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

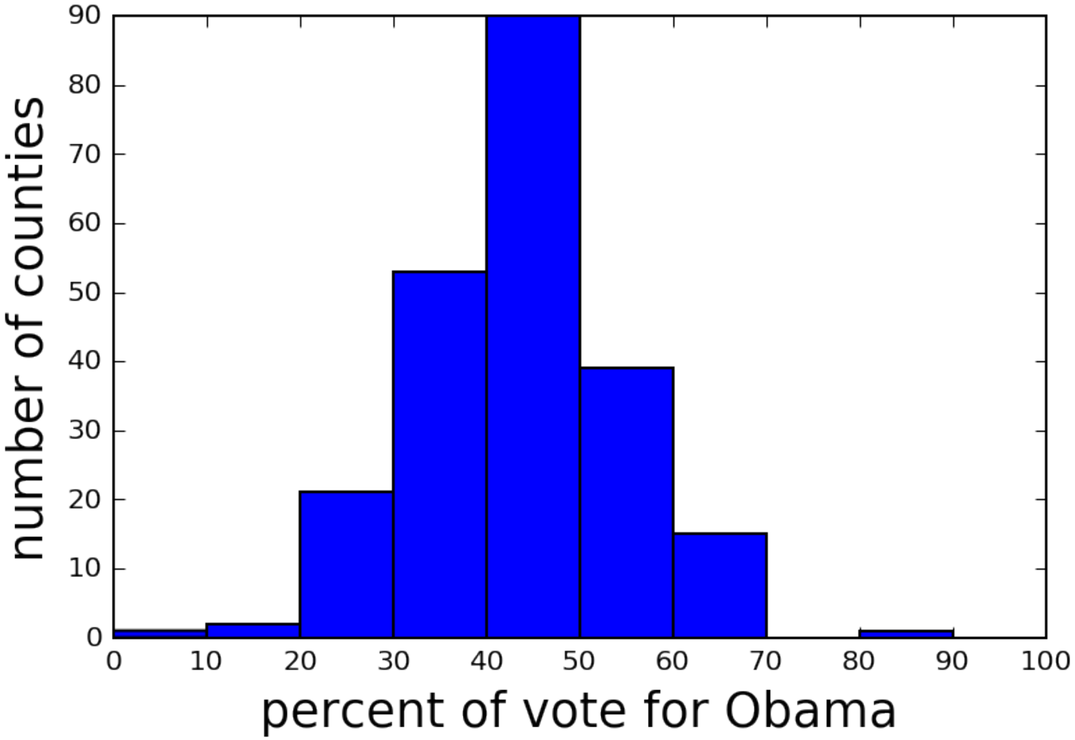
```
In [1]: import pandas as pd

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!

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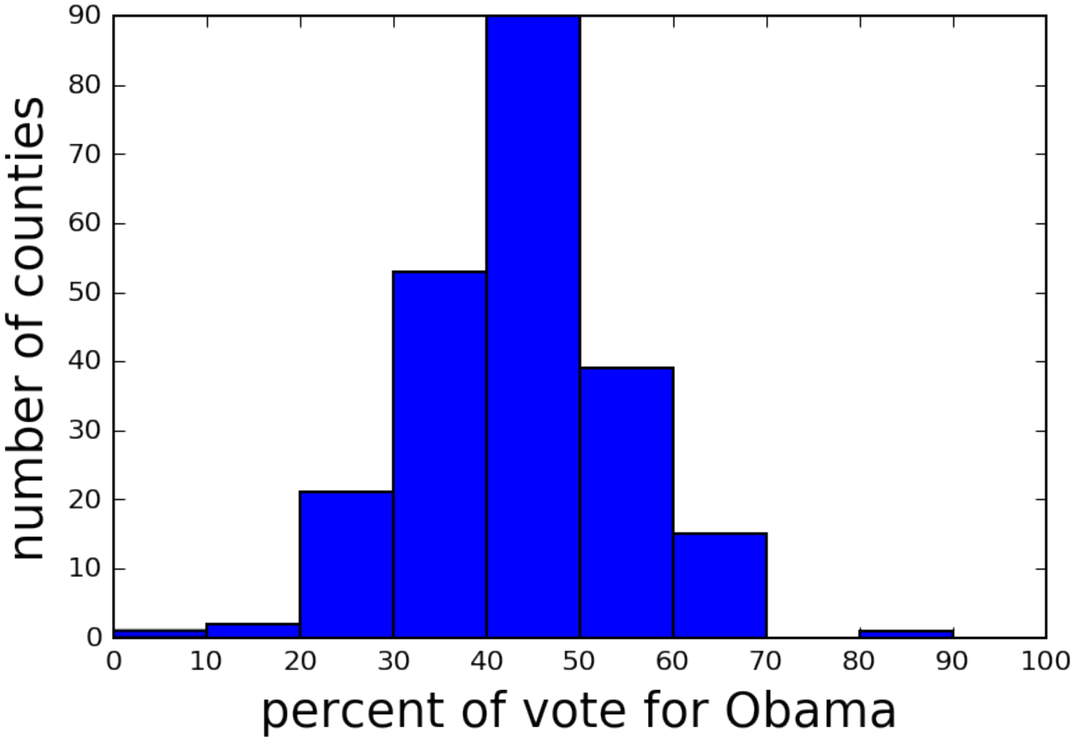
# Plotting a histogram

# 2008 US swing state election results



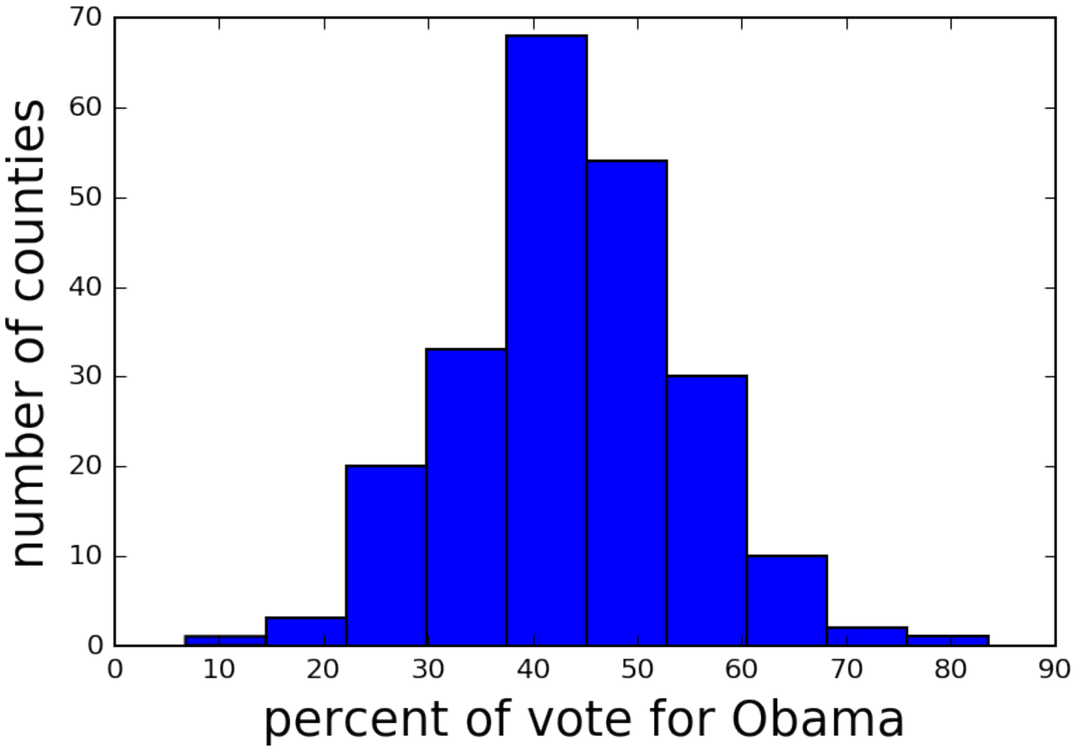

*Data retrieved from Data.gov (https://www.data.gov/)*

# 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()
```

