Machine Learning : 06048203

Feature Engineering

Feature Engineering and Data Preparation

Feature Scaling

Feature Scaling

X1		X2	X3	X4
$	179.43	56.784	34.6181	3.55
$	641.87	62.054	47.7306	1.692
$	556.30	64.13	55.596	1.559
$	578.47	63.377	52.7121	1.679
$	591.16	61.553	46.1315	1.984
$	242.03	58.29	39.2952	2.942
$	364.66	59.93	42.4628	2.494
$	190.68	57.271	36.2725	3.419
$	547.23	63.763	54.1971	1.634
$	359.69	59.375	41.5105	2.128
$	438.08	60.484	43.493	2.47
$	637.17	62.525	49.428	1.725

Feature Scaling

Min-Max scaling Normalization

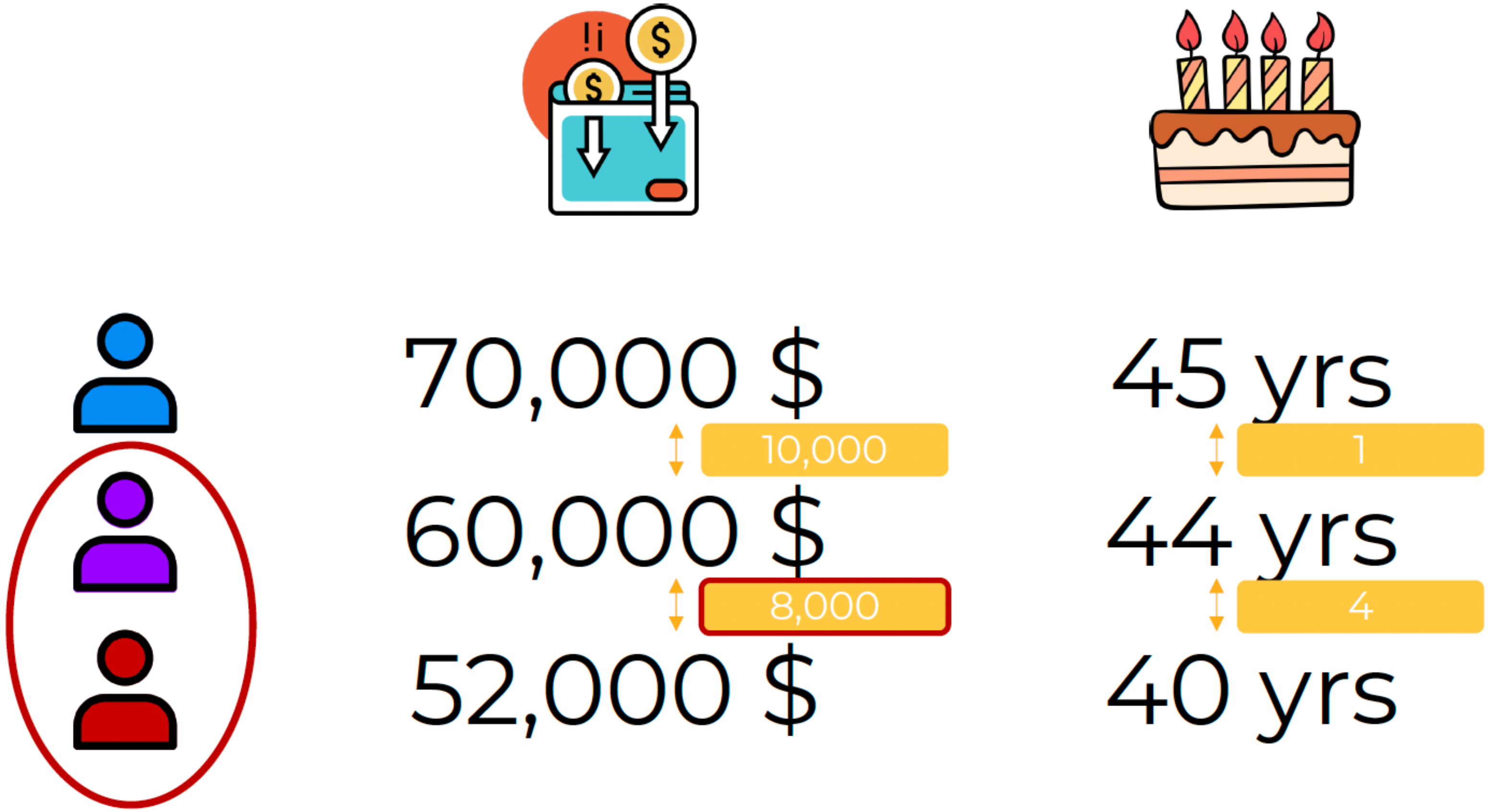
$$X' = \frac{X - X_{min}}{X_{max} - X_{min}}$$

