CSC196: Analyzing Data

Course Wrapup

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Outline

- Pandas Overview
- Course Recap
- Additional Resources

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Pandas

Open source library for data handling and manipulation in high-performance environments.

Installation If you are using Anaconda package manager,

```
conda install pandas
```

Or if you are using PyPi (pip) package manager,

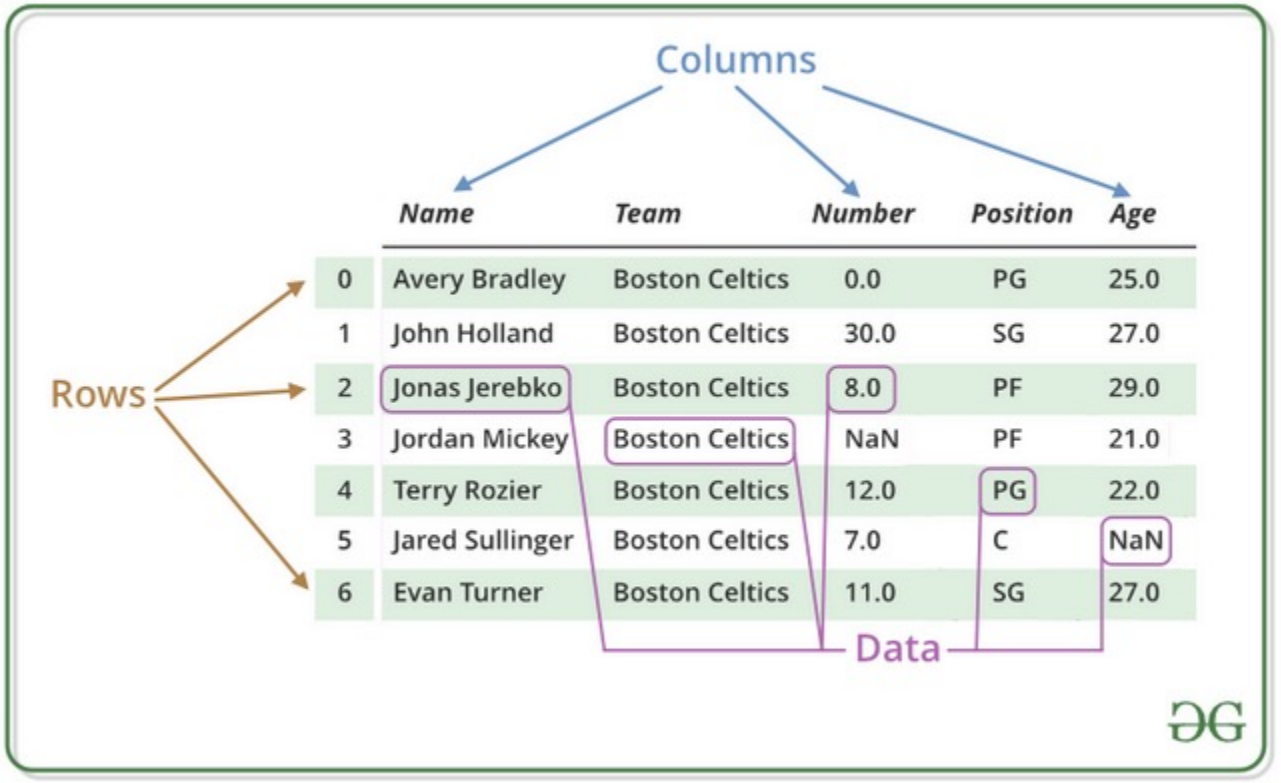
```
pip install pandas
```

See Pandas documentation for more detailed instructions

https://pandas.pydata.org/docs/getting_started/install.html

DataFrame

Primary data structure : Essentially a table



[Source: https://www.geeksforgeeks.org/python-pandas-dataframe/]

DataFrame Example

Create and print an entire DataFrame

```
# import pandas as pd
import pandas as pd

# list of strings
lst = ['Geeks', 'For', 'Geeks', 'is',
            'portal', 'for', 'Geeks']

# Calling DataFrame constructor on list
df = pd.DataFrame(lst)
print(df)
```