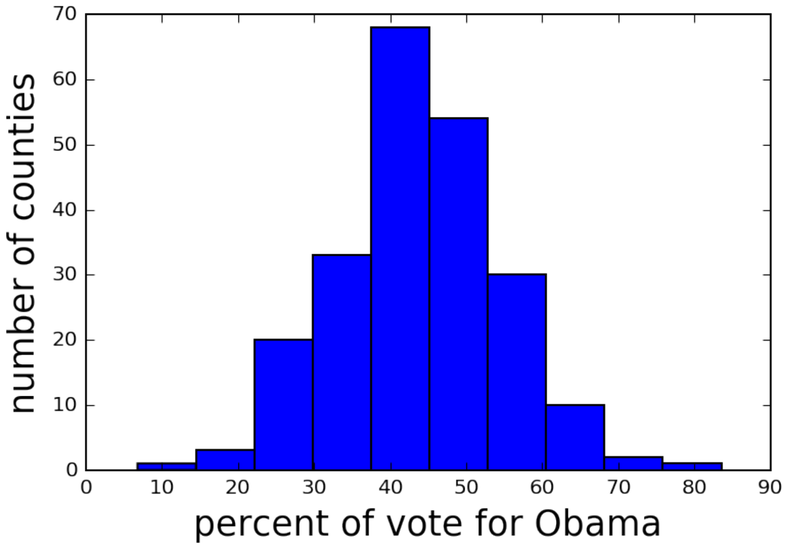
- Always label your axes

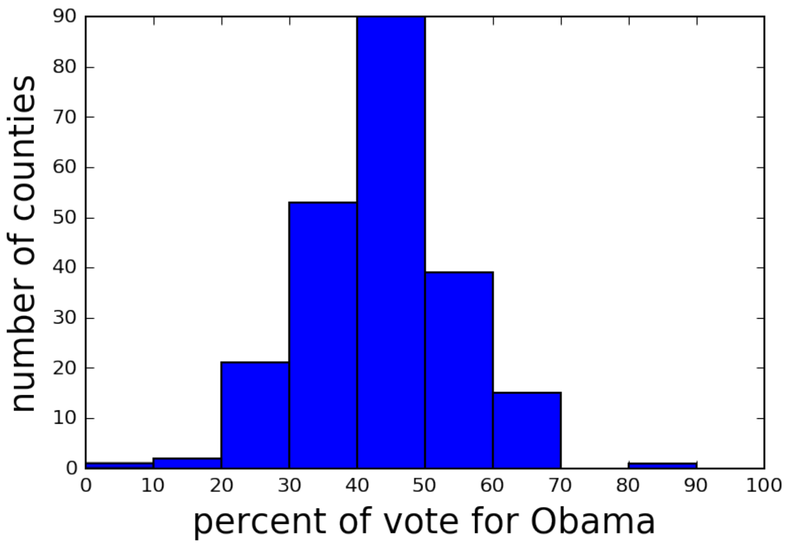
# 2008 US swing state election results




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

# Histograms with different binning

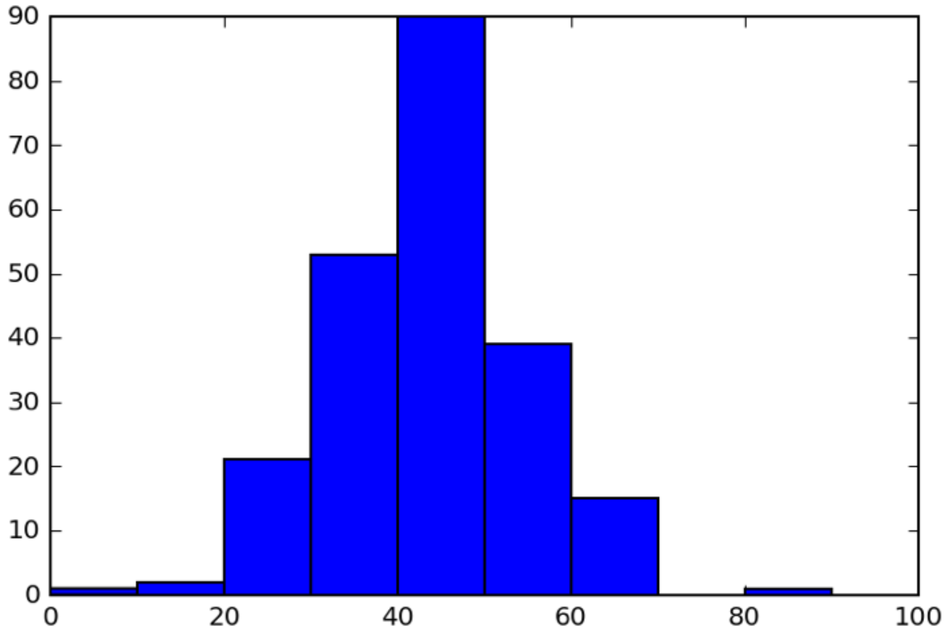



*Data retrieved from Data.gov (https://www.data.gov/)*

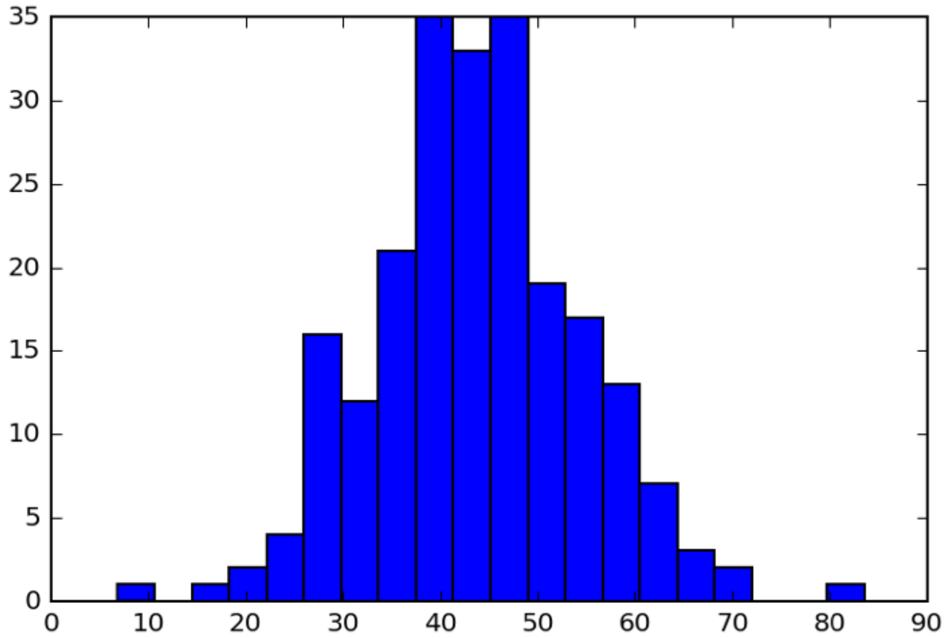