[0 ; 1]

Standard Scaler Normalization

$$X' = \frac{X - \mu}{\sigma}$$

Feature Scaling



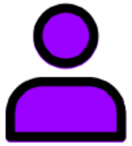
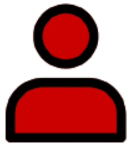
Feature Scaling

Min-Max scaling Normalization

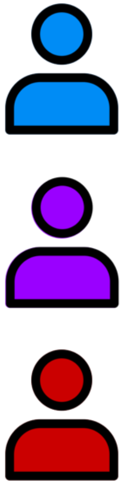
$$X' = \frac{X - X_{min}}{X_{max} - X_{min}}$$

[0 ; 1]

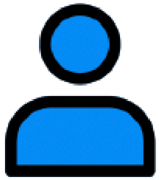
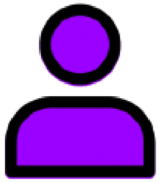
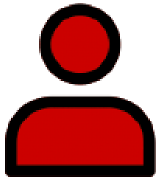
Feature Scaling

		
	70,000 $	45 yrs
	60,000 $	44 yrs
	52,000 $	40 yrs

Feature Scaling

		
	1	45 yrs
	0.444	44 yrs
	0	40 yrs

Feature Scaling

		
	1	1
	0.444	0.75
	0	0

Min-Max scaling Normalization

```python
from sklearn.preprocessing import MinMaxScaler
import pandas as pd
data   = [[-1, 2], [-0.5, 6], [0, 10], [1, 18]]
scaler = MinMaxScaler()


xdata = pd.DataFrame(data, columns=['x1', 'x2'])
xdata
```

✓ 0.0s

	x1	x2
0	-1.0	2
1	-0.5	6
2	0.0	10
3	1.0	18

```python
xscale = scaler.fit_transform(xdata)
xscale = pd.DataFrame(xscale, columns=['x1', 'x2'])
xscale
```

✓ 0.0s

	x1	x2
0	0.00	0.00
1	0.25	0.25
2	0.50	0.50
3	1.00	1.00

```python
x = scaler.inverse_transform(xscale)
x = pd.DataFrame(x,  columns=['x1', 'x2'])
x
```

✓ 0.0s

	x1	x2
0	-1.0	2.0
1	-0.5	6.0
2	0.0	10.0
3	1.0	18.0

$$X' = \frac{X - X_{min}}{X_{max} - X_{min}}$$

$$X = X'(X_{max} - X_{min}) + X_{min}$$

Standard Scaler Normalization

```python
from sklearn.preprocessing import StandardScaler

import pandas as pd
data   = [[-1, 2], [-0.5, 6], [0, 10], [1, 18]]
scaler = StandardScaler()


xdata = pd.DataFrame(data, columns=['x1', 'x2'])
xdata
```

✓ 0.0s

	x1	x2
0	-1.0	2
1	-0.5	6
2	0.0	10
3	1.0	18

```python
xscale = scaler.fit_transform(xdata)
xscale = pd.DataFrame(xscale, columns=['x1', 'x2'])
xscale
```

✓ 0.0s

	x1	x2
0	-1.183216	-1.183216
1	-0.507093	-0.507093
2	0.169031	0.169031
3	1.521278	1.521278

```python
x = scaler.inverse_transform(xscale)
x = pd.DataFrame(x,  columns=['x1', 'x2'])
x
```

