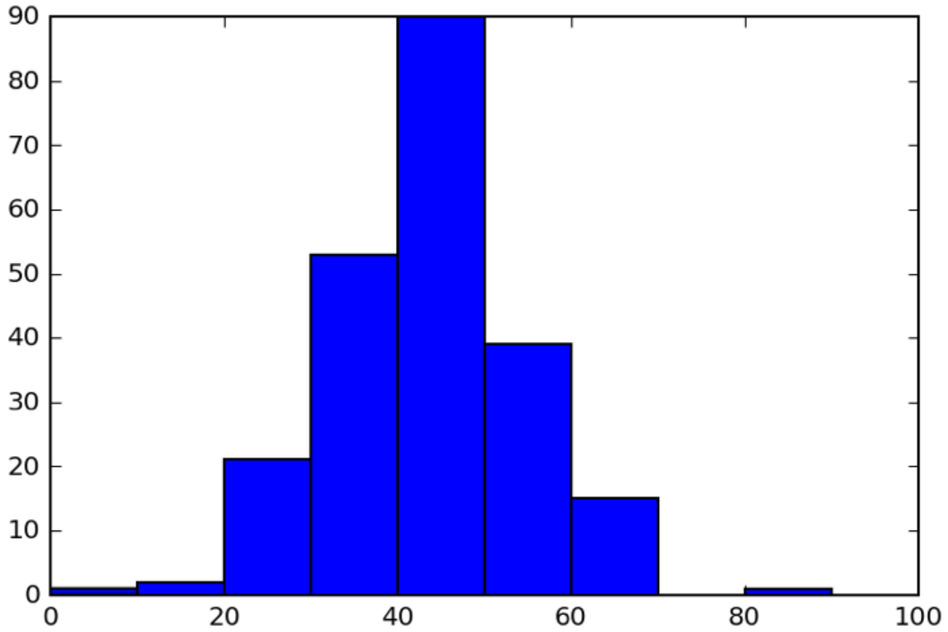




Data retrieved from Data.gov (https://www.data.gov/)

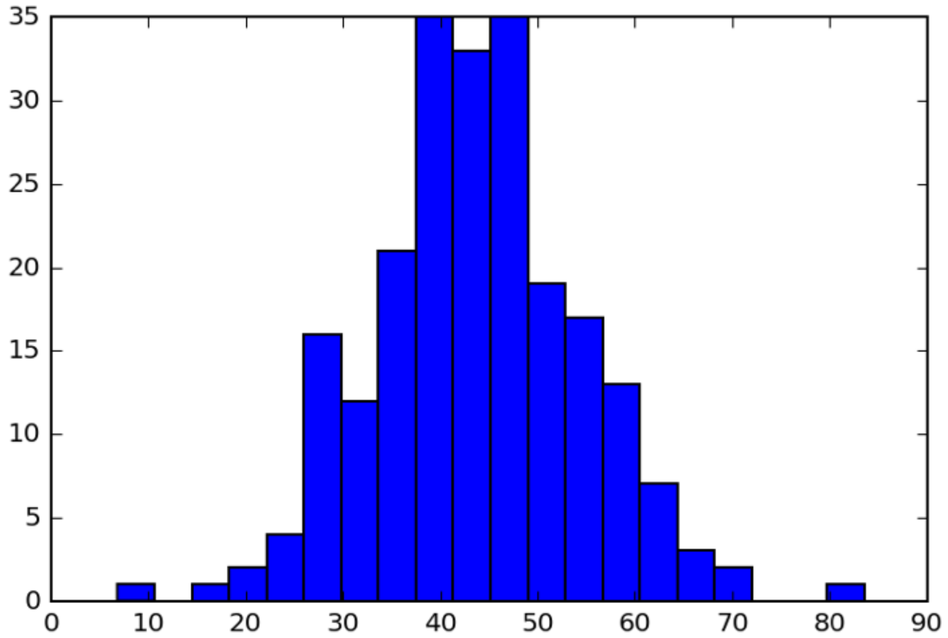
Setting the bins of a histogram

```
In [1]: bin_edges = [0, 10, 20, 30, 40, 50,
   ...:              60, 70, 80, 90, 100]

In [2]: _ = plt.hist(df_swing['dem_share'], bins=bin_edges)

In [3]: plt.show()
```



Setting the bins of a histogram

```
In [1]: _ = plt.hist(df_swing['dem_share'], bins=20)

In [2]: plt.show()
```