# Setting the bins of a histogram

```
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()
```



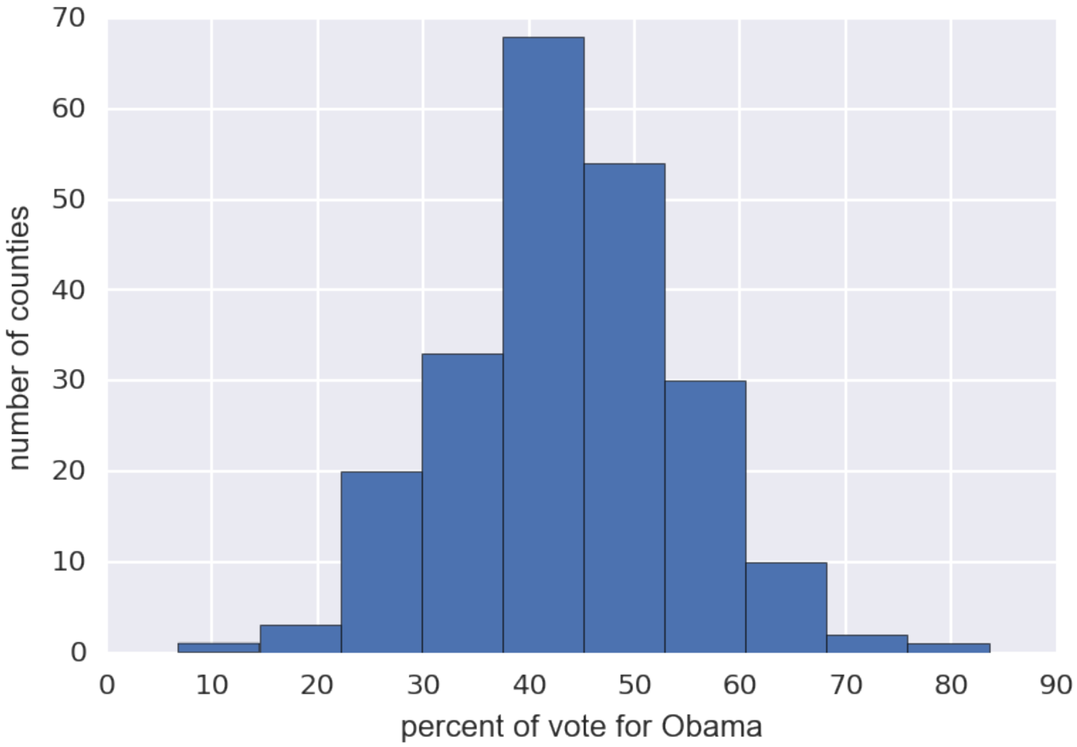
# Seaborn

- 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/)*

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# Let’s practice!

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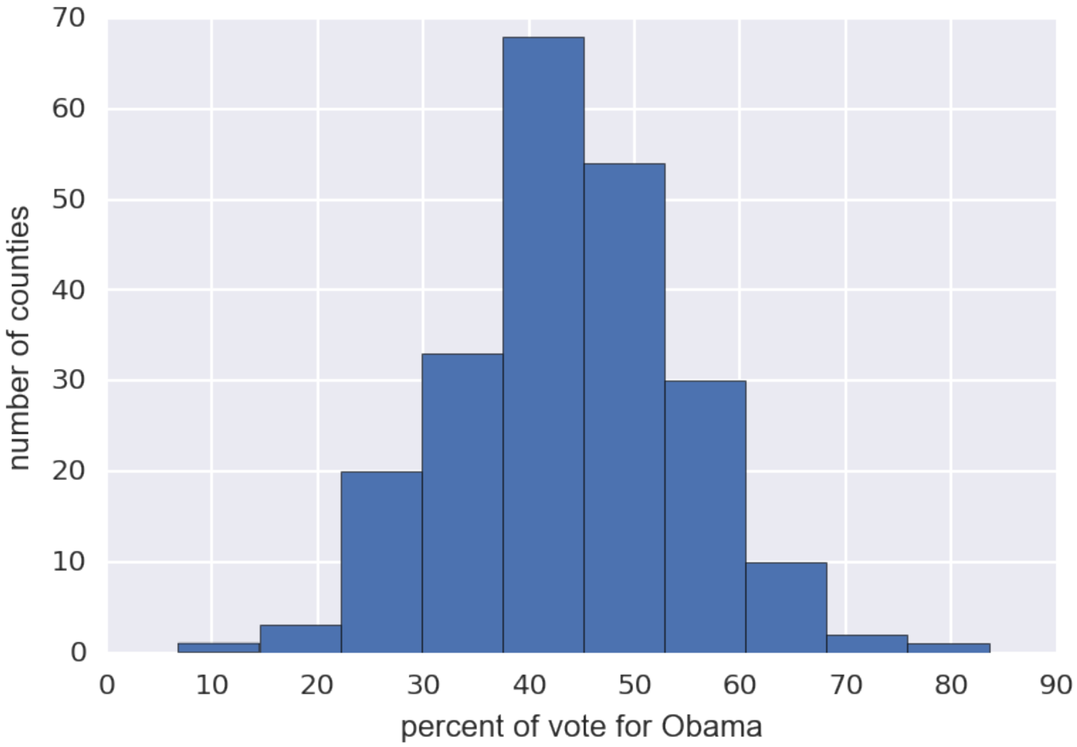
# Plot all of your data: Bee swarm plots