	0
0	Geeks
1	For
2	Geeks
3	is
4	portal
5	for
6	Geeks

[Source: https://www.geeksforgeeks.org/python-pandas-dataframe/]

DataFrame Example

Can create named columns using dictionary

```
import pandas as pd

# intialise data of lists.
data = {'Name':['Tom', 'nick', 'krish', 'jack'],
        'Age':[20, 21, 19, 18]}

# Create DataFrame
df = pd.DataFrame(data)

# Print the output.
print(df)
```

	Name	Age
0	Tom	20
1	nick	21
2	krish	19
3	jack	18

[Source: https://www.geeksforgeeks.org/python-pandas-dataframe/]

DataFrame : Selecting Columns

Select columns to print by name,

```
# Import pandas package
import pandas as pd

# Define a dictionary containing employee data
data = {'Name':['Jai', 'Princi', 'Gaurav', 'Anuj'],
        'Age':[27, 24, 22, 32],
        'Address':['Delhi', 'Kanpur', 'Allahabad', 'Kannauj'],
        'Qualification':['Msc', 'MA', 'MCA', 'Phd']}

# Convert the dictionary into DataFrame
df = pd.DataFrame(data)

# select two columns
print(df[['Name', 'Qualification']])
```

	Name	Qualification
0	Jai	Msc
1	Princi	MA
2	Gaurav	MCA
3	Anuj	Phd

[Source: https://www.geeksforgeeks.org/python-pandas-dataframe/]

DataFrame : Selecting Rows

Select columns to print by name,

```
import pandas as pd
import numpy as np

# Define a dictionary containing employee data
data = {'Name':['Jai', 'Princi', 'Gaurav', 'Anuj'],
        'Age':[27, 24, 22, 32],
        'Address':['Delhi', 'Kanpur', 'Allahabad', 'Kannauj'],
        'Qualification':['Msc', 'MA', 'MCA', 'Phd']}

# Convert the dictionary into DataFrame
df = pd.DataFrame(data)

# Print rows 1 & 2
row = df.loc[1:2]
print(row)
```

Output

	Name	Age	Address	Qualification
1	Princi	24	Kanpur	MA
2	Gaurav	22	Allahabad	MCA

DataFrame : Selecting Rows

`head()` and `tail()` select rows from beginning / end

```
import pandas as pd
import numpy as np

# Define a dictionary containing employee data
data = {'Name':['Jai', 'Princi', 'Gaurav', 'Anuj'],
        'Age':[27, 24, 22, 32],
        'Address':['Delhi', 'Kanpur', 'Allahabad', 'Kannauj'],
        'Qualification':['Msc', 'MA', 'MCA', 'Phd']}

# Convert the dictionary into DataFrame
df = pd.DataFrame(data)

# Print first / last rows
first2 = df.head(2)
last2 = df.tail(2)
print(first2)
print('\n', last2)
```

Output

```
     Name  Age Address Qualification
0     Jai   27   Delhi           Msc
1  Princi   24  Kanpur            MA

     Name  Age    Address Qualification
2  Gaurav   22  Allahabad           MCA
3    Anuj   32    Kannauj           Phd
```

Reading Data from Files

Easy reading / writing of standard formats,

```
df = pd.read_json("data.json")
print(df)
df.to_csv("data.csv", index=False)
df_csv = pd.read_csv("data.csv")
print(df_csv.head(2))
```

Output

```
     Duration  Pulse  Maxpulse  Calories
0          60    110       130     409.1
1          60    117       145     479.0
2          60    103       135     340.0
3          45    109       175     282.4
4          45    117       148     406.0
..        ...    ...       ...       ...
164        60    105       140     290.8
165        60    110       145     300.4
166        60    115       145     310.2
167        75    120       150     320.4
168        75    125       150     330.4

[169 rows x 4 columns]
   Duration  Pulse  Maxpulse  Calories
0        60    110       130     409.1
1        60    117       145     479.0
```

Data Structure Conversions

Working with DataFrames outside of Pandas can be tricky,

```
df['Duration']
```

```
0      60
1      60
2      60
3      45
4      45
      ..
164    60
165    60
166    60
167    75
168    75
Name: Duration, Length: 169, dtype: int64
```

