NYU Center for Data Science

DS-UA 112
Introduction to Data Science

Week 3: Lecture 2

Tables – Arranging Data in Rows and Columns

Center for
Data Science

NYU

How can tables help us to summarize data?

DS-UA 112
Introduction to Data Science

Week 3: Lecture 2

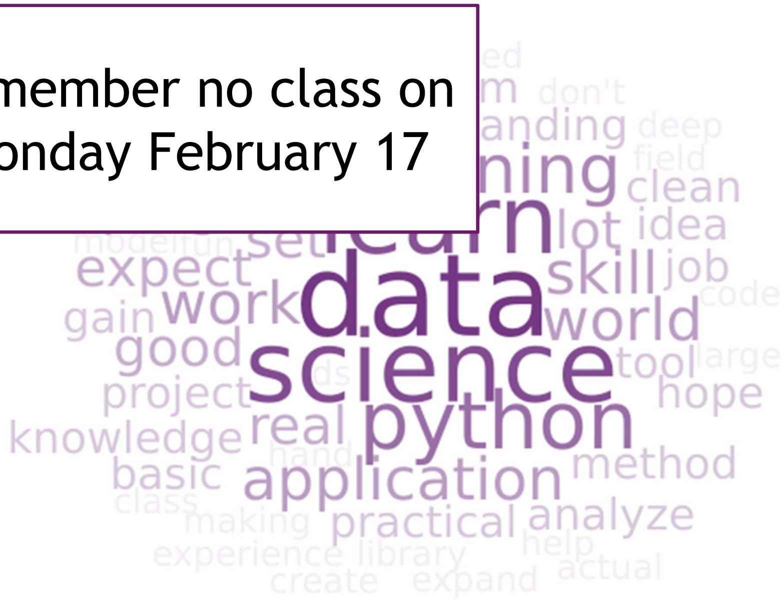
Tables – Arranging Data in Rows and Columns

Adapted from DeNero and Hug

Announcements

- Please check Week 3 agenda on NYU Classes
  - Homework 1
  - Lab 3
  - Grader Office Hours
- Remember to post to Piazza

Remember no class on Monday February 17



Review

Rules for Determining the Chance of Events

$$0 \leq P(\text{an event happens}) \leq 1$$

- Probability is a number that reflects the likelihood of events
  - 0 least likely
  - 1 most likely

- Two events are complementary when one or the other must occur but they cannot occur together
  - Complementary events have related probabilities

$$\boxed{P(\text{an event doesn't happen}) = 1 - P(\text{an event happens})}$$

Review

Rules for Determining the Chance of Events

- We can use multiplication to determine the chance that two events happened together

$$P(n \text{ and } y) = P(n|y) \cdot P(y)$$

$$\boxed{P(n|y) = P(n)}$$

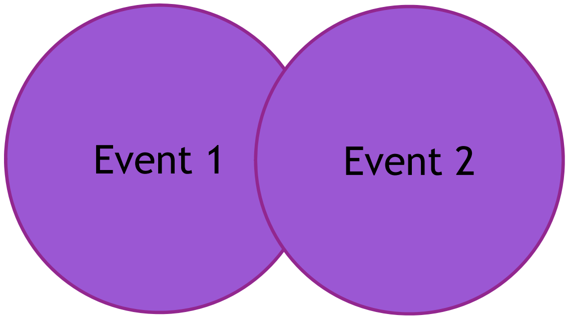
- When two events are unrelated to each other, we have independent events

Review

Rules for Determining the Chance of Events

- We can use addition to determine the chance that two events happened separately

$$P(n \text{ or } y) = P(n) + P(y) - P(n \text{ and } y)$$



- When two events can happen together, we must remember to subtract to avoid counting the probabilities twice

Review

Rules for Determining the Chance of Events

- Sometimes we want to switch the order we take the events. Bayes rule helps us to rearrange

$$\begin{aligned}\frac{P(n|y)P(y)}{P(n)} &= \frac{P(n \text{ and } y)}{P(y)}\frac{P(y)}{P(n)}\\ &= \frac{P(n \text{ and } y)}{P(n)}\\ &= P(y|n)\end{aligned}$$

$$P(y|n) = \frac{P(n|y)P(y)}{P\left((n \text{ and } 1880) \text{ or } (n \text{ and } 1881)\ldots\right)}$$

- We can expand the denominator of the left hand side with complementary events

Review

Rules for Determining the Chance of Events

- Sometimes we want to switch the order we take the events. Bayes rule helps us to rearrange

$$\frac{P(n|y)P(y)}{P(n)} = \frac{P(n \text{ and } y)}{P(y)} \frac{P(y)}{P(n)}$$
$$= \frac{P(n \text{ and } y)}{P(n)}$$
$$= P(y|n)$$

$$\frac{P(n|y)P(y)}{\ldots 1881)\ldots)}$$

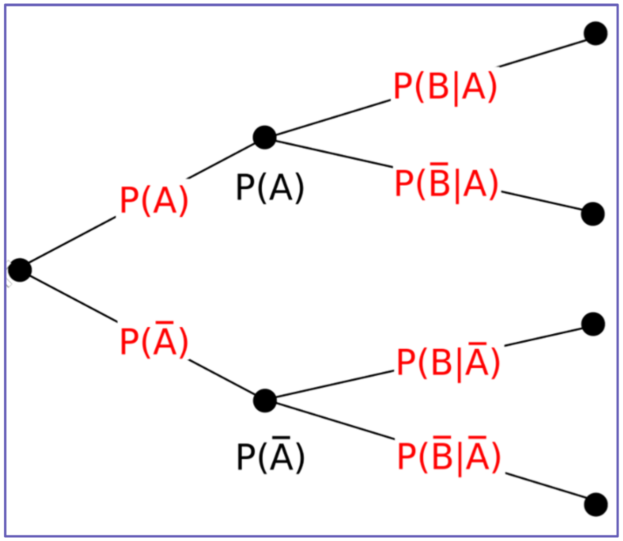
$$P(n \text{ and } 1880) + P(n \text{ and } 1881) + \ldots$$
$$= P(n|1880)P(1880) + P(n|1881)P(1881) + \ldots$$

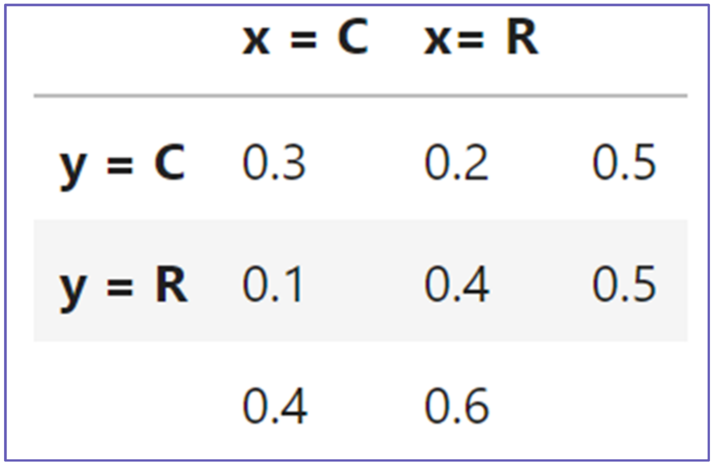
- We can expand the denominator of the left hand side with complementary events

Review

Rules for Determining the Chance of Events

- Trees are graphs that help us keep track of conditional probabilities.