# 2008 US swing state election results

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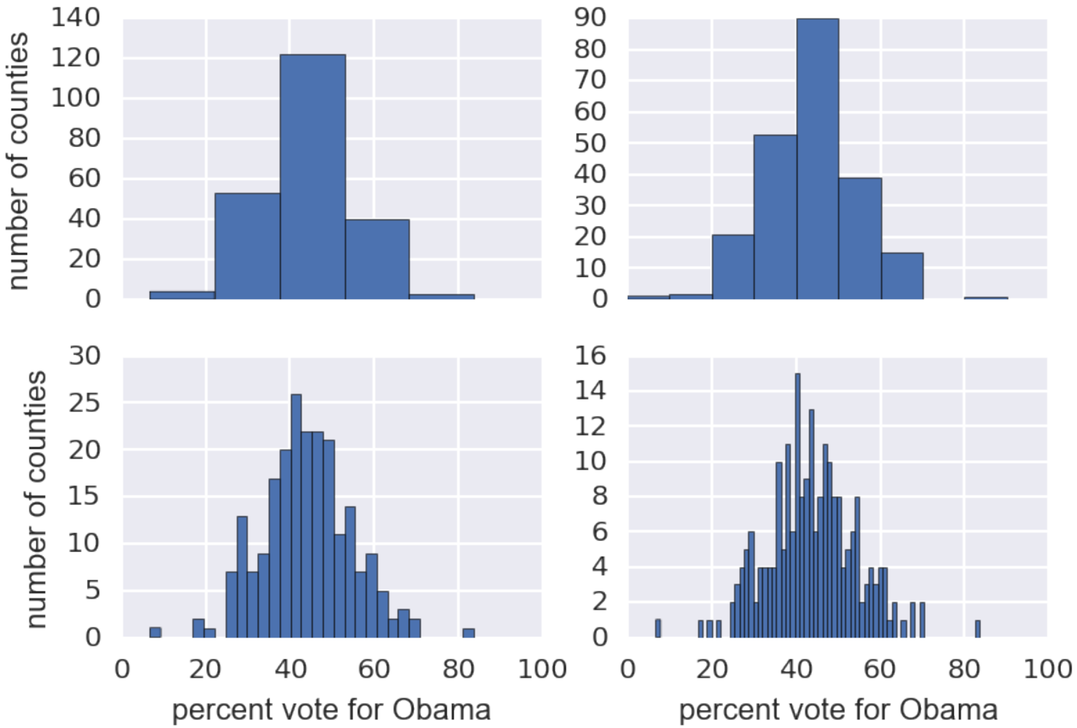
# 2008 US swing state election results