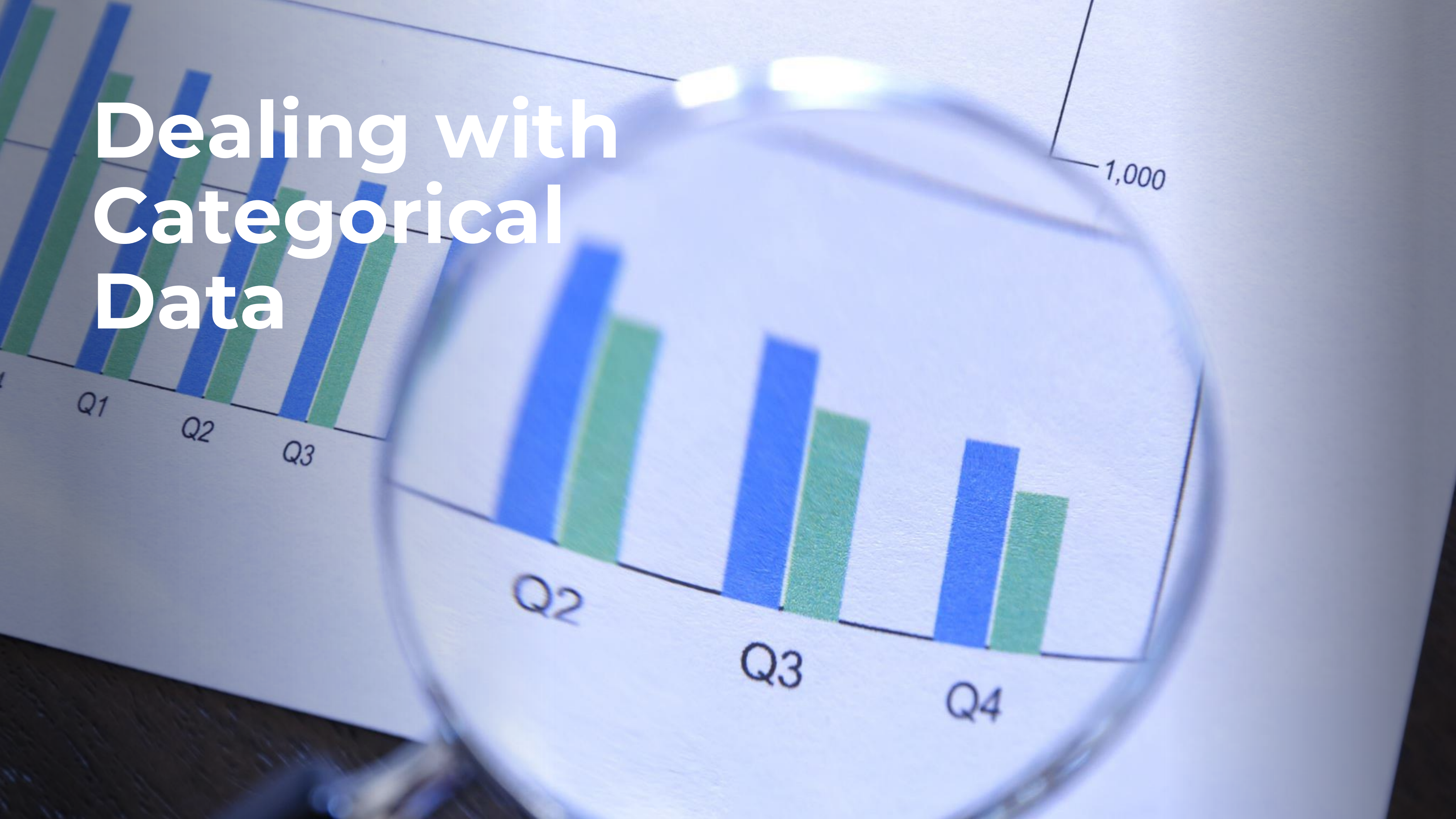
✓ 0.0s

	x1	x2
0	-1.0	2.0
1	-0.5	6.0
2	0.0	10.0
3	1.0	18.0

$$X' = \frac{X - \mu}{\sigma}$$

$$X = \sigma X' + \mu$$

Dealing with Categorical Data



Feature Engineering

- Integer Encoding
  - Directly convert categories into integers 1,2,3…N

Country
USA
MEX
CAN
USA

Feature Engineering

- Integer Encoding
  - Possible issue is implied ordering and relationship (ordinal variable)

Country
USA
MEX
CAN
USA

Country
1
2
3
1

Feature Engineering

- Integer Encoding
  - Pros:
    - Very easy to do and understand.
    - Does not increase number of features.
  - Cons:
    - Implies ordered relationship between categories.

Feature Engineering

* One Hot Encoding (Dummy Variables)
    * Convert categories into individual features that are either 0 or 1

Country
USA
MEX
CAN
USA

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - Convert categories into individual features that are either 0 or 1

Country
USA
MEX
CAN
USA

USA	MEX	CAN
1	0	0
0	1	0
0	0	1
1	0	0

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - No ordered relationship is implied between categories.

Country
USA
MEX
CAN
USA

USA	MEX	CAN
1	0	0
0	1	0
0	0	1
1	0	0

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - We can try to reduce this feature column expansion by creating higher level categories.
  - For example, regions or continents instead of countries.

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - Consider a binary category (only two options):

Vertical Direction
UP
DOWN
UP
DOWN

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - Consider a binary category (only two options):

Vertical Direction
UP
DOWN
UP
DOWN

UP	DOWN
1	0
0	1
1	0
0	1

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - The new columns are duplicate information with inverted encoding.

Vertical Direction
UP
DOWN
UP
DOWN

UP	DOWN
1	0
0	1
1	0
0	1

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - Easily fixed by simply dropping last column.