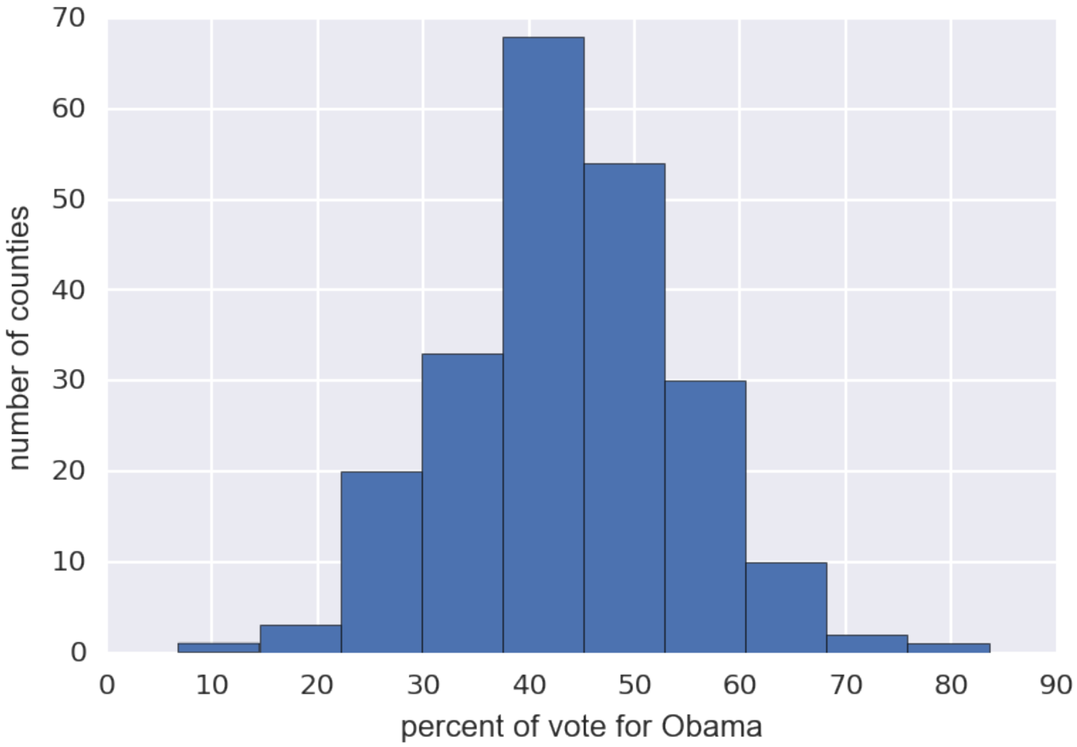
Seaborn

- An excellent Matplotlib-based statistical data visualization package written by Michael Waskom

Setting Seaborn styling

```
In [1]: import seaborn as sns

In [2]: sns.set()

In [3]: _ = plt.hist(df_swing['dem_share'])

In [4]: _ = plt.xlabel('percent of vote for Obama')

In [5]: _ = plt.ylabel('number of counties')

In [6]: plt.show()
```

A Seaborn-styled histogram



Data retrieved from Data.gov (https://www.data.gov/)

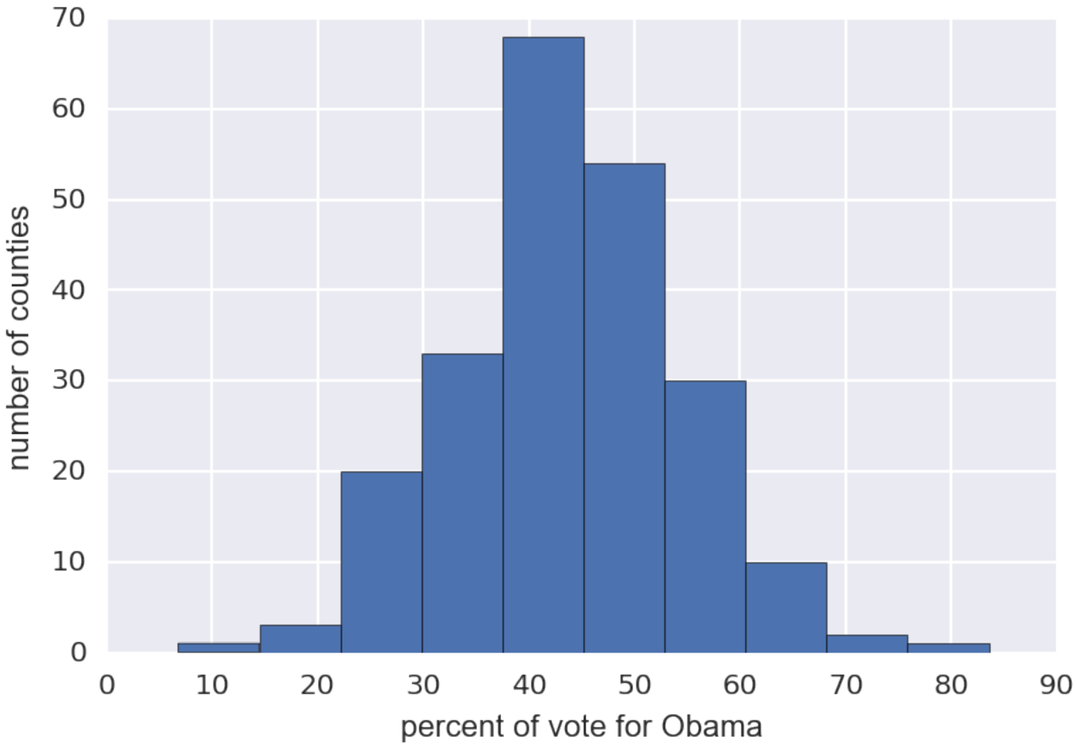
STATISTICAL THINKING IN PYTHON I

Let’s practice!