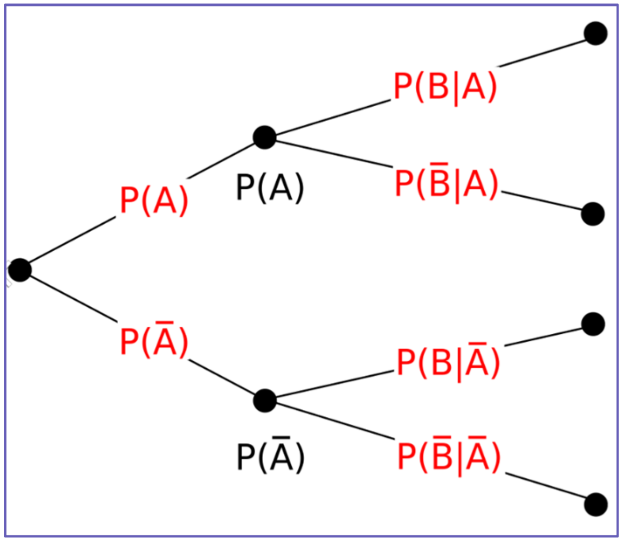
	x = C	x= R	
y = C	0.3	0.2	0.5
y = R	0.1	0.4	0.5
	0.4	0.6	

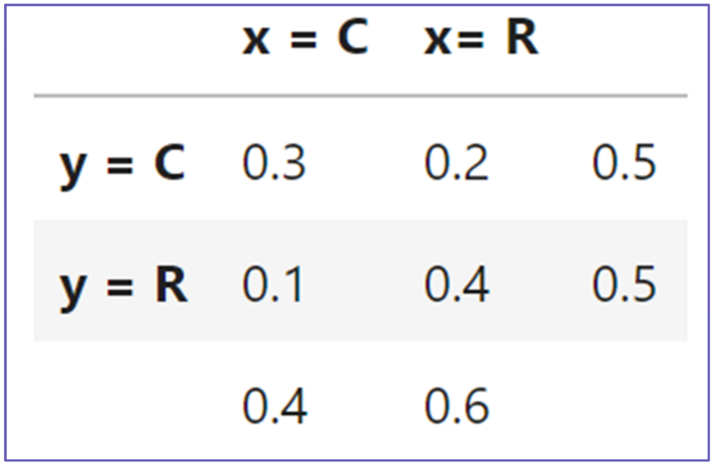
- Tables are rows and columns of numbers that help us keep track of different outcomes for two events

Review

Rules for Determining the Chance of Events

- Trees are graphs that help us keep track of conditional probabilities.





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Agenda

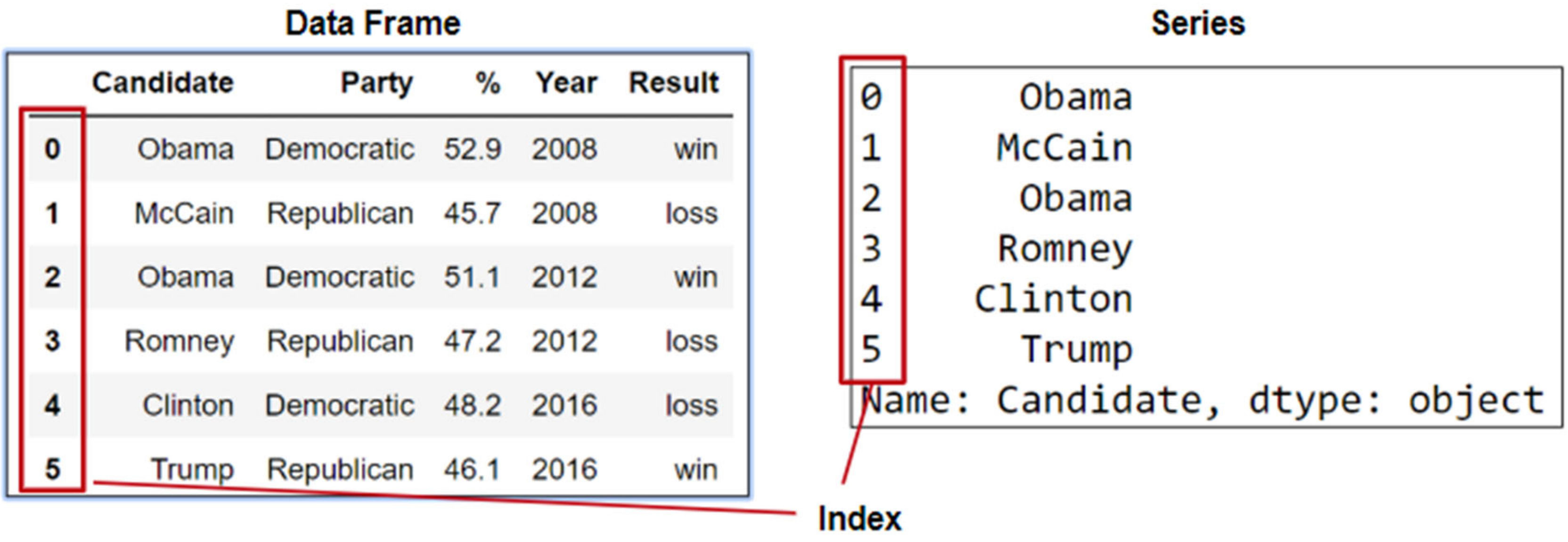
- Summaries of Numbers
  - Average, Expected Value
  - Standard Deviation
- Tables
  - Using the pandas package to manipulate tables
  - Series and Data Frames
  - Indexing (with [], loc, and iloc)
  - Averaging, Sorting, and Removing Duplicates

References

- Nolan, Lau, Gonzalez (Chapter 3.2)
- Shah (Chapter 5.1-5.4)

Tables

- pandas is a package for accessing and modifying tabular data
- pandas stores data in three formats
  - Data Frame: 2D data.
  - Series: 1D data.
  - Index: collection of labels.



Data Frame

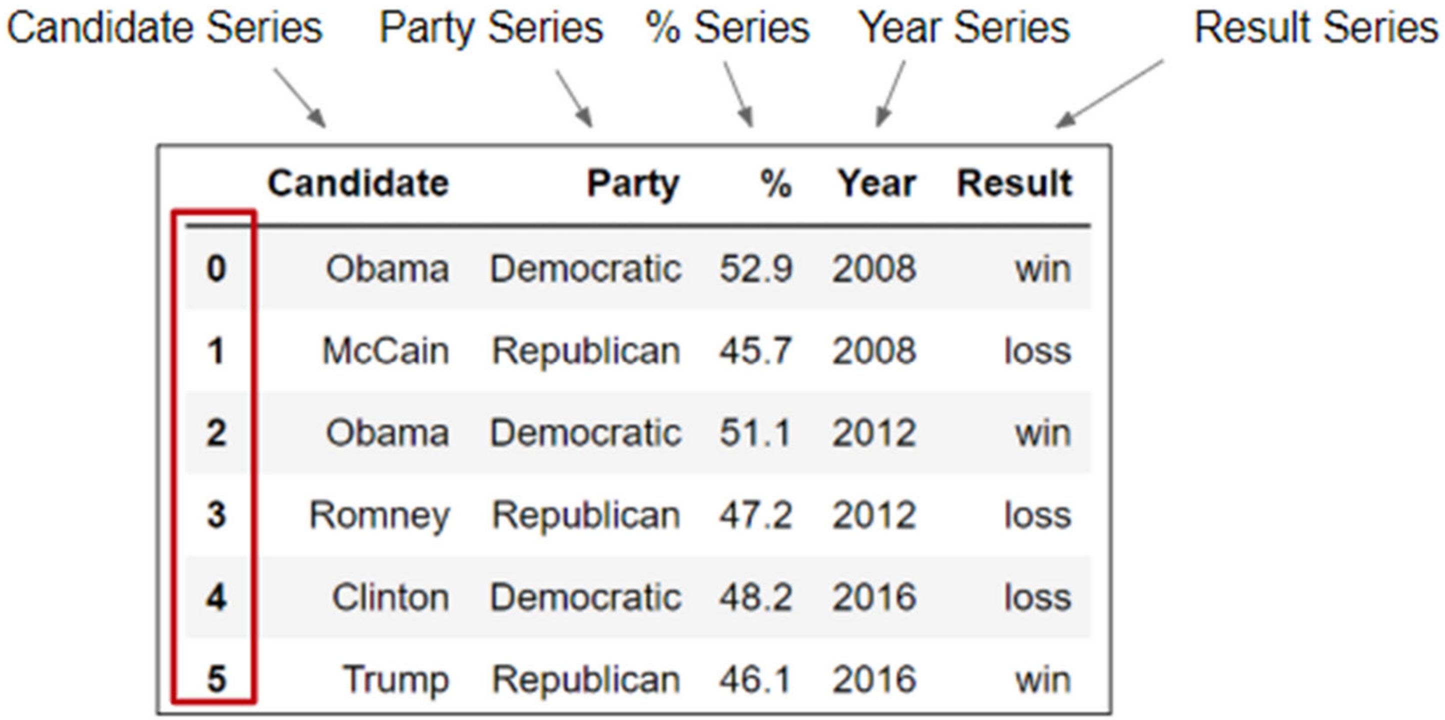
	Candidate	Party	%	Year	Result
0	Obama	Democratic	52.9	2008	win
1	McCain	Republican	45.7	2008	loss
2	Obama	Democratic	51.1	2012	win
3	Romney	Republican	47.2	2012	loss
4	Clinton	Democratic	48.2	2016	loss
5	Trump	Republican	46.1	2016	win