We can easily convert to built-in types, for example to a list (e.g. to use in Numpy or whatever),

```
L = df['Duration'].to_list()
print(L)
```

```
[60, 60, 60, 45, 45, 60, 60, 45, 30, 60, 60, 60, 60, 60, 60, 60, 60, 45, 60, 45, 60, 45, 60, 45, 60, 60, 60, 60, 60,
60, 60, 45, 60, 60, 60, 60, 60, 60, 60, 45, 45, 60, 60, 60, 60, 60, 60, 45, 45, 60, 60, 80, 60, 60, 30, 60, 60, 45, 2
0, 45, 210, 160, 160, 45, 20, 180, 150, 150, 20, 300, 150, 60, 90, 150, 45, 90, 45, 45, 120, 270, 30, 45, 30, 120, 4
5, 30, 45, 120, 45, 20, 180, 45, 30, 15, 20, 20, 30, 25, 30, 90, 20, 90, 90, 90, 30, 30, 180, 30, 90, 210, 60, 45, 1
5, 45, 60, 60, 60, 60, 60, 60, 30, 45, 60, 60, 60, 60, 60, 60, 90, 60, 60, 60, 60, 60, 60, 20, 45, 45, 45, 20, 60, 6
0, 45, 45, 60, 45, 60, 60, 30, 60, 60, 60, 60, 30, 60, 60, 60, 60, 60, 30, 30, 45, 45, 45, 60, 60, 60, 75, 75]
```

Summary Statistics

Easily compute summary statistics on data

```
print('Min: ', df['Duration'].min())
print('Max: ', df['Duration'].max())
print('Median: ', df['Duration'].median())
```

```
Min:  15
Max:  300
Median:  60.0
```

Can also count occurrences of unique values,

```
df['Duration'].value_counts()
```

```
60     79
45     35
30     16
20      9
90      8
150     4
120     3
180     3
15      2
75      2
160     2
210     2
270     1
25      1
300     1
80      1
Name: Duration, dtype: int64
```

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Course Overview

Course Objective *develop a solid fundamental understanding of probability and statistics and learn how to apply them to a diverse set of problems.*

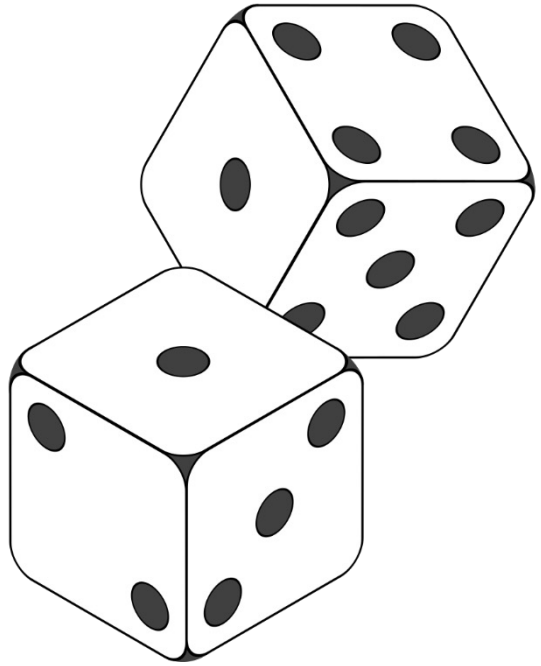
Probability	Statistical Estimation	Hypothesis Testing	Bayesian Probability
Random events / variables, distributions / densities, moments	Sampling distributions, central limit, one- and two-sample estimation	Confidence intervals, p-values	Bayes' rule, prior / posterior, credible intervals, model validation

Probability and Statistics

Suppose we roll <u>two fair dice</u>…

- What are the possible outcomes?
- What is the *probability* of rolling **even** numbers?