STATISTICAL THINKING IN PYTHON I

Plot all of your data: Bee swarm plots

2008 US swing state election results



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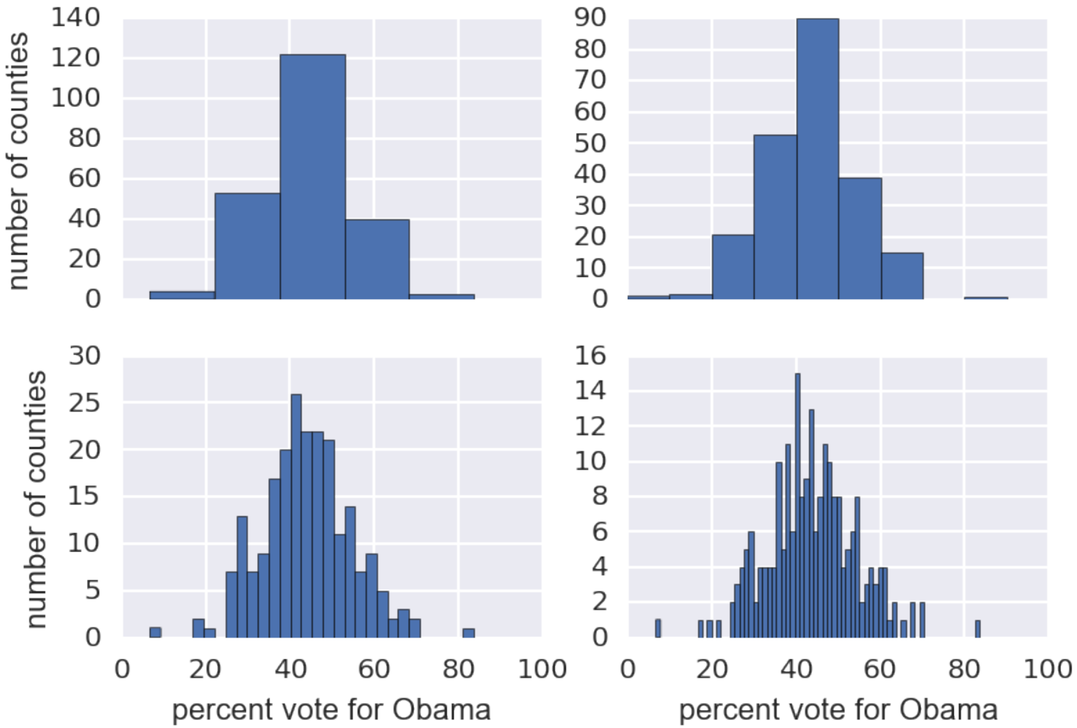
2008 US swing state election results

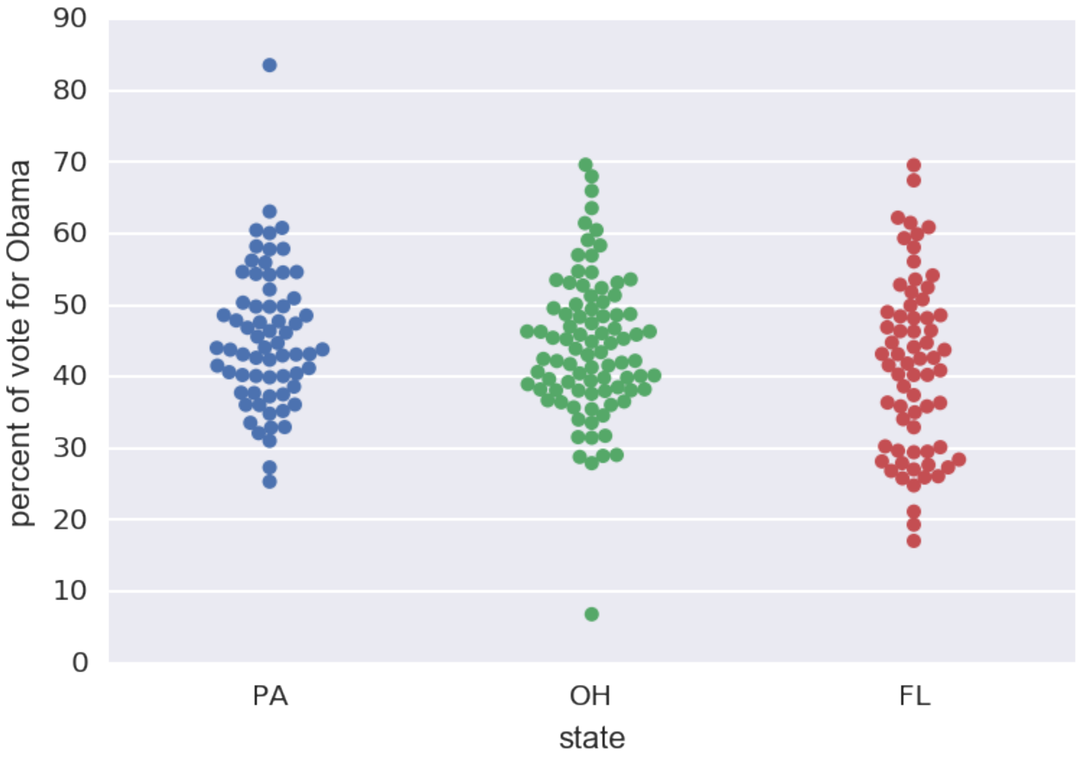


Data retrieved from Data.gov (https://www.data.gov/)