Series

```
0          Obama
1         McCain
2          Obama
3         Romney
4        Clinton
5          Trump
Name: Candidate, dtype: object
```

Tables

- Data Frame is a collection of Series with the same Index



Candidate Series

Party Series

% Series

Year Series

Result Series

	Candidate	Party	%	Year	Result
0	Obama	Democratic	52.9	2008	win
1	McCain	Republican	45.7	2008	loss
2	Obama	Democratic	51.1	2012	win
3	Romney	Republican	47.2	2012	loss
4	Clinton	Democratic	48.2	2016	loss
5	Trump	Republican	46.1	2016	win

Tables

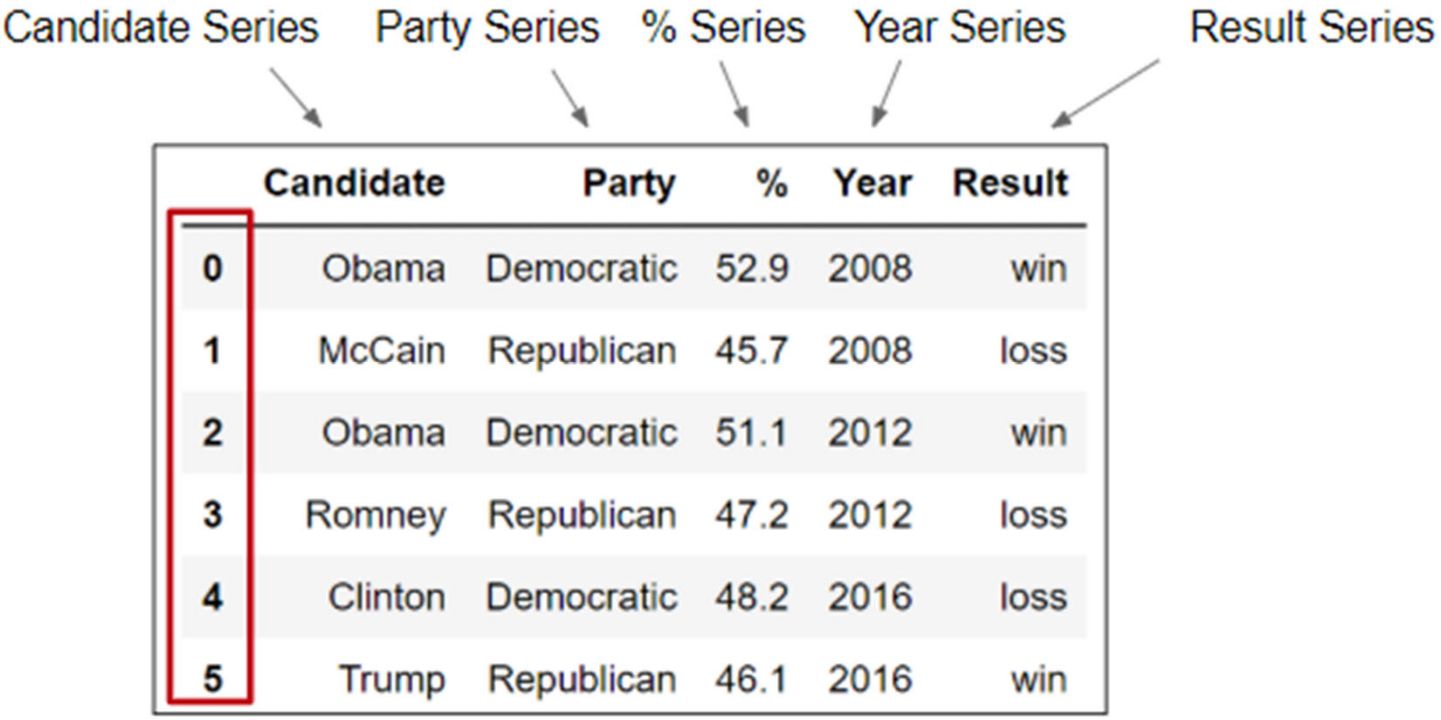
- Indices may not be numbers
  - Collection of strings

  “Candidate1”, “Candidate2”, …

- Indices may not be unique
  - Indices are just labels of the rows

  “CandidateDemocrat”, “CandidateRepublican”,

  “CandidateDemocrat” …



Candidate Series

Party Series

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Tables

However columns are unique

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  - Collection of strings

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- Indices may not be unique
  - Indices are just labels of the rows

  “CandidateDemocrat”, “CandidateRepublican”,

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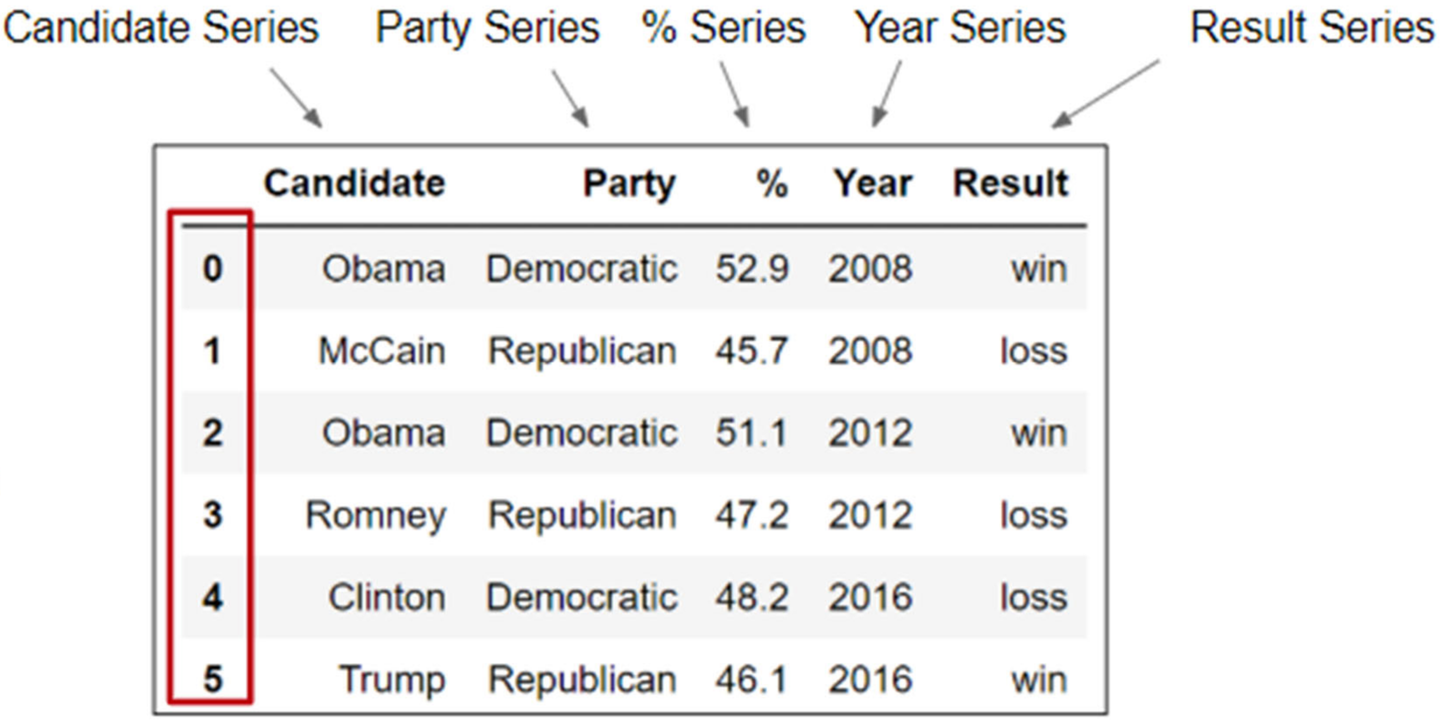

