# Chapter 7

April 24, 2025

### 0.1 Hands-On Data Preprocessing in Python

Learn how to effectively prepare data for successful data analytics

AUTHOR: Dr. Roy Jafari

## 1 Chapter 7: Classification

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
```

### 1.1 Classification models

#### 1.1.1 Example of designing a classification model

#### 1.1.2 Classification Algorithms

### 1.2 K-Nearest Neighbors (KNN)

#### 1.2.1 Example of using KNN for classification

[2]:
```
applicant_df = pd.read_csv('CustomerLoan.csv')
applicant_df.drop(columns = ['Name'],inplace=True)
applicant_df
```

[2]:

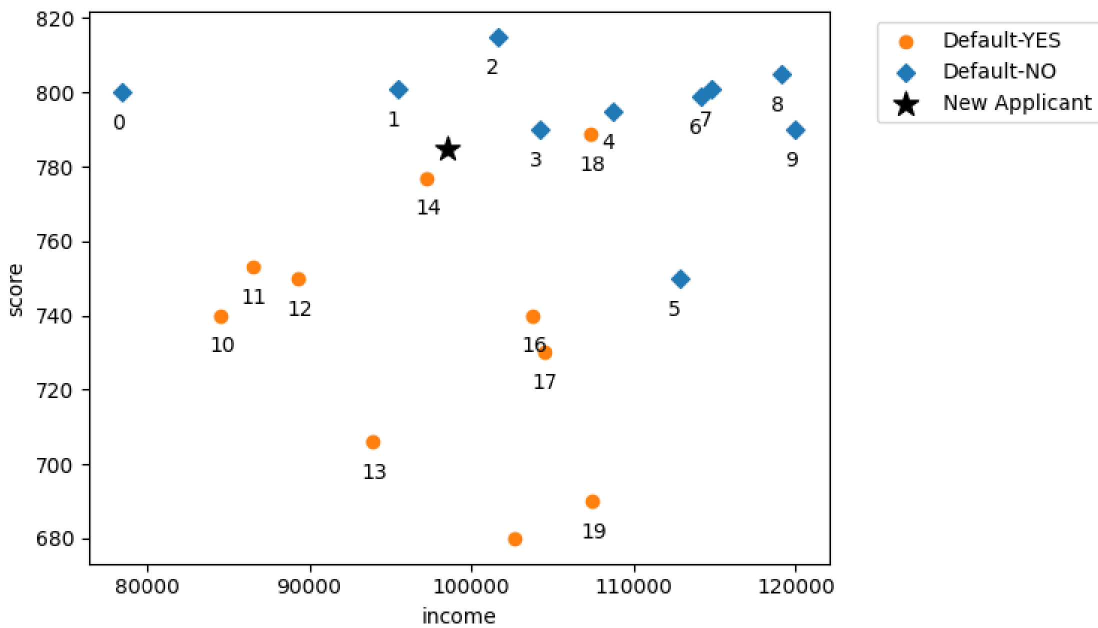
| | income | score | default |
|---|---|---|---|
| 0 | 78479 | 800 | NO |
| 1 | 95483 | 801 | NO |
| 2 | 101641 | 815 | NO |
| 3 | 104234 | 790 | NO |
| 4 | 108726 | 795 | NO |
| 5 | 112845 | 750 | NO |
| 6 | 114114 | 799 | NO |
| 7 | 114799 | 801 | NO |
| 8 | 119147 | 805 | NO |
| 9 | 119976 | 790 | NO |
| 10 | 84519 | 740 | Yes |
| 11 | 86504 | 753 | Yes |
| 12 | 89292 | 750 | Yes |

```
13   93941    706     Yes
14   97262    777     Yes
15  102658    680     Yes
16  103760    740     Yes
17  104451    730     Yes
18  107388    789     Yes
19  107400    690     Yes
20   98487    785     NaN
```

[3]:
```
newApplicant = applicant_df.iloc[20]
newApplicant
```

[3]:
```
income     98487
score        785
default      NaN
Name: 20, dtype: object
```

[4]:
```
applicant_df = pd.read_csv('CustomerLoan.csv')
applicant_df.drop(index = [20],inplace=True)
fig, ax = plt.subplots()

subset = applicant_df.loc[applicant_df['default']=='Yes']
ax.scatter(subset.income, subset.score, marker='o', label='Default-YES',␣
 ↪color='C1')