Vertical Direction
UP
DOWN
UP
DOWN

UP
1
0
1
0

Feature Engineering

- One Hot Encoding (Dummy Variables)
  - This can be extended to more than 2 categories:

Country
USA
MEX
CAN
USA

USA	MEX
1	0
0	1
0	0
1	0

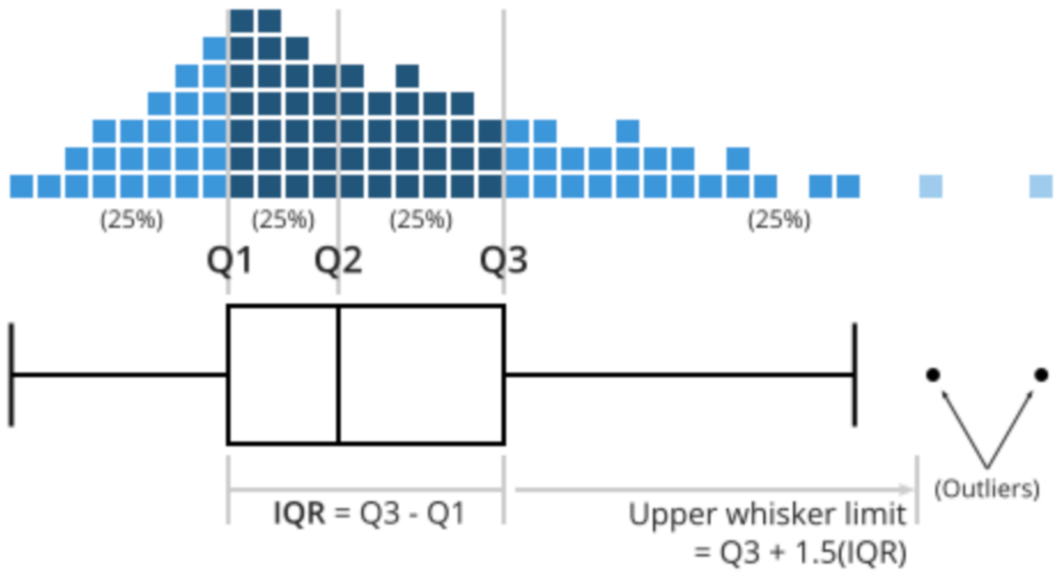
Feature Engineering

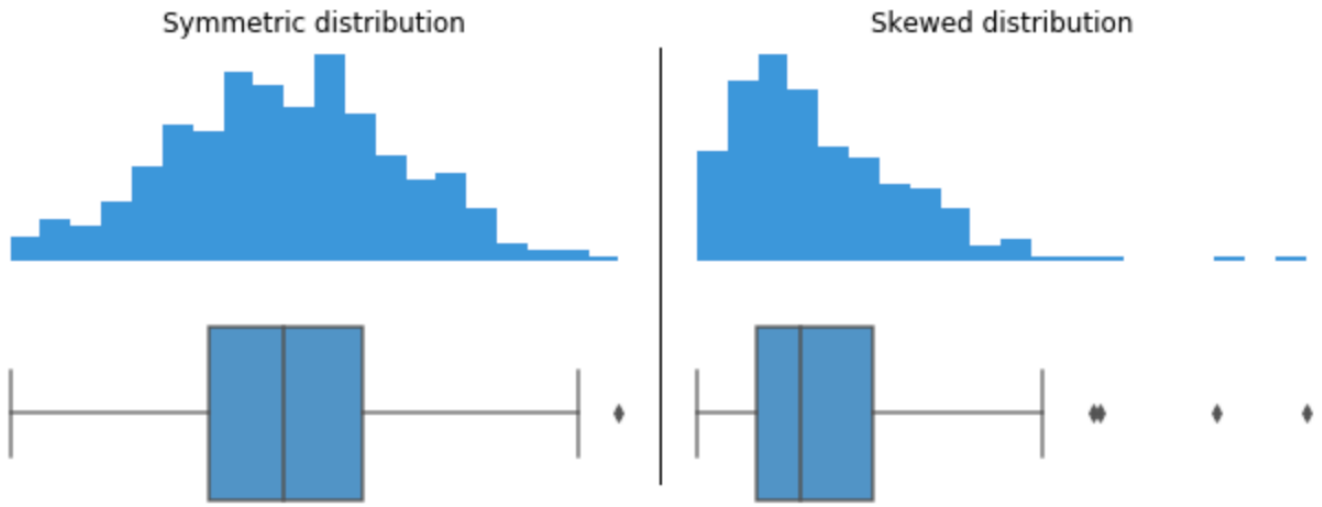
- One Hot Encoding (Dummy Variables)
    - Pros:
        - No ordering implied.
    - Cons:
        - Potential to create many more feature columns and coefficients.
        - Dummy variable trap consideration.
        - Not easy to add new categories.

Dealing with Outliers

Outliers

- Often a data set will have a few points that are extreme outliers.
- It’s often better to simply remove these few points from the data set in order to have a more generalized model.


(25%)
(25%)
(25%)
(25%)
Q1
Q2
Q3
(Outliers)
IQR = Q3 - Q1
Upper whisker limit
= Q3 + 1.5(IQR)


Symmetric distribution
Skewed distribution