Binning bias

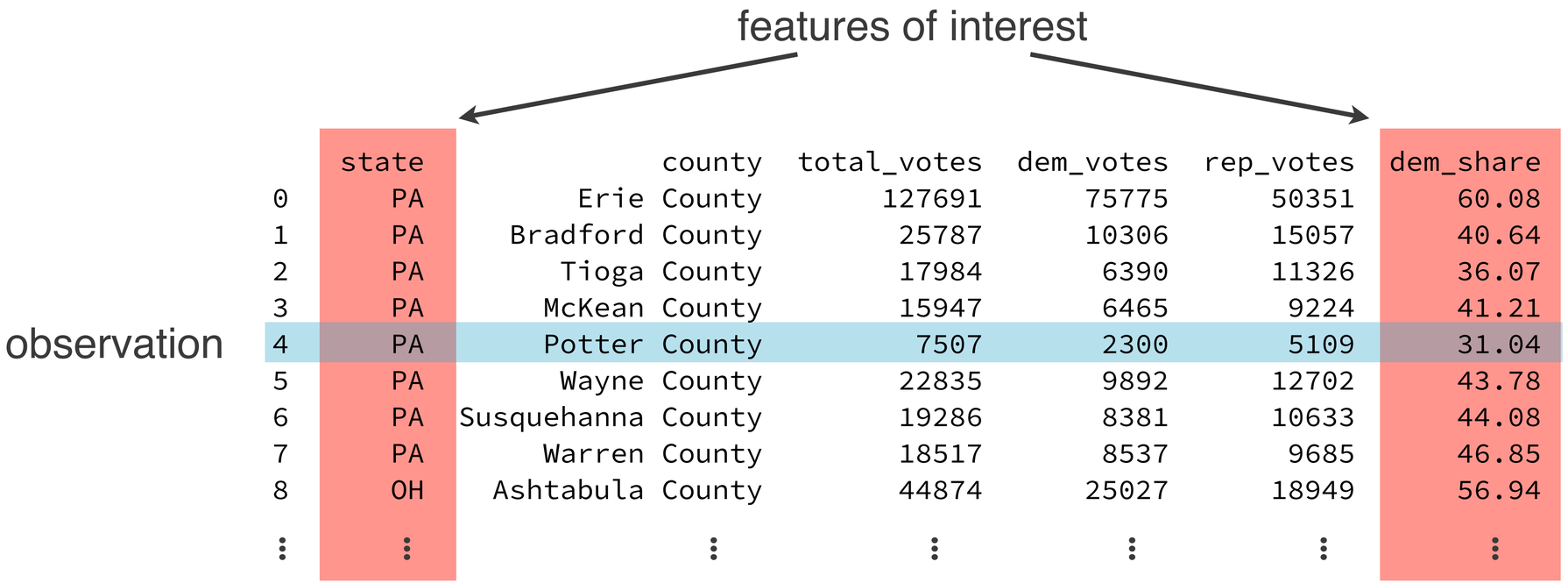
- The same data may be interpreted differently depending on choice of bins

Bee swarm plot



Data retrieved from Data.gov (https://www.data.gov/)

Organization of the data frame



	state	county	total_votes	dem_votes	rep_votes	dem_share
0	PA	Erie County	127691	75775	50351	60.08
1	PA	Bradford County	25787	10306	15057	40.64
2	PA	Tioga County	17984	6390	11326	36.07
3	PA	McKean County	15947	6465	9224	41.21
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7	PA	Warren County	18517	8537	9685	46.85
8	OH	Ashtabula County	44874	25027	18949	56.94
⋮	⋮	⋮	⋮	⋮	⋮	⋮

Data retrieved from Data.gov (https://www.data.gov/)

Generating a bee swarm plot

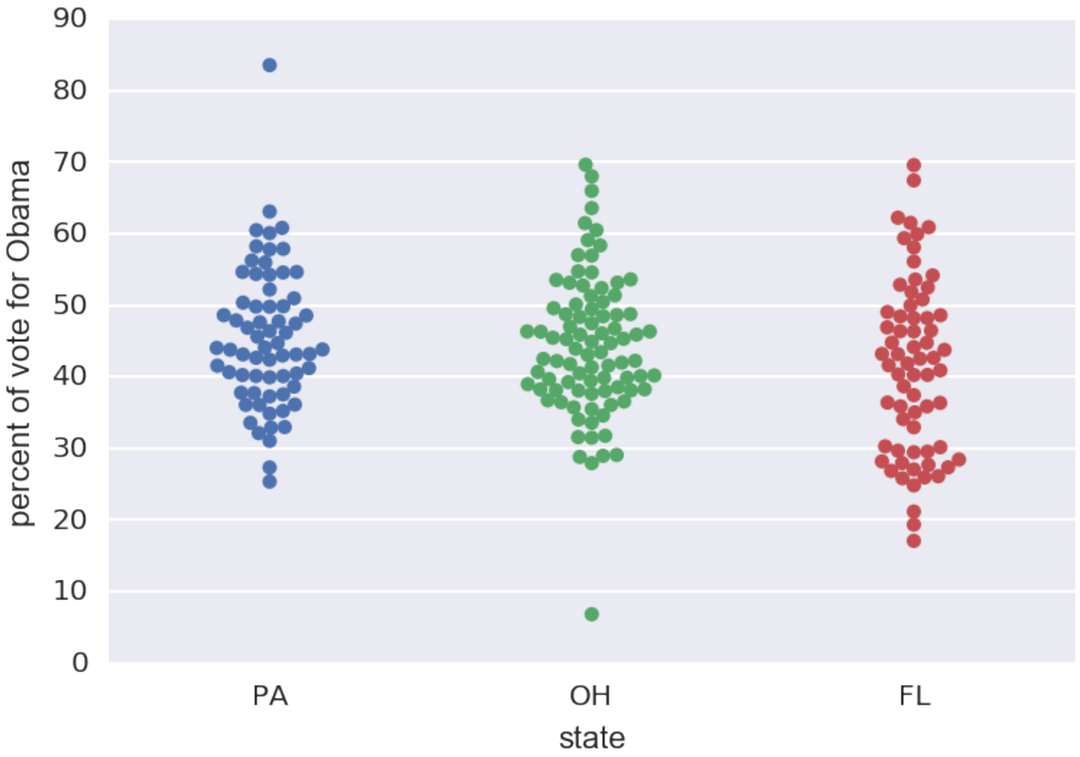
```
In [1]: _ = sns.swarmplot(x='state', y='dem_share', data=df_swing)

In [2]: _ = plt.xlabel('state')

In [3]: _ = plt.ylabel('percent of vote for Obama')

In [4]: plt.show()
```