subset = applicant_df.loc[applicant_df['default']=='NO']
ax.scatter(subset.income, subset.score, marker='D', label='Default-NO',␣
 ↪color='C0')

ax.scatter(newApplicant.income, newApplicant.score, marker='*', label='New␣
 ↪Applicant', color='black', s=150)

plt.xlabel('income')  # set x-axis label
plt.ylabel('score')  # set y-axis label

for _, row in applicant_df.iterrows():
    ax.annotate(row.Name, (row.income -700, row.score-10))

handles, labels = ax.get_legend_handles_labels()

ax.legend(handles, labels, bbox_to_anchor=(1.05, 1))

plt.show()
```




[5]:
```
applicant_df = pd.read_csv('CustomerLoan.csv')
applicant_df['income_Normalized'] = (applicant_df.income - applicant_df.income.
 ↪min())/(applicant_df.income.max() - applicant_df.income.min())
applicant_df['score_Normalized'] = (applicant_df.score - applicant_df.score.
 ↪min())/(applicant_df.score.max() - applicant_df.score.min())
```

[6]:
```
applicant_df.drop(columns = ['Name'])
```

[6]:

| | income | score | default | income_Normalized | score_Normalized |
|---|---|---|---|---|---|
| 0 | 78479 | 800 | NO | 0.000000 | 0.888889 |
| 1 | 95483 | 801 | NO | 0.409765 | 0.896296 |
| 2 | 101641 | 815 | NO | 0.558161 | 1.000000 |
| 3 | 104234 | 790 | NO | 0.620647 | 0.814815 |
| 4 | 108726 | 795 | NO | 0.728896 | 0.851852 |
| 5 | 112845 | 750 | NO | 0.828156 | 0.518519 |
| 6 | 114114 | 799 | NO | 0.858737 | 0.881481 |
| 7 | 114799 | 801 | NO | 0.875244 | 0.896296 |
| 8 | 119147 | 805 | NO | 0.980023 | 0.925926 |
| 9 | 119976 | 790 | NO | 1.000000 | 0.814815 |
| 10 | 84519 | 740 | Yes | 0.145553 | 0.444444 |
| 11 | 86504 | 753 | Yes | 0.193387 | 0.540741 |
| 12 | 89292 | 750 | Yes | 0.260573 | 0.518519 |
| 13 | 93941 | 706 | Yes | 0.372605 | 0.192593 |
| 14 | 97262 | 777 | Yes | 0.452635 | 0.718519 |
| 15 | 102658 | 680 | Yes | 0.582669 | 0.000000 |
| 16 | 103760 | 740 | Yes | 0.609225 | 0.444444 |

```
17  104451    730     Yes            0.625877           0.370370
18  107388    789     Yes            0.696653           0.807407
19  107400    690     Yes            0.696942           0.074074
20   98487    785     NaN            0.482155           0.777778
```

[7]:
```
from sklearn.neighbors import KNeighborsClassifier

predictors = ['income_Normalized','score_Normalized']
target = 'default'

Xs = applicant_df[predictors].drop(index=[20])
y= applicant_df[target].drop(index=[20])

knn = KNeighborsClassifier(n_neighbors=4)
knn.fit(Xs, y)

newApplicant = pd.DataFrame({'income_Normalized':
                             applicant_df.iloc[20].income_Normalized,
                             'score_Normalized':
                             applicant_df.iloc[20].score_Normalized},
                             index = [20])
predict_y = knn.predict(newApplicant)
print(predict_y)
```

```
['NO']
```

## 1.3 Decision Trees

### 1.3.1 Example of using Decision Trees for classification

[10]:
```
from sklearn.tree import DecisionTreeClassifier

predictors = ['income','score']
target = 'default'

Xs = applicant_df[predictors].drop(index=[20])
y= applicant_df[target].drop(index=[20])

classTree = DecisionTreeClassifier()
classTree.fit(Xs, y)

newApplicant = pd.DataFrame({'income':
                             applicant_df.iloc[20].income,
                             'score':
                             applicant_df.iloc[20].score},
                             index = [20])

predict_y = classTree.predict(newApplicant)
```

```python
print(predict_y)
```

['Yes']

[11]:
```python
from sklearn.tree import plot_tree
plot_tree(classTree,
        feature_names=predictors,
        class_names=y.unique(),
        filled=True,
        impurity=False)
plt.show()
```