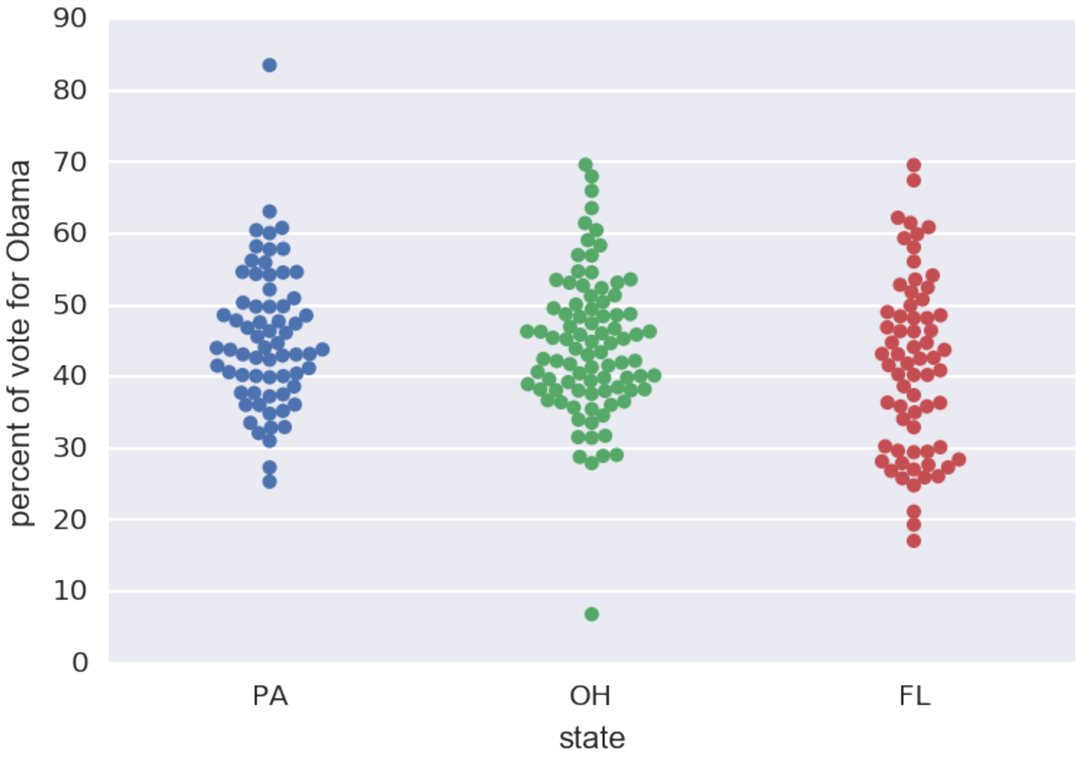



*Data retrieved from Data.gov (https://www.data.gov/)*

# Binning bias

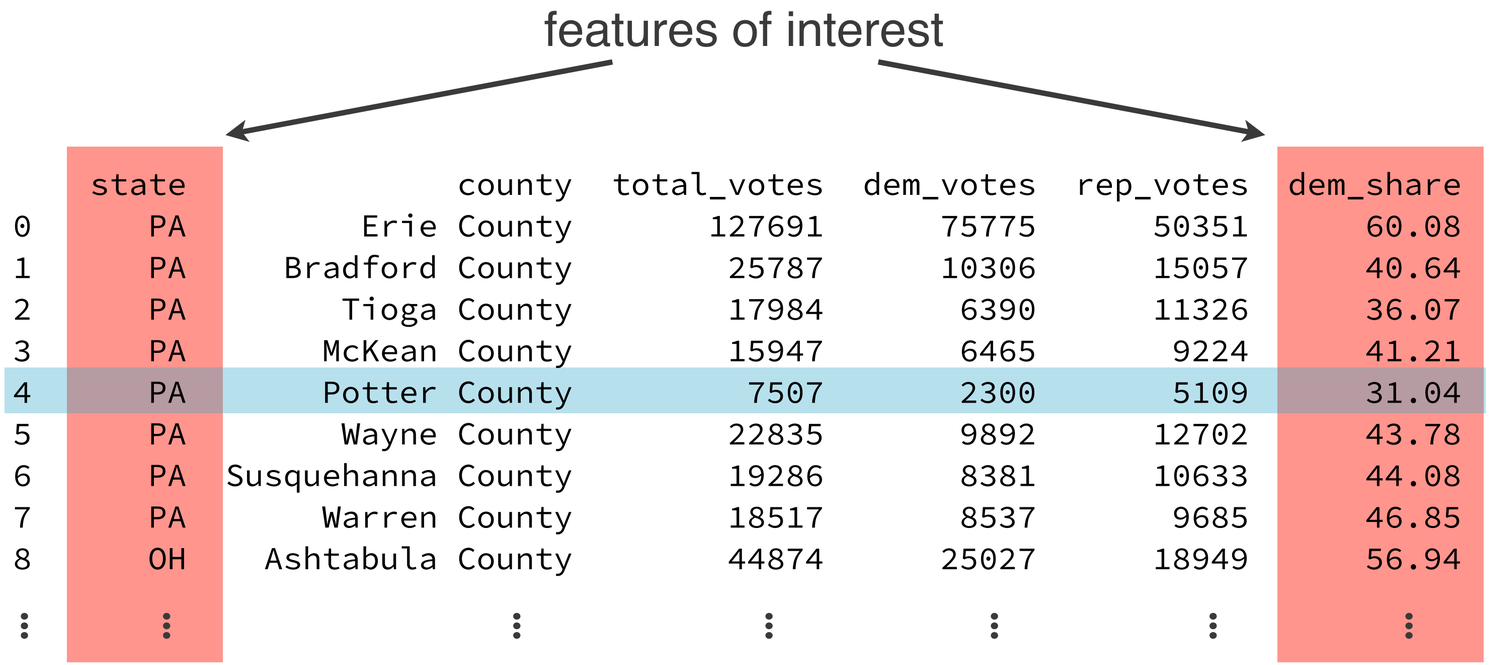
- The same data may be interpreted differently depending on choice of bins

# 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 |
| 4 | PA | Potter County | 7507 | 2300 | 5109 | 31.04 |
| 5 | PA | Wayne County | 22835 | 9892 | 12702 | 43.78 |
| 6 | PA | Susquehanna County | 19286 | 8381 | 10633 | 44.08 |
| 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