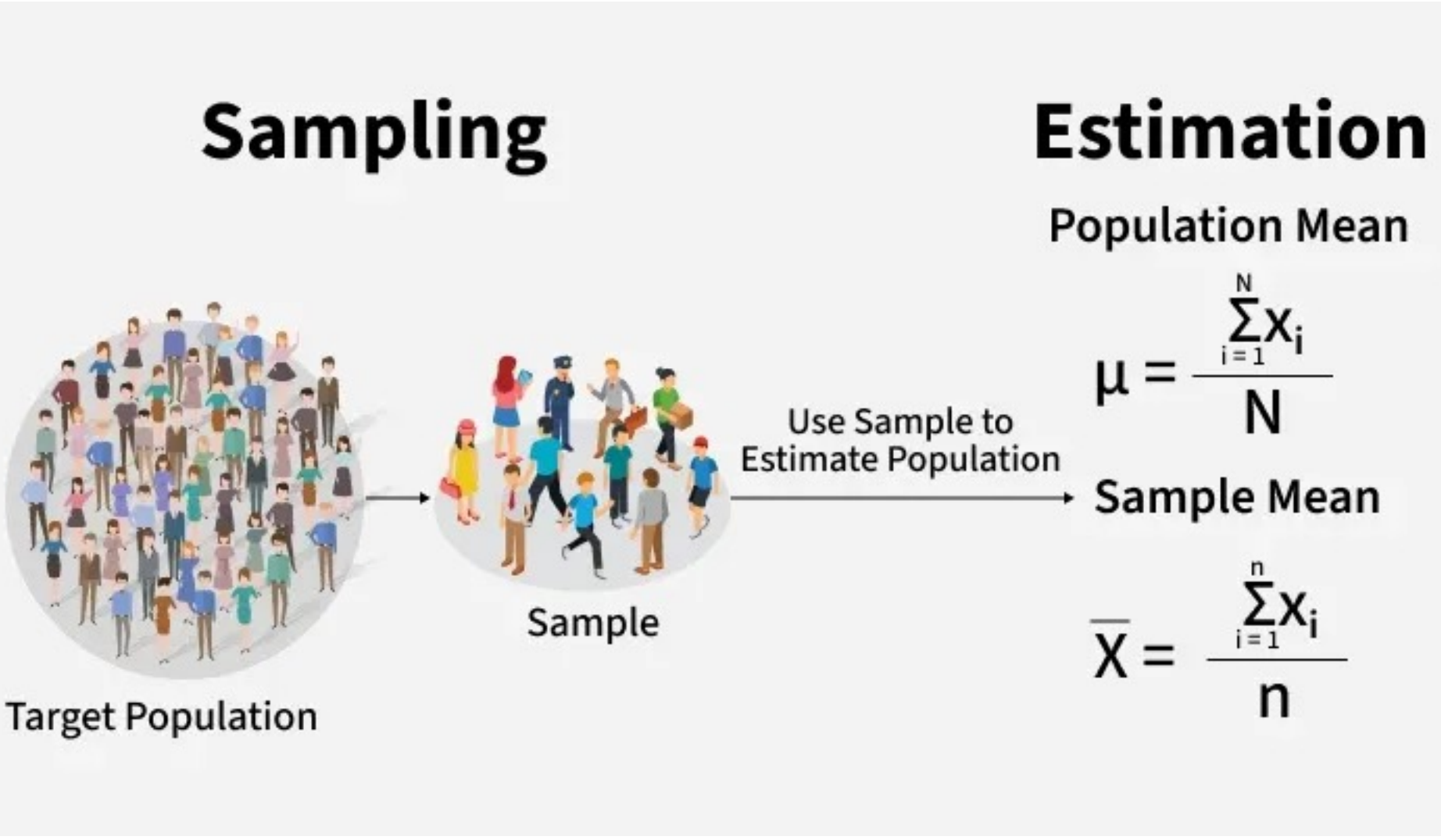
*… this is an **experiment** or **random process**.*