	Candidate	Party	%	Year	Result
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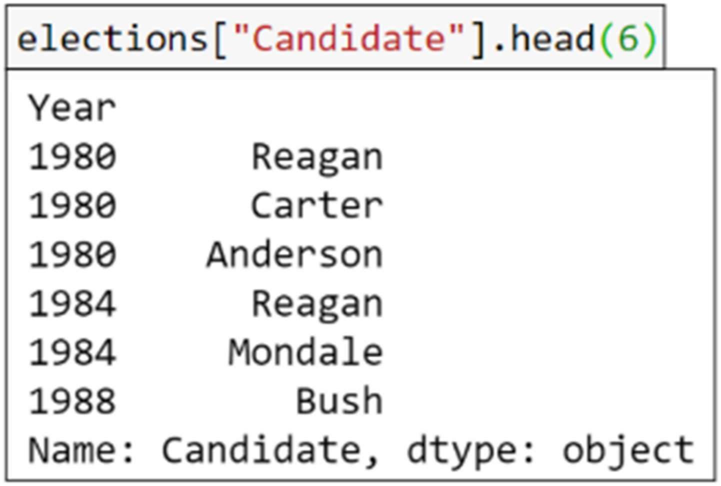
4	Clinton	Democratic	48.2	2016	loss
5	Trump	Republican	46.1	2016	win

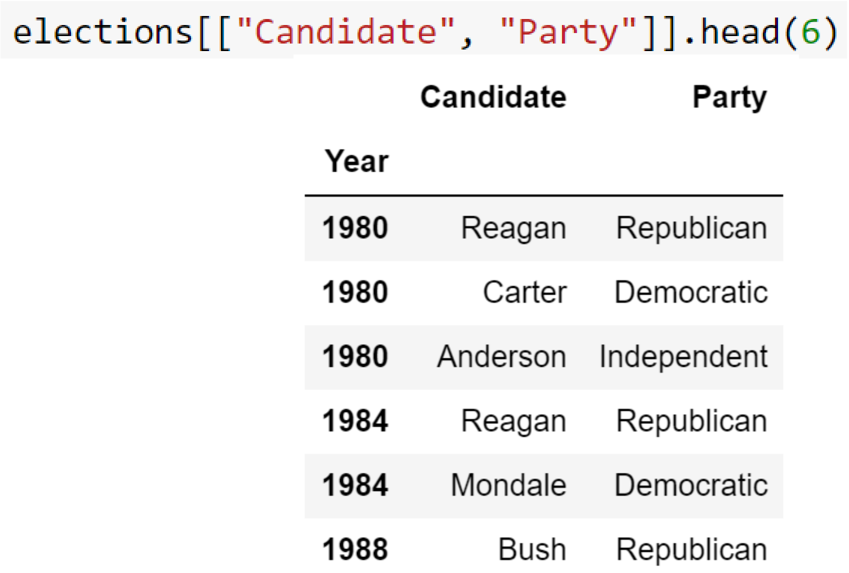
Tables

- Select column to extract Series or collection of Series from Data Frame



```
elections["Candidate"].head(6)
```

```
Year
1980        Reagan
1980        Carter
1980      Anderson
1984        Reagan
1984       Mondale
1988          Bush
Name: Candidate, dtype: object
```



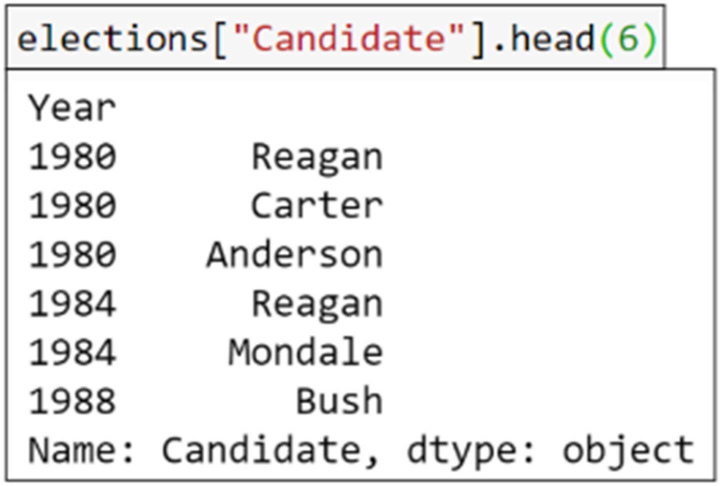
```
elections[["Candidate", "Party"]].head(6)
```

Year	Candidate	Party
1980	Reagan	Republican
1980	Carter	Democratic
1980	Anderson	Independent
1984	Reagan	Republican
1984	Mondale	Democratic
1988	Bush	Republican

- Passing a name to [] gives us a Series
- Passing a List to [] gives us a Data Frame

Tables

- Select column to extract Series or collection of Series from Data Frame



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1984       Reagan
1984      Mondale
1988         Bush
Name: Candidate, dtype: object
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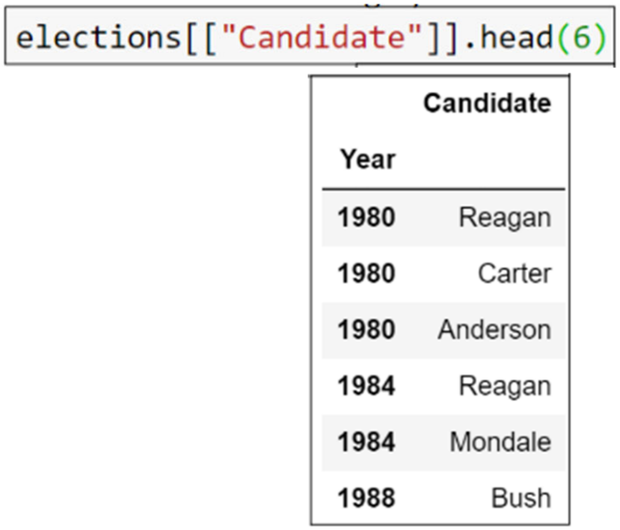