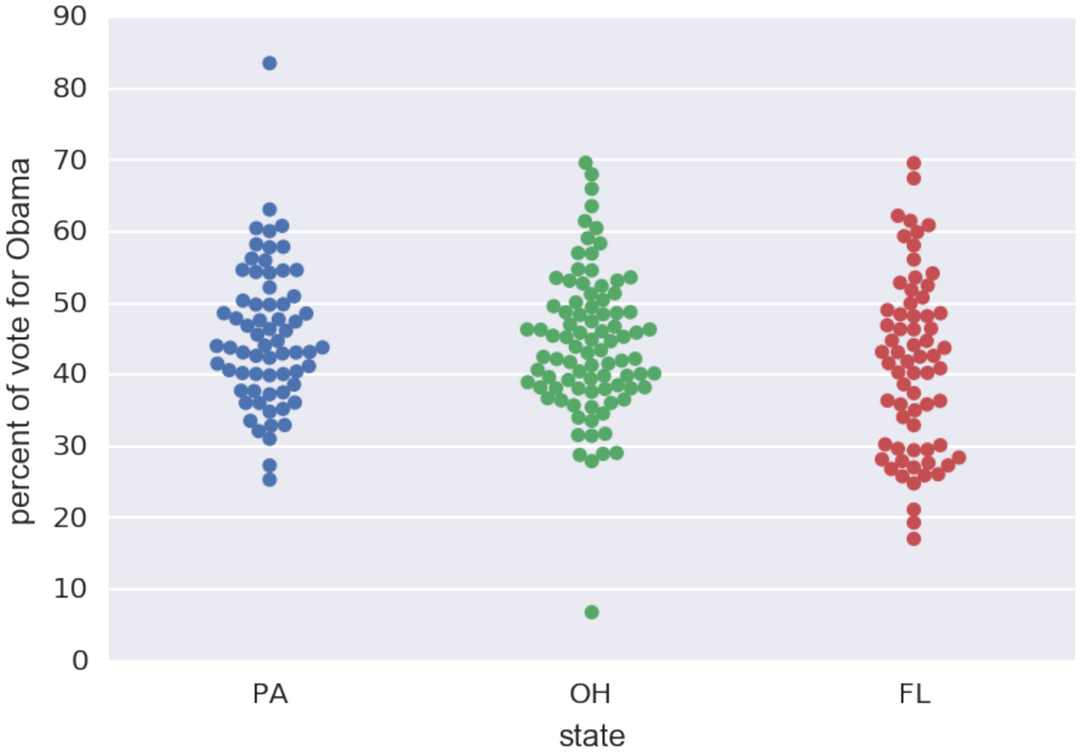
```
In [1]: _ = sns.swarmplot(x='state', y='dem_share', data=df_swing)

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!

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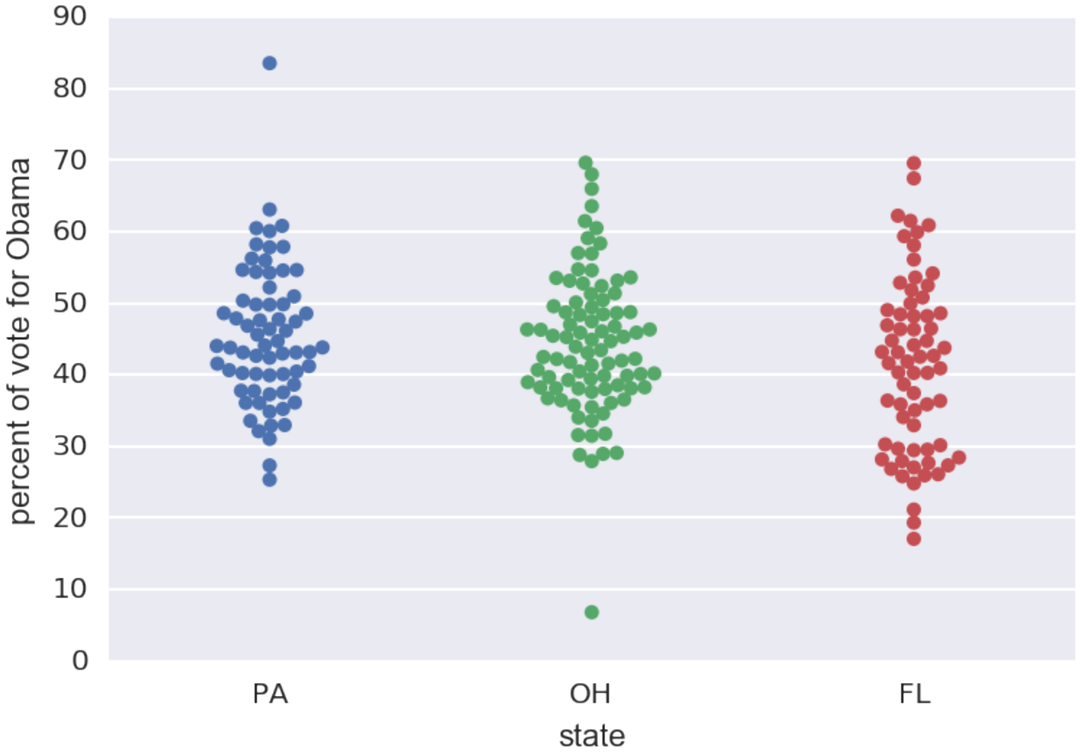
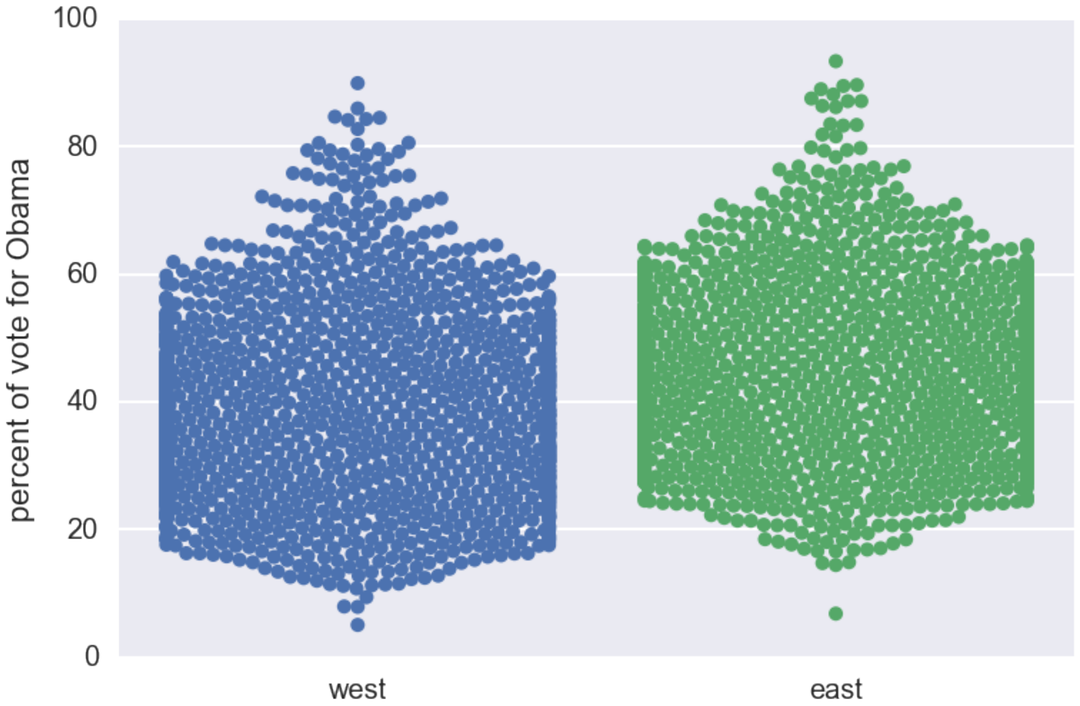
# Plot all of your data: ECDFs

# 2008 US swing state election results



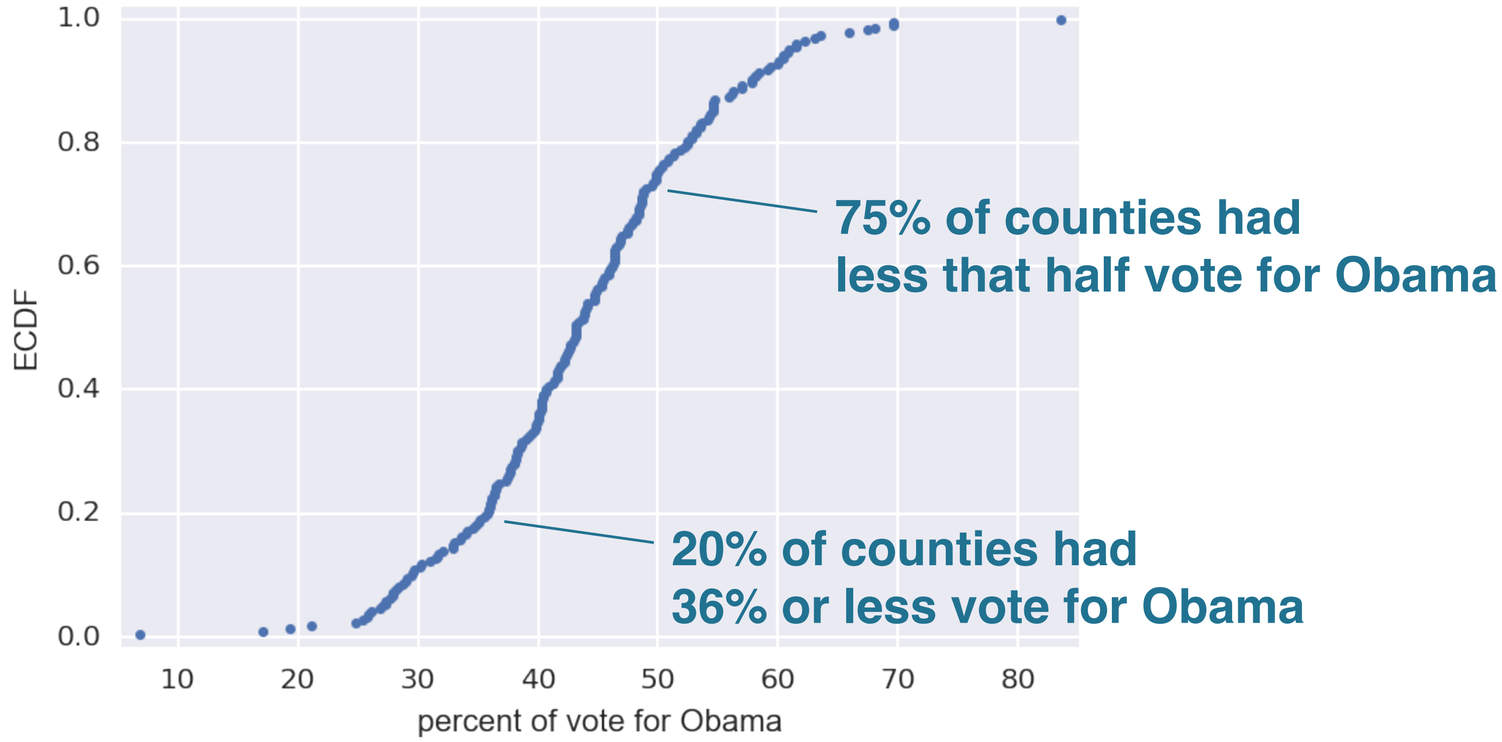