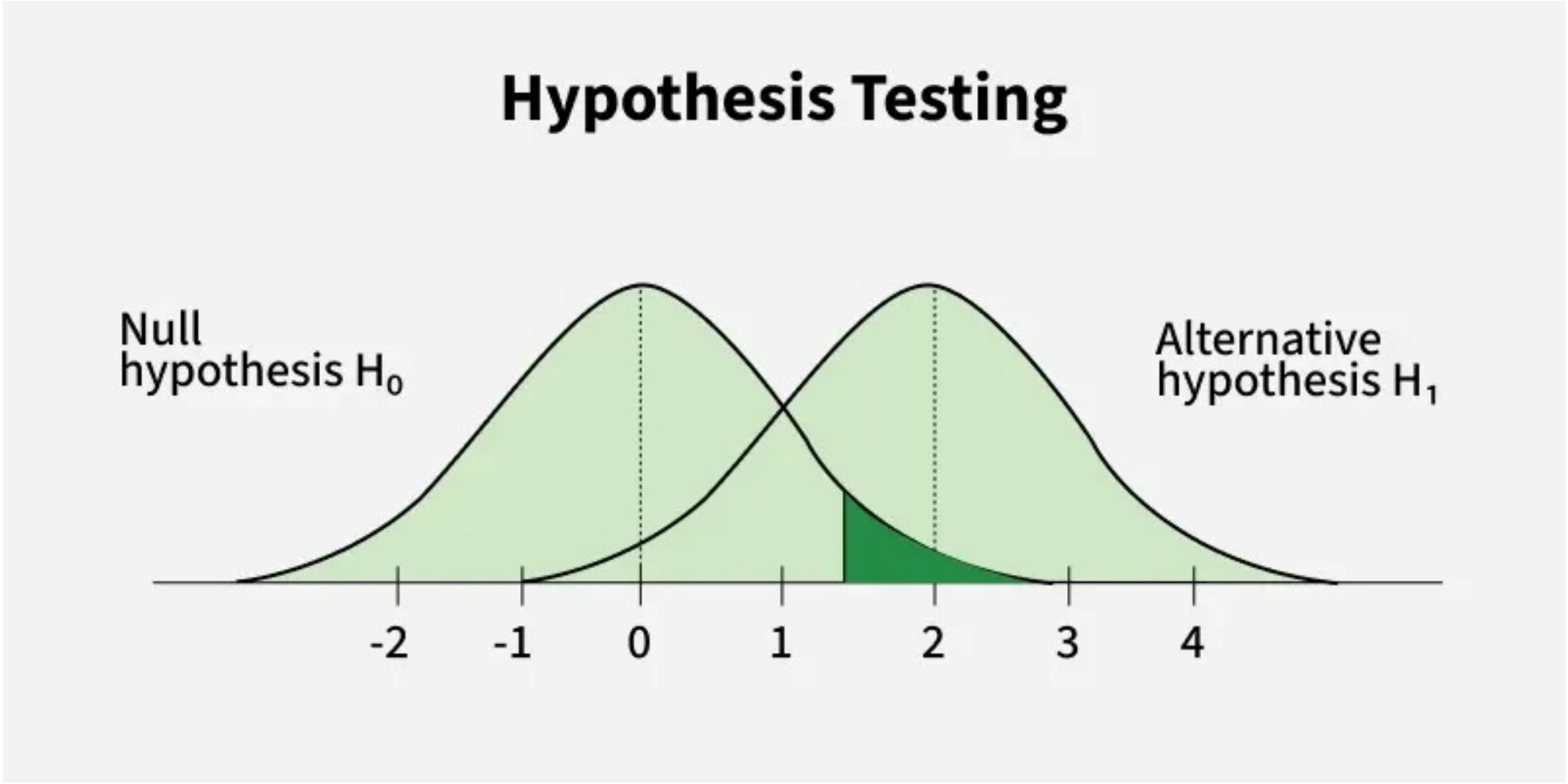
We learned how to…

- Mathematically formulate outcomes and their probabilities?
- Describe characteristics of random processes
- Estimate unknown quantities (e.g. are the dice actually fair?)
- Characterize the uncertainty in random outcomes
- Identify and measure dependence among random quantities