2008 US swing state election results



Data retrieved from Data.gov (https://www.data.gov/)

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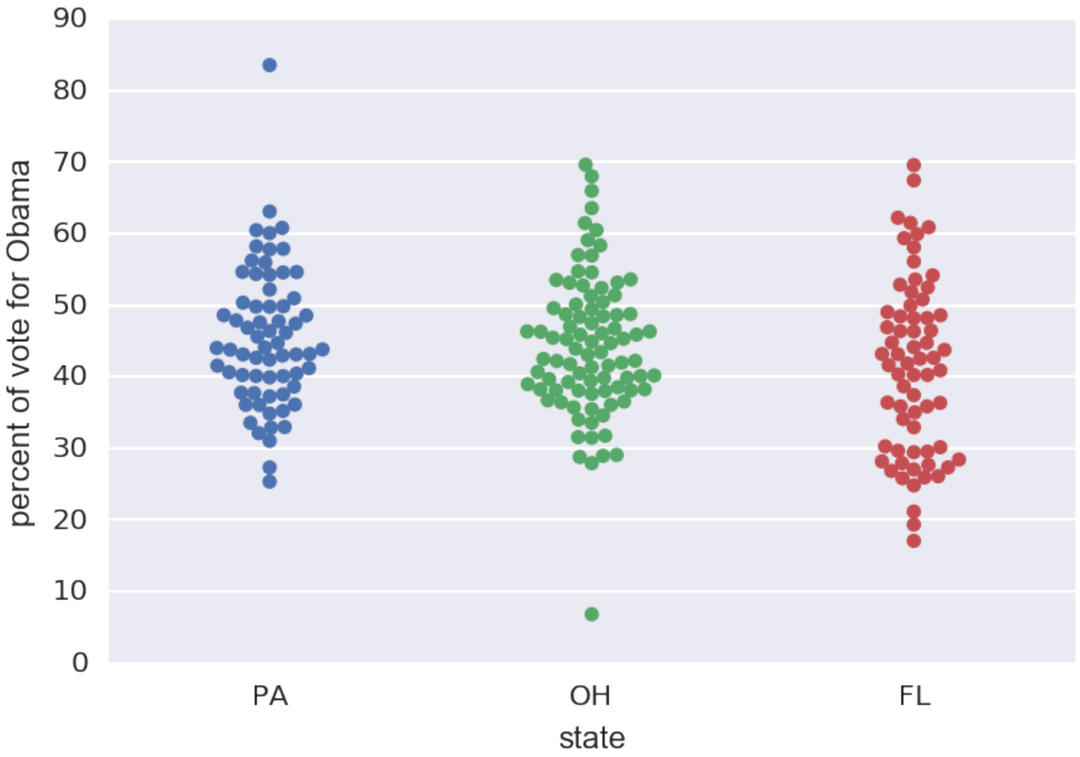
Let’s practice!