*Data retrieved from Data.gov (https://www.data.gov/)*

# 2008 US election results: East and West




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

# Empirical cumulative distribution function (ECDF)

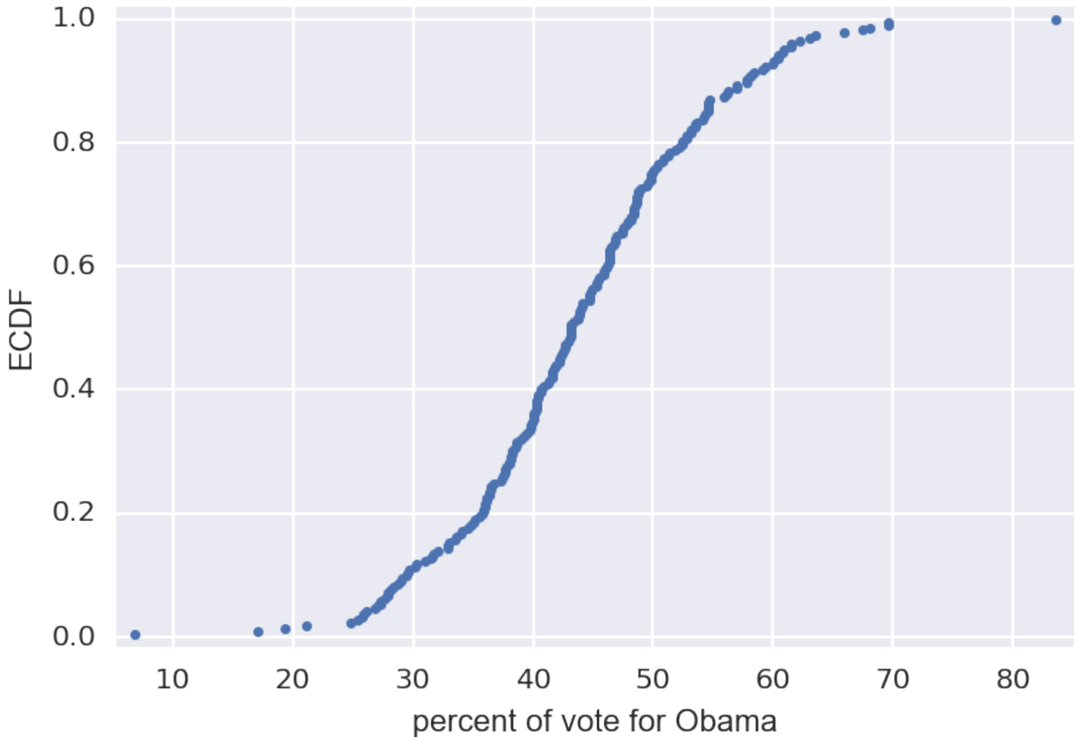



*Data retrieved from Data.gov (https://www.data.gov/)*

# Making an ECDF

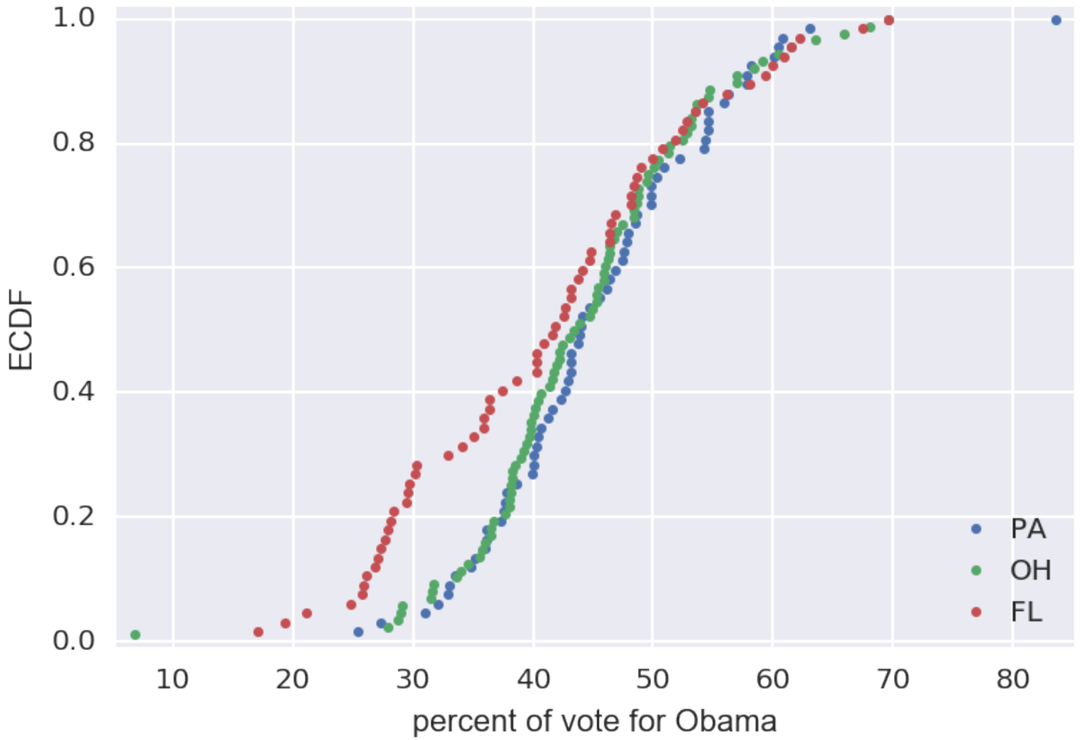
```
In [1]: import numpy as np