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elections[["Candidate"]].head(6)
```

	Candidate
Year	
1980	Reagan
1980	Carter
1980	Anderson
1984	Reagan
1984	Mondale
1988	Bush

- Passing a name to [] gives us a Series
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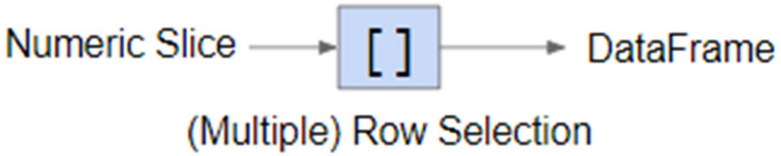
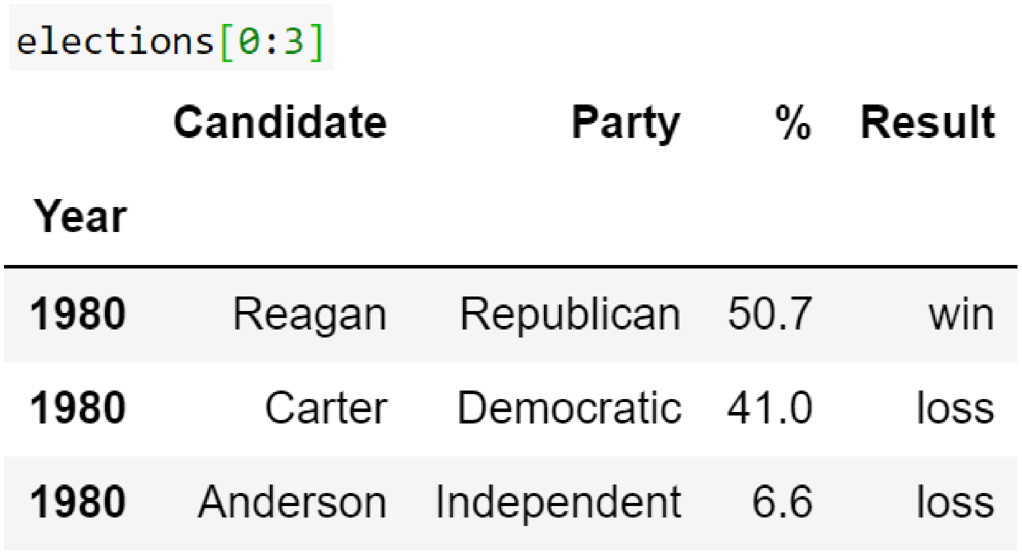
Tables

- Select row to extract Data Frame consisting of adjacent rows





```
elections[0:3]
```

	Candidate	Party	%	Result
Year				
1980	Reagan	Republican	50.7	win
1980	Carter	Democratic	41.0	loss
1980	Anderson	Independent	6.6	loss

- Note that you must indicate adjacent rows with a numeric range such as 0:3 for 0,1,2

Tables

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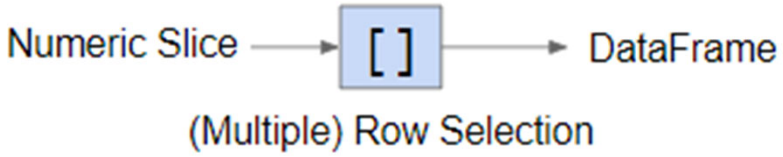


```
elections[0:3]
```

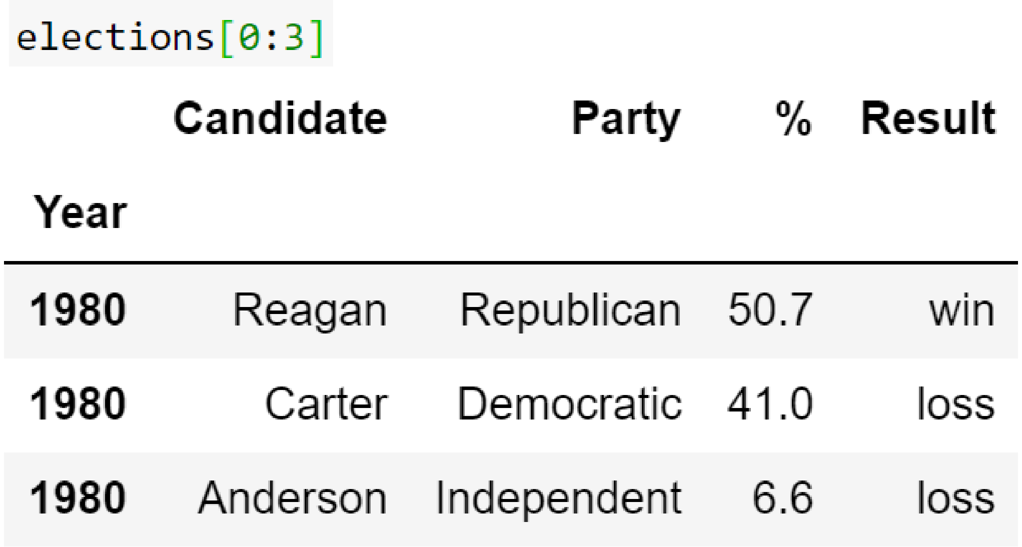
	Candidate	Party	%	Result
Year				
1980	Reagan	Republican	50.7	win
1980	Carter	Democratic	41.0	loss
1980	Anderson	Independent	6.6	loss

```
elections[0]
```

[illegible]te that you must [illegible]cent rows wit[illegible]c range such as 0:[illegible] for 0,1,2

Tables

- Select row to extract Data Frame consisting of adjacent rows



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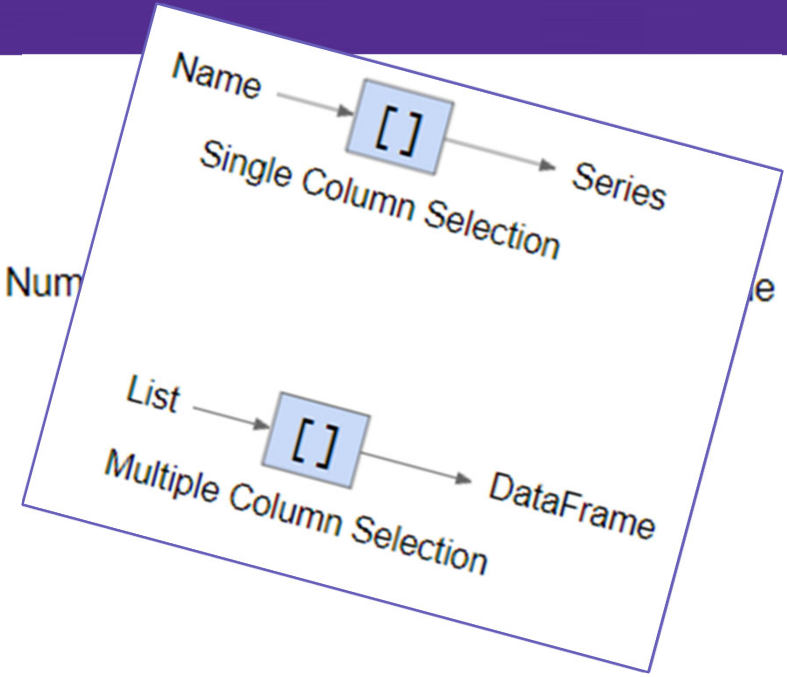
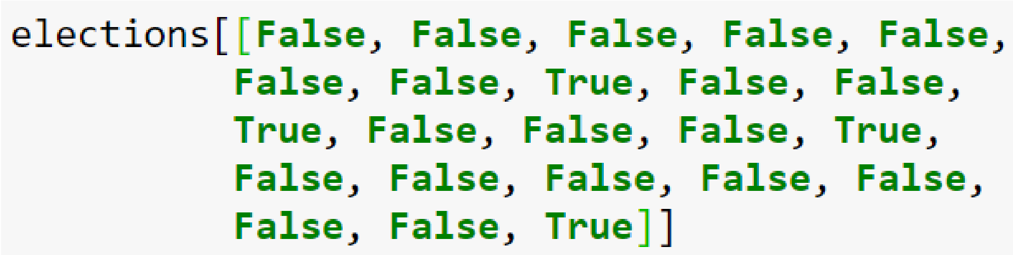


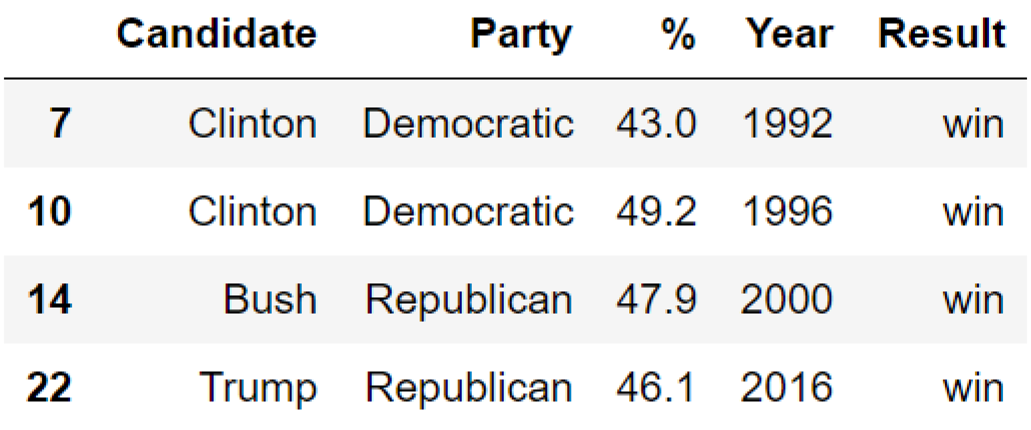
- Note that you must indicate adjacent rows with a numeric range such as 0:3 for 0,1,2

Tables

- Use logical expression to select rows that may not be adjacent in the table
- You can pass a collection of True and False values
- Often you obtain these values by comparing a Series with a variable