STATISTICAL THINKING IN PYTHON I

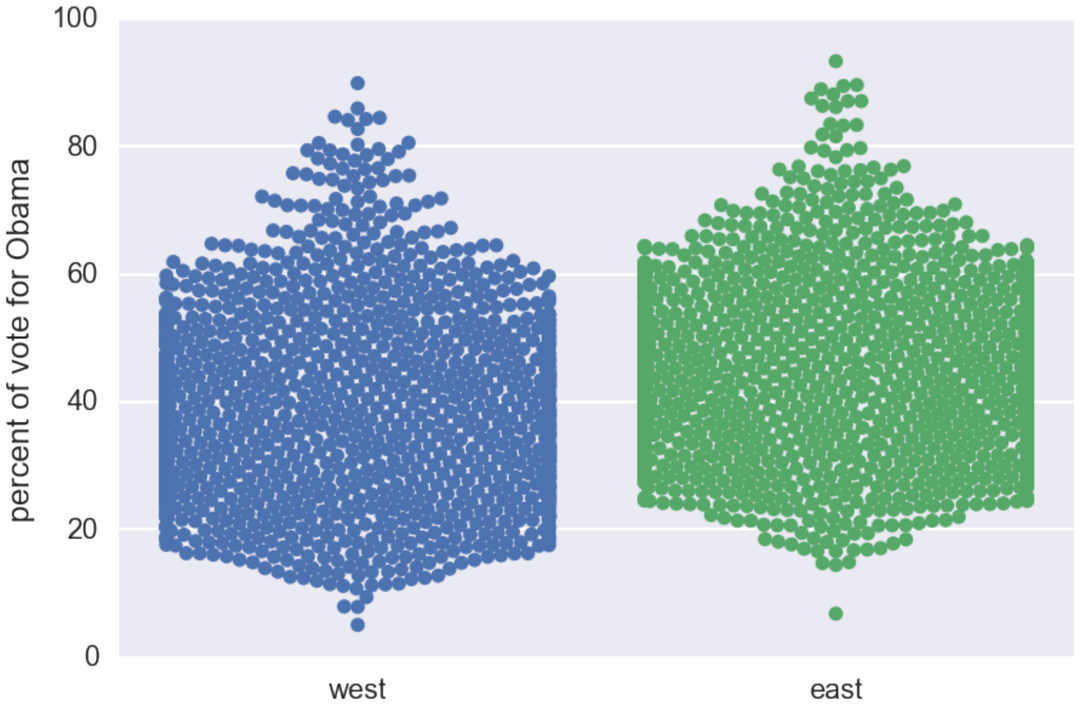
Plot all of your data: ECDFs

2008 US swing state election results



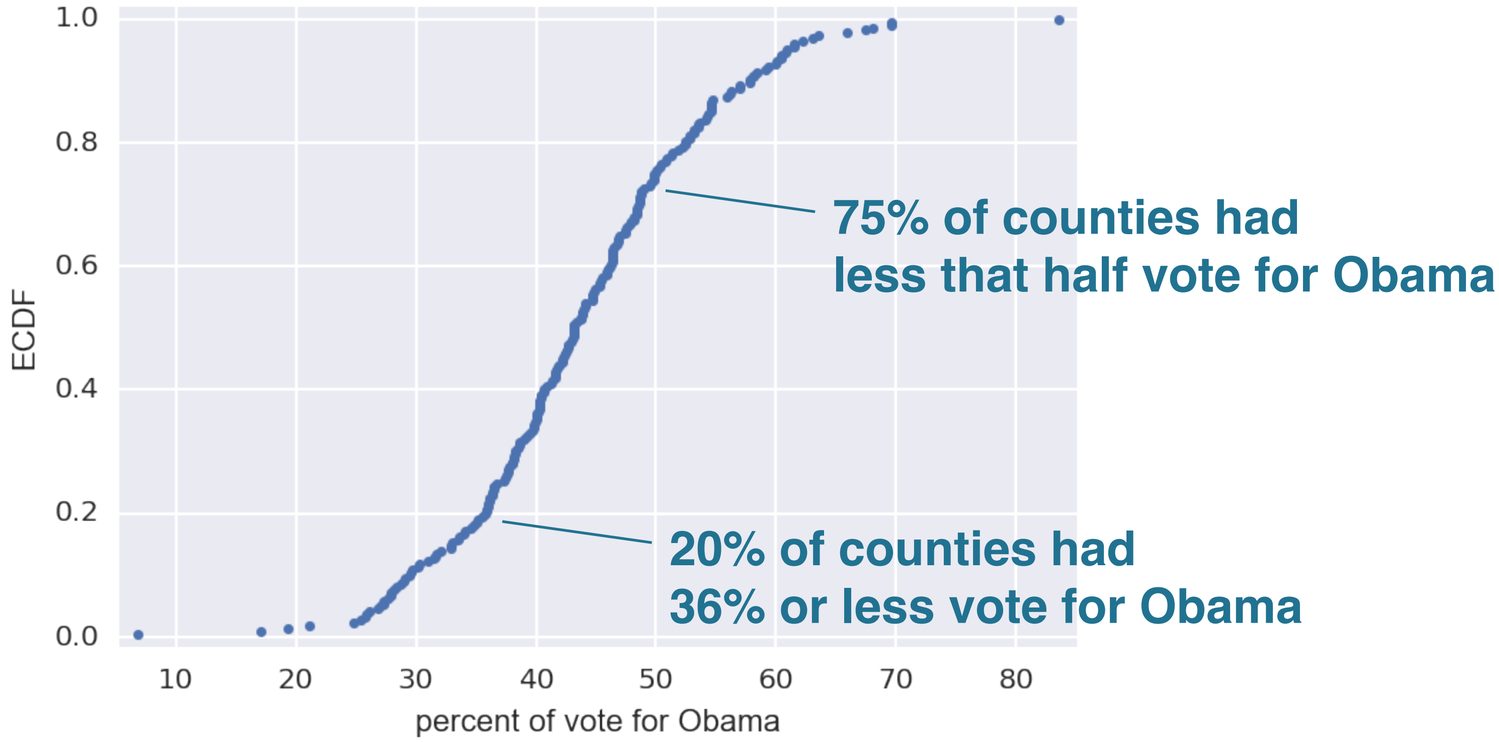
Data retrieved from Data.gov (https://www.data.gov/)

2008 US election results: East and West



Data retrieved from Data.gov (https://www.data.gov/)

Empirical cumulative distribution function (ECDF)