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/)*

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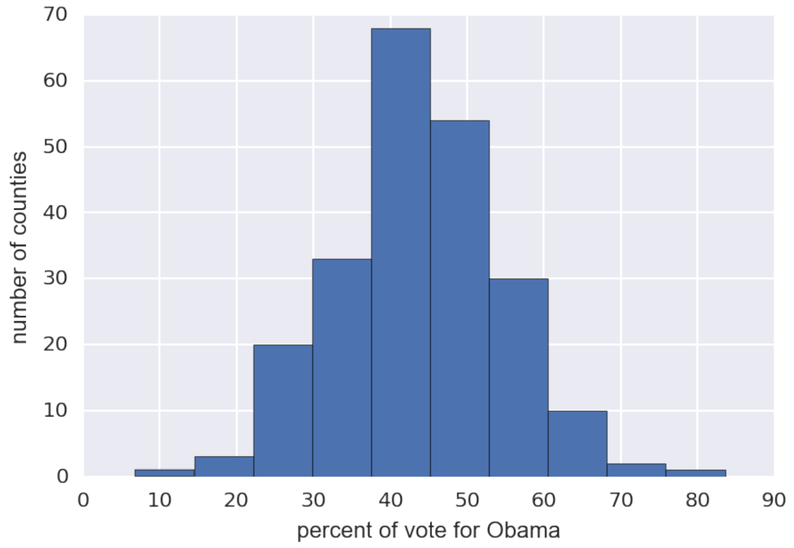
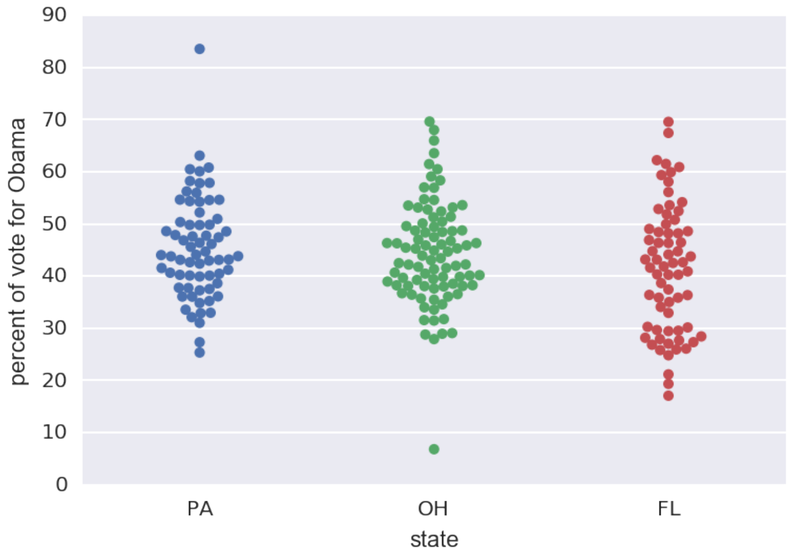
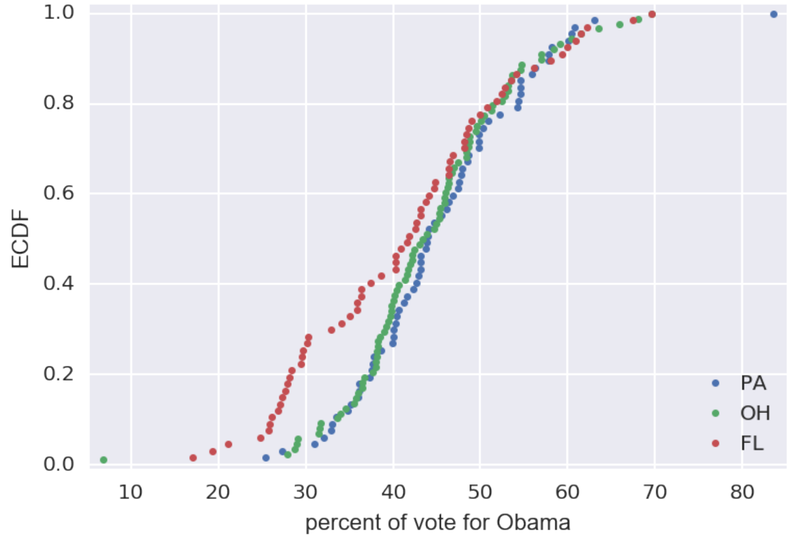
# Let’s practice!

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()`

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# Let’s get to work!