Hamed-Mohammadzadeh-9812762418

June 2, 2022

[86]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

1 Exploring the Data:

[87]:
```
raw_data = pd.read_csv('data/train.csv')
raw_data.head()
```

[87]:
```
   Unnamed: 0      id  Gender      Customer Type  Age   Type of Travel  \
0           0   70172    Male     Loyal Customer   13  Personal Travel
1           1    5047    Male  disloyal Customer   25  Business travel
2           2  110028  Female     Loyal Customer   26  Business travel
3           3   24026  Female     Loyal Customer   25  Business travel
4           4  119299    Male     Loyal Customer   61  Business travel

      Class  Flight Distance  Inflight wifi service  \
0  Eco Plus              460                      3
1  Business              235                      3
2  Business             1142                      2
3  Business              562                      2
4  Business              214                      3

   Departure/Arrival time convenient  …  Inflight entertainment  \
0                                  4  …                       5
1                                  2  …                       1
2                                  2  …                       5
3                                  5  …                       2
4                                  3  …                       3

   On-board service  Leg room service  Baggage handling  Checkin service  \
0                 4                 3                 4                4
1                 1                 5                 3                1
2                 4                 3                 4                4
3                 2                 5                 3                1
```

```
4                  3                  4                  4                 3

   Inflight service  Cleanliness  Departure Delay in Minutes  \
0                 5            5                          25
1                 4            1                           1
2                 4            5                           0
3                 4            2                          11
4                 3            3                           0

   Arrival Delay in Minutes             satisfaction
0                      18.0  neutral or dissatisfied
1                       6.0  neutral or dissatisfied
2                       0.0                satisfied
3                       9.0  neutral or dissatisfied
4                       0.0                satisfied

[5 rows x 25 columns]
```

2 PreProcessing:

- drop unnamed column
- drop id column
- drop rows that have Nan

[88]:
```python
data = raw_data.drop(['id', 'Unnamed: 0'], axis=1)
data = data.dropna(axis=0)
```

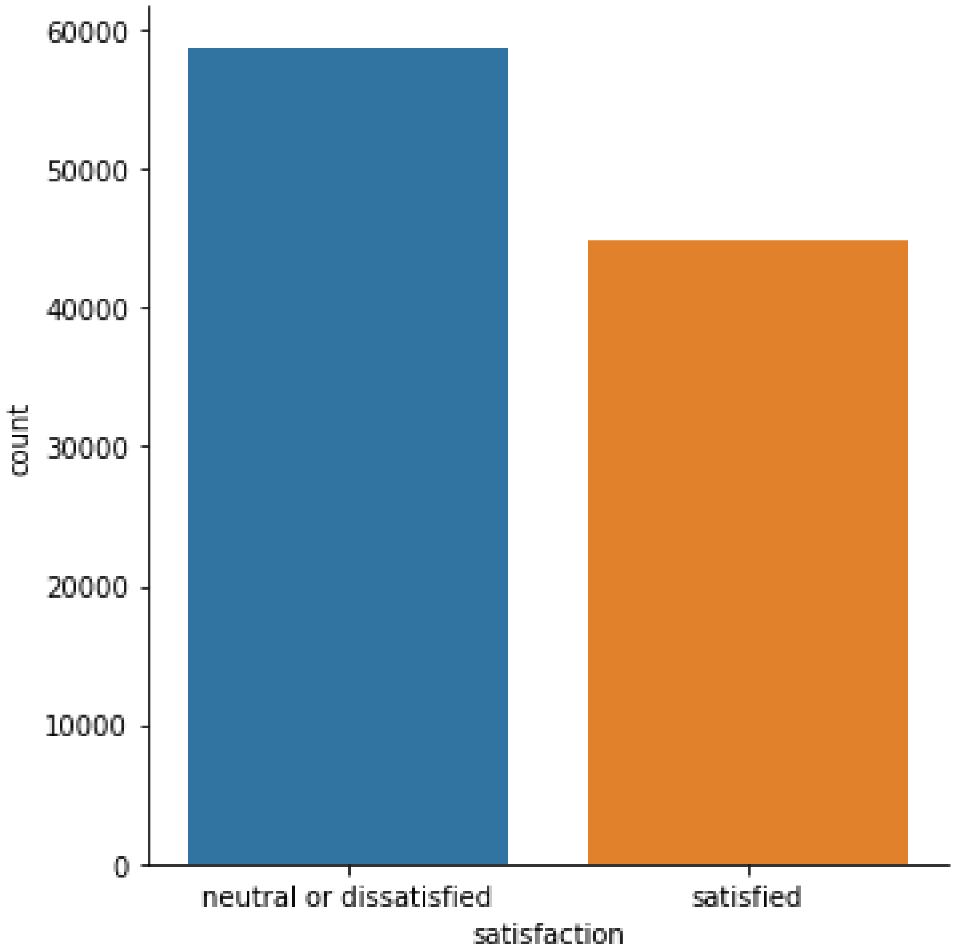
[89]:
```python
data.describe()
```