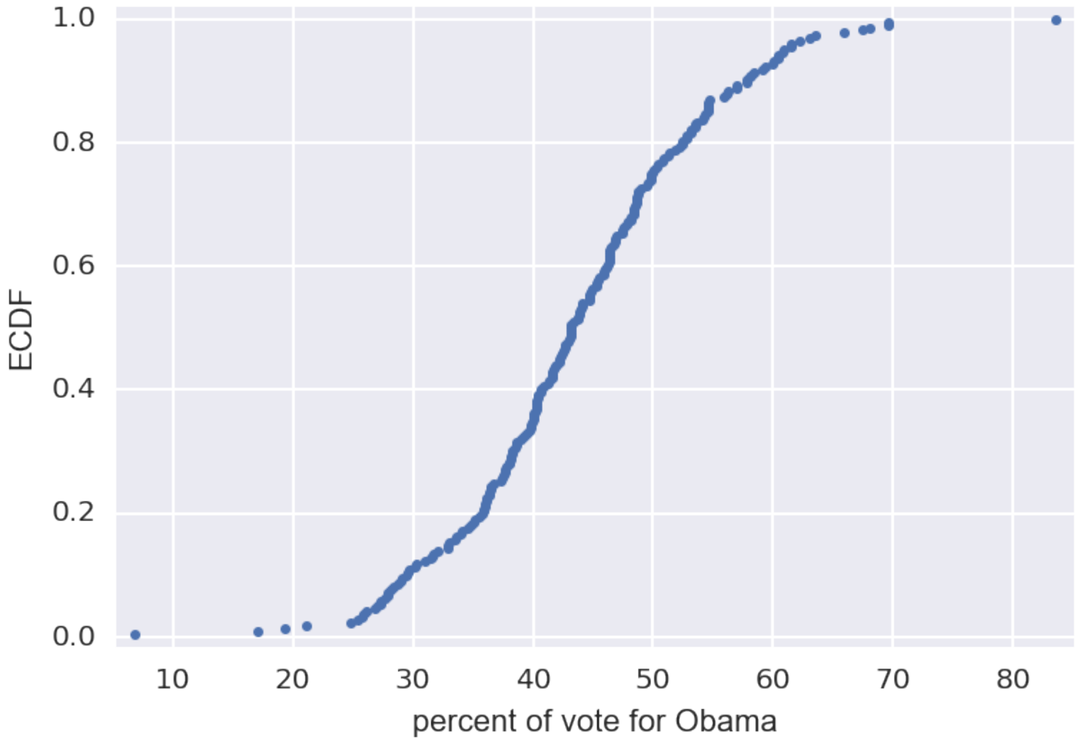


Data retrieved from Data.gov (https://www.data.gov/)

Making an ECDF

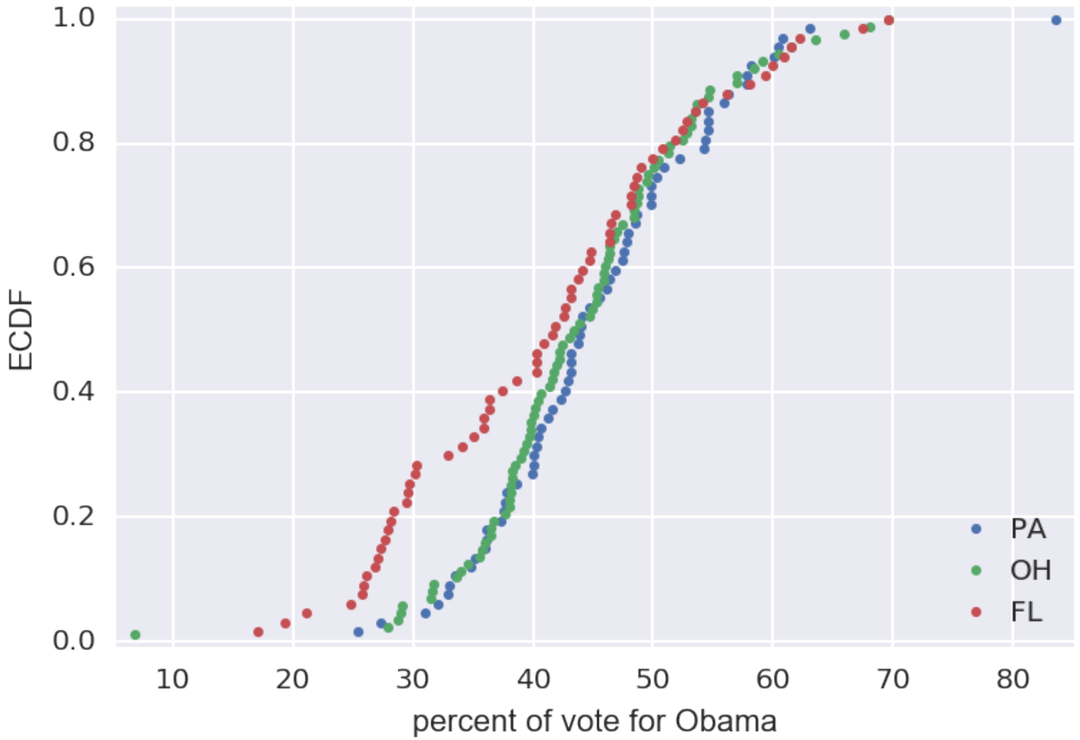
```
In [1]: import numpy as np

In [2]: x = np.sort(df_swing['dem_share'])

In [3]: y = np.arange(1, len(x)+1) / len(x)

In [4]: _ = plt.plot(x, y, marker='.', linestyle='none')

In [5]: _ = plt.xlabel('percent of vote for Obama')

In [6]: _ = plt.ylabel('ECDF')

In [7]: plt.margins(0.02) # Keeps data off plot edges

In [8]: plt.show()
```