Statistical Estimation

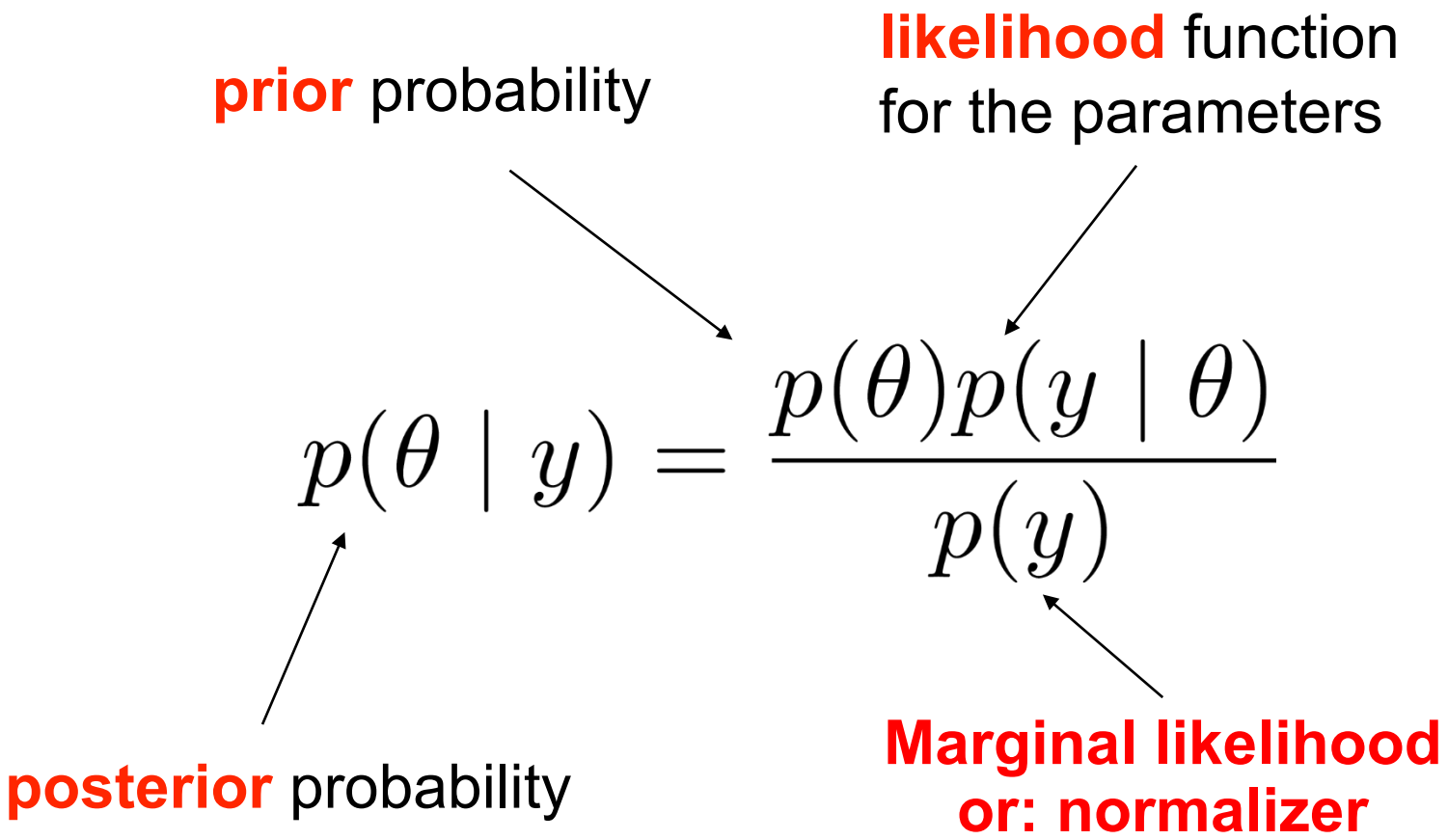


Hypothesis Testing



Bayesian Probability

Posterior represents all uncertainty <u>after</u> observing data…



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Additional Relevant Courses

- CSC 280 : Introduction to AI
- CSC 380 : Principles of Data Science
- CSC 480 : Principles of Machine Learning
- CSC 444 : Introduction to Data Visualization

Videos

3Blue1Brown

- Accessible videos on a variety of math topics
- Nicely produced, engaging graphics
- A number of ML / Data Science / Statistics topics covered

Steve Brunton – YouTube Channel

- More detailed videos on math / engineering topics
- Good linear algebra and machine learning videos
- Associated book,