```
elections[[False, False, False, False, False,
          False, False, True, False, False,
          True, False, False, False, True,
          False, False, False, False, False,
          False, False, True]]
```



	Candidate	Party	%	Year	Result
7	Clinton	Democratic	43.0	1992	win
10	Clinton	Democratic	49.2	1996	win
14	Bush	Republican	47.9	2000	win
22	Trump	Republican	46.1	2016	win

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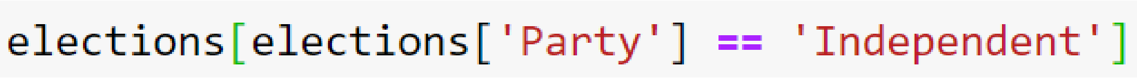
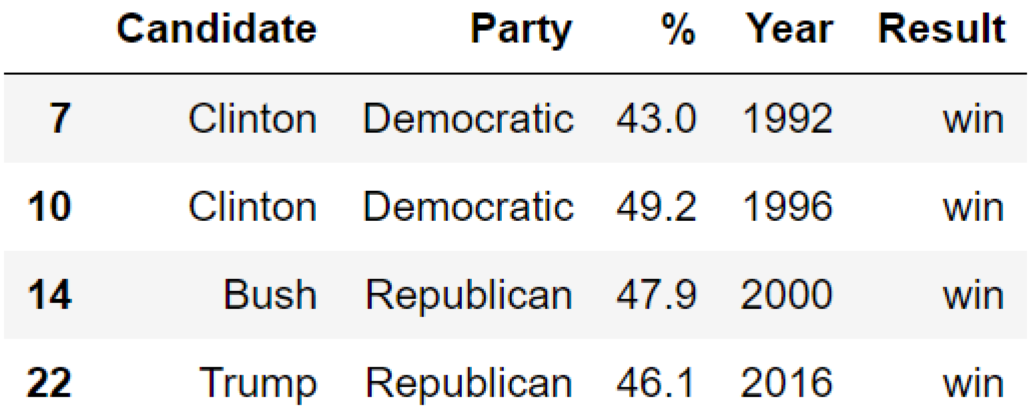


```
elections[elections['Party'] == 'Independent']
```



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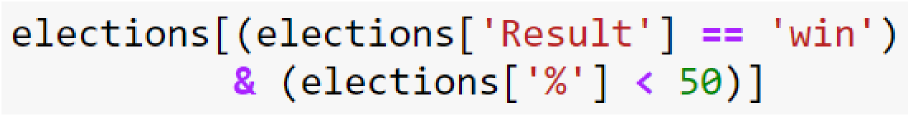
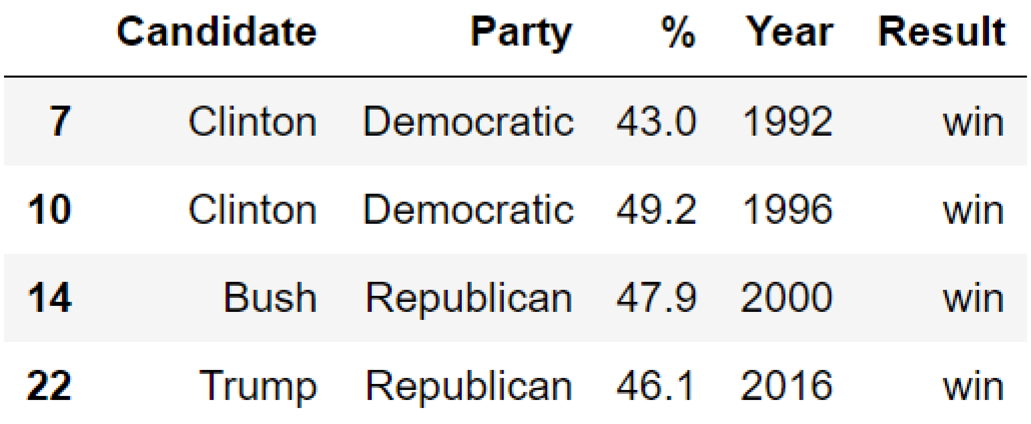
You must use & for “and”, | for “or”, ~ for “not”



```
elections[(elections['Result'] == 'win')
         & (elections['%'] < 50)]
```



	Candidate	Party	%	Year	Result
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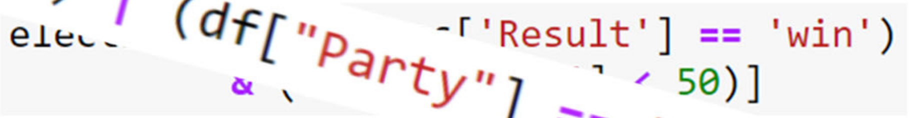
10	Clinton	Democratic	49.2	1996	win
14	Bush	Republican	47.9	2000	win
22	Trump	Republican	46.1	2016	win

Tables

```
df[(df["Party"] == "Democratic") | (df["Party"] == "Republican")]
```

- Use logical expre... to select rows that ...t be adjacent
- You can pass ... collection of True and False values
- Often you obtain these values by comparing a Series with a variable

```
df[df["Party"].isin(["Republican", "Democratic"])]
```



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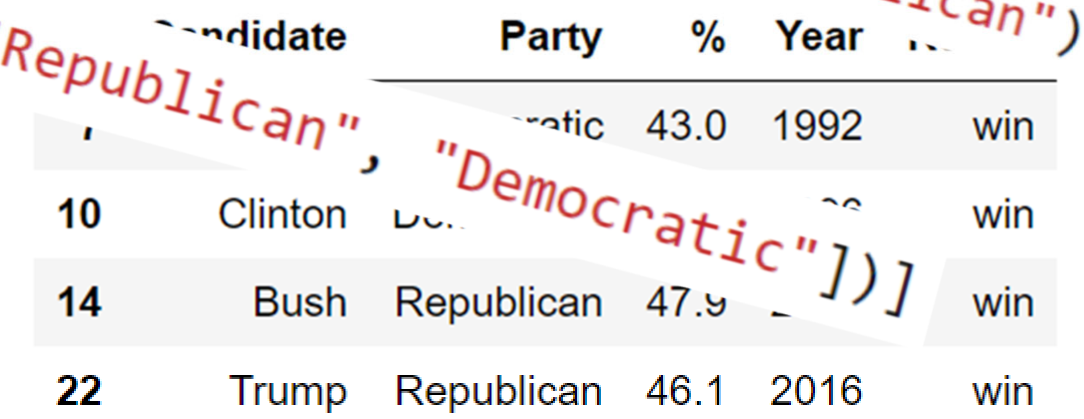

	...ndidate	Party	%	Year	...
7	[illegible]	...ratic	43.0	1992	win
10	Clinton	De...	...6	[illegible]	win
14	Bush	Republican	47.9	[illegible]	win
22	Trump	Republican	46.1	2016	win

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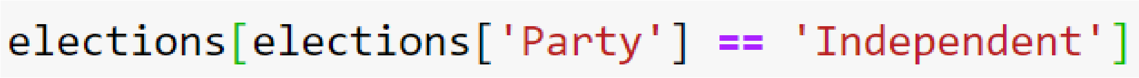
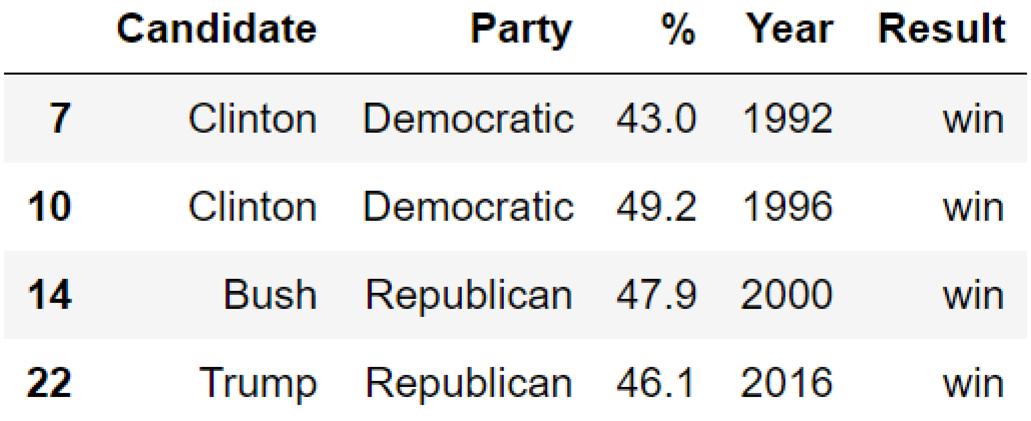