2008 US swing state election ECDF



Data retrieved from Data.gov (https://www.data.gov/)

2008 US swing state election ECDFs



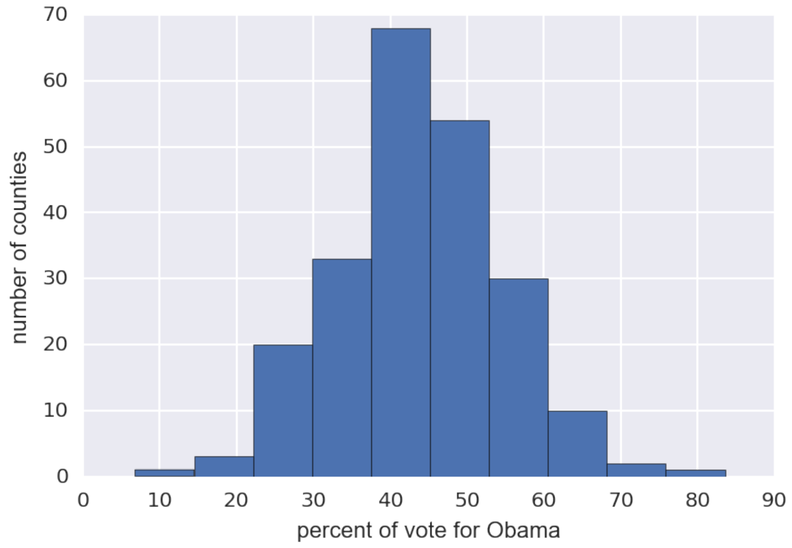
Data retrieved from Data.gov (https://www.data.gov/)

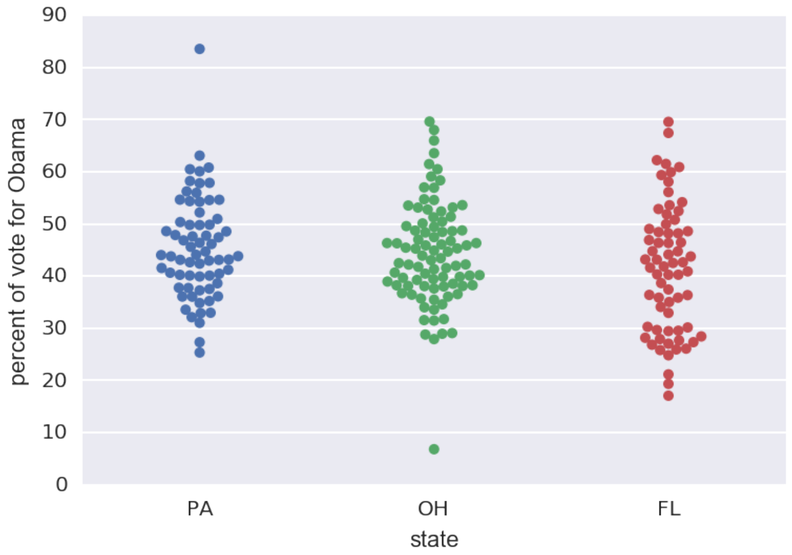
STATISTICAL THINKING IN PYTHON I

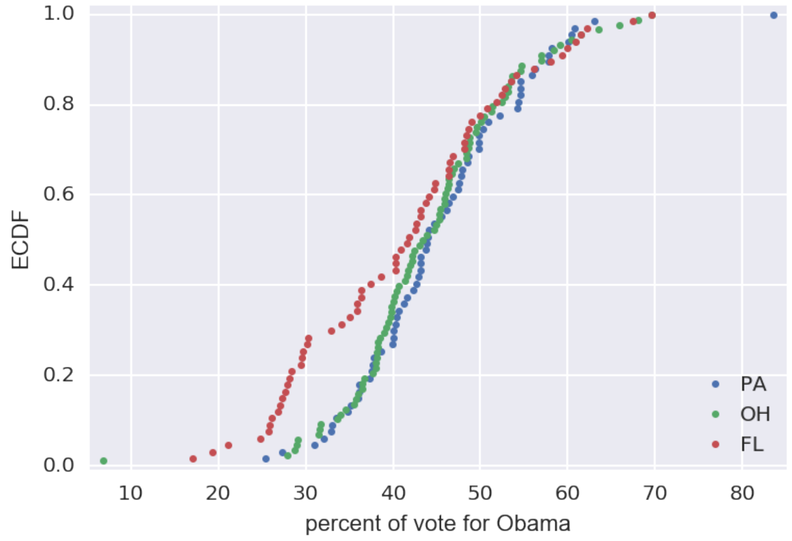
Let’s practice!

STATISTICAL THINKING IN PYTHON I

Onward toward the whole story!


number of counties
percent of vote for Obama
0
10
20
30
40
50
60
70
80
90


percent of vote for Obama
state
PA
OH
FL


ECDF
percent of vote for Obama
PA
OH
FL

“Exploratory data analysis can never be the whole story, but nothing else can serve as the foundation stone.”

—John Tukey

Coming up...

- Thinking probabilistically
- Discrete and continuous distributions
- The power of hacker statistics using `np.random()`

STATISTICAL THINKING IN PYTHON I

Let’s get to work!