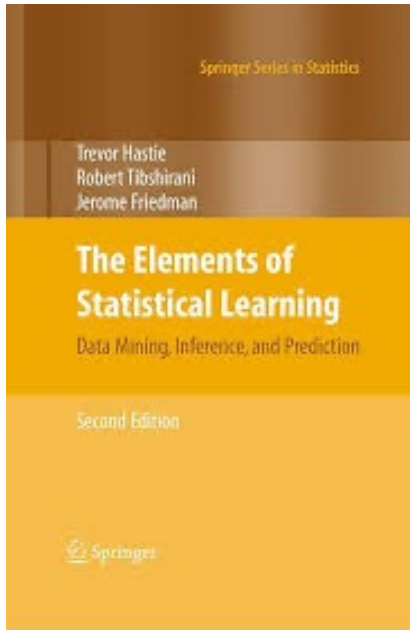
Data-Driven Science and Engineering : ML, Dynamical Systems, and control

Videos

MIT Open Courseware

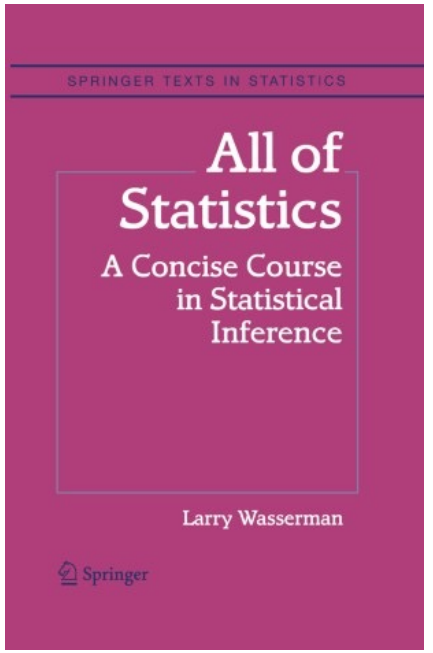
- Lots of topics freely available
- Excellent Linear Algebra course by Prof. Gilbert Strang (YouTube lectures)
- All assignments and exams available online

Textbooks



Hastie et al., “The Elements of Statistical Learning 2nd Ed.” Springer, 2009

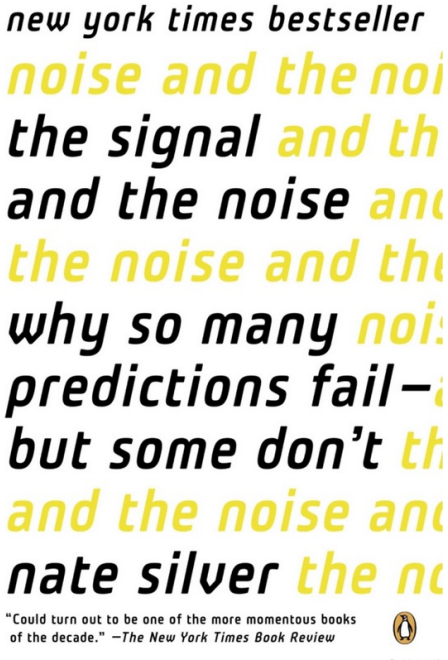
(UA Library)



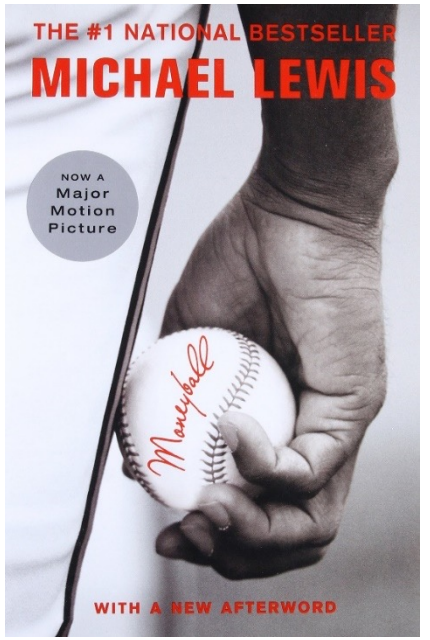
Wasserman, L. “All of Statistics.” Springer, 2004

(Springer)

Non-Textbooks



Silver, N. "The Signal and The Noise." Penguin, 2015



Lewis, M. "Moneyball." W. W. Norton, 2011