```
elections[elections['Party'] == 'Independent']
```



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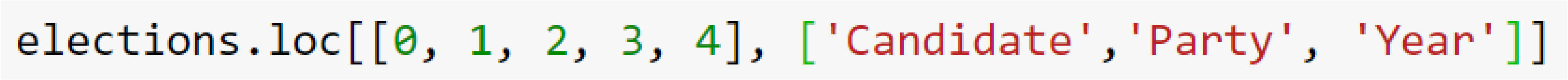
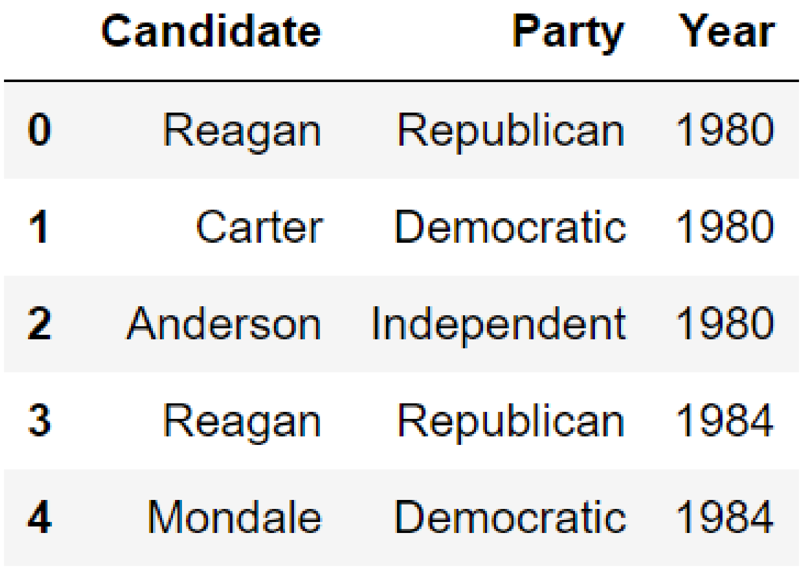
Tables



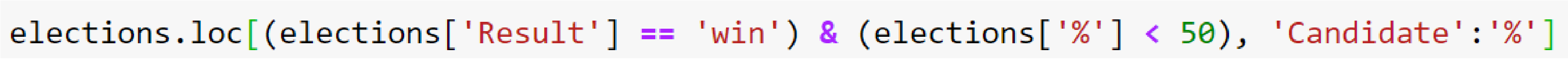
```
elections.loc[[0, 1, 2, 3, 4], ['Candidate','Party', 'Year']]
```

- Use loc and iloc to specify both rows and columns
- loc accesses by
  - value of label
  - True or False
- iloc accesses by
  - row number
  - column number



	Candidate	Party	Year
0	Reagan	Republican	1980
1	Carter	Democratic	1980
2	Anderson	Independent	1980
3	Reagan	Republican	1984
4	Mondale	Democratic	1984

Tables



```
elections.loc[(elections['Result'] == 'win') & (elections['%'] < 50), 'Candidate':'%']
```

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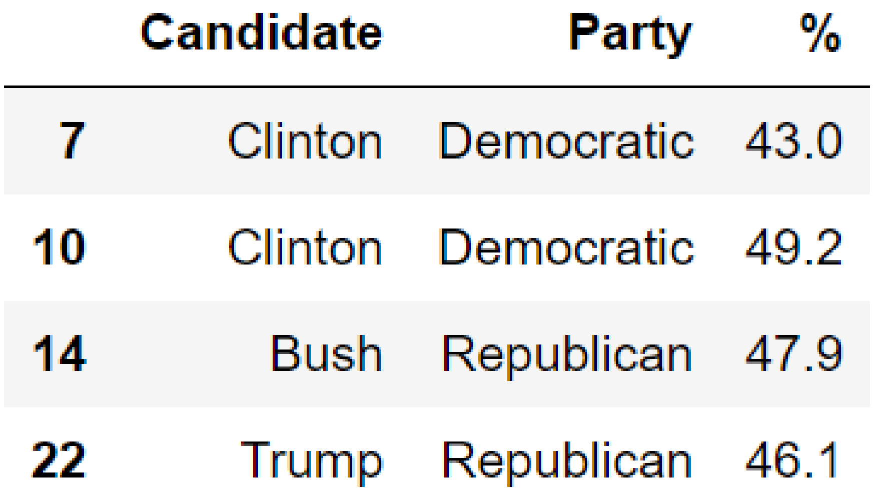
  - column number



	Candidate	Party	%
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22	Trump	Republican	46.1

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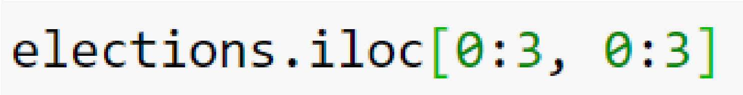
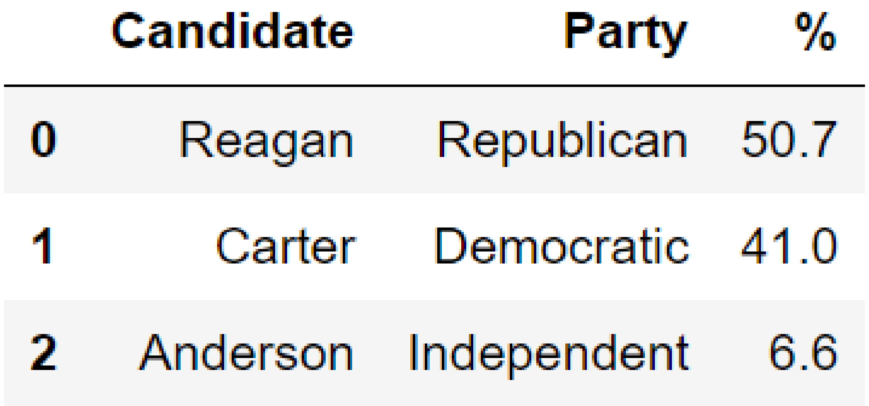


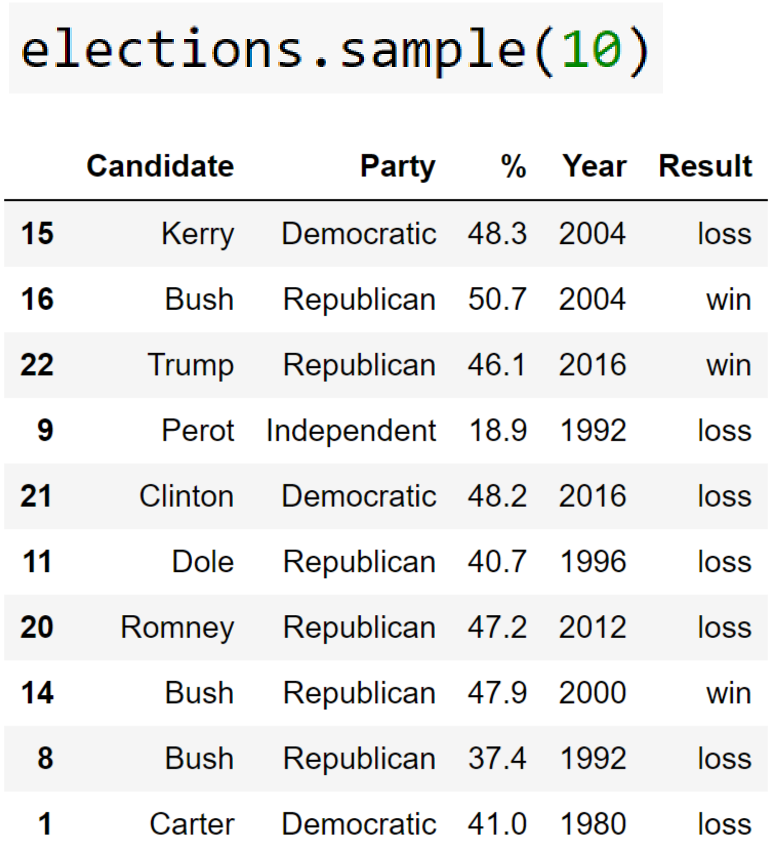
```
elections.iloc[0:3, 0:3]
```



	Candidate	Party	%
0	Reagan	Republican	50.7
1	Carter	Democratic	41.0
2	Anderson	Independent	6.6

Tables

- Use sample to random select from the rows
  - With replacement
  - Without replacement



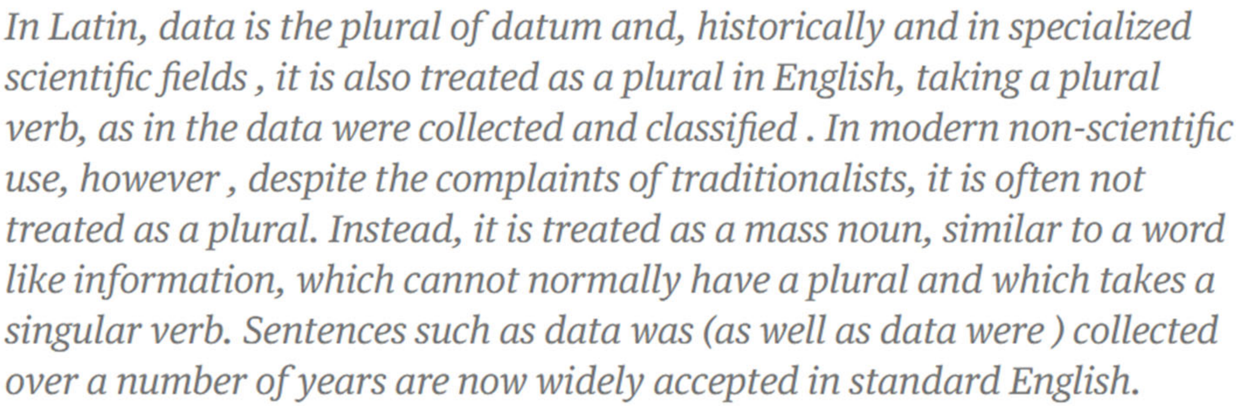
```
elections.sample(10)
```

	Candidate	Party	%	Year	Result
15	Kerry	Democratic	48.3	2004	loss
16	Bush	Republican	50.7	2004	win
22	Trump	Republican	46.1	2016	win
9	Perot	Independent	18.9	1992	loss
21	Clinton	Democratic	48.2	2016	loss
11	Dole	Republican	40.7	1996	loss
20	Romney	Republican	47.2	2012	loss
14	Bush	Republican	47.9	2000	win
8	Bush	Republican	37.4	1992	loss
1	Carter	Democratic	41.0	1980	loss

Questions

- ▶ Questions on Piazza?
- ▶ Question for You!

Should the word data be understood as singular or plural?



In Latin, data is the plural of datum and, historically and in specialized scientific fields , it is also treated as a plural in English, taking a plural verb, as in the data were collected and classified . In modern non-scientific use, however , despite the complaints of traditionalists, it is often not treated as a plural. Instead, it is treated as a mass noun, similar to a word like information, which cannot normally have a plural and which takes a singular verb. Sentences such as data was (as well as data were) collected over a number of years are now widely accepted in standard English.

Questions

- ▶ Questions on Piazza?
- ▶ Question for You!

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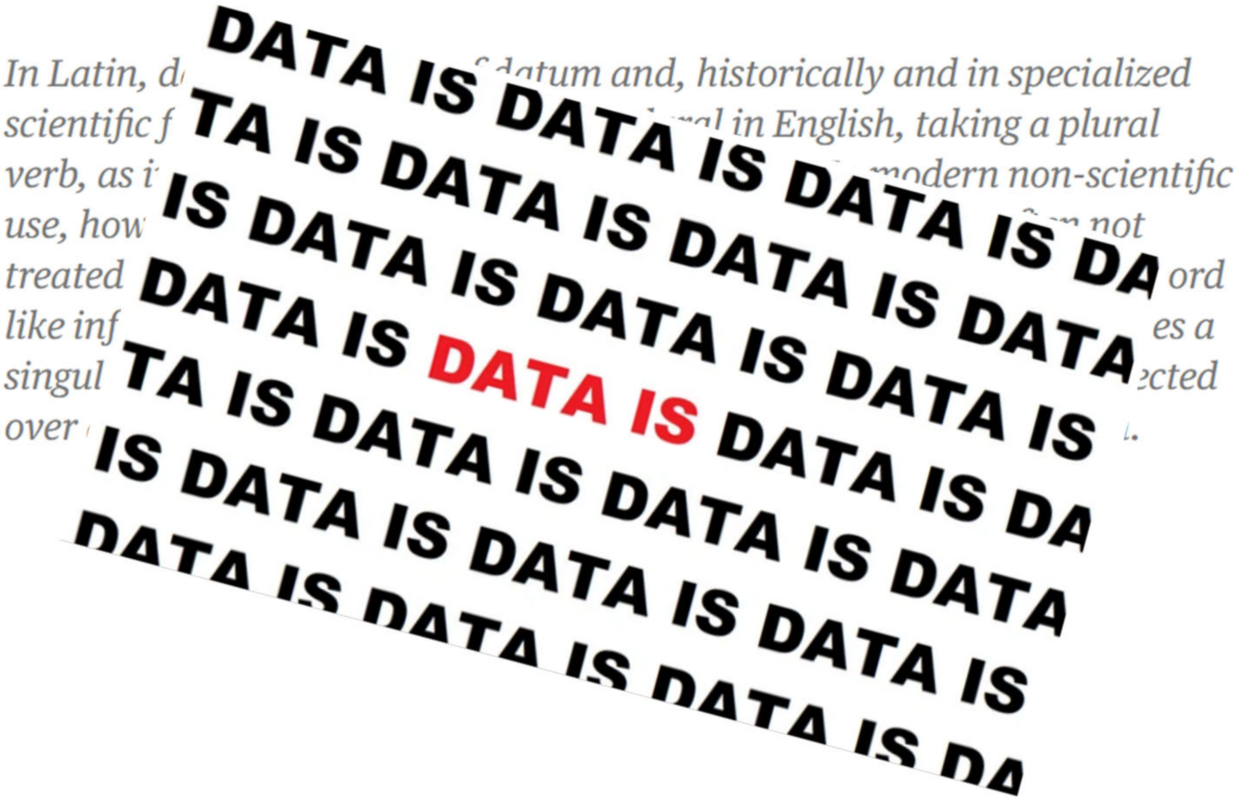
In Latin, d… …datum and, historically and in specialized
scientific f… …al in English, taking a plural
verb, as i… …modern non-scientific
use, how… …not
treated… …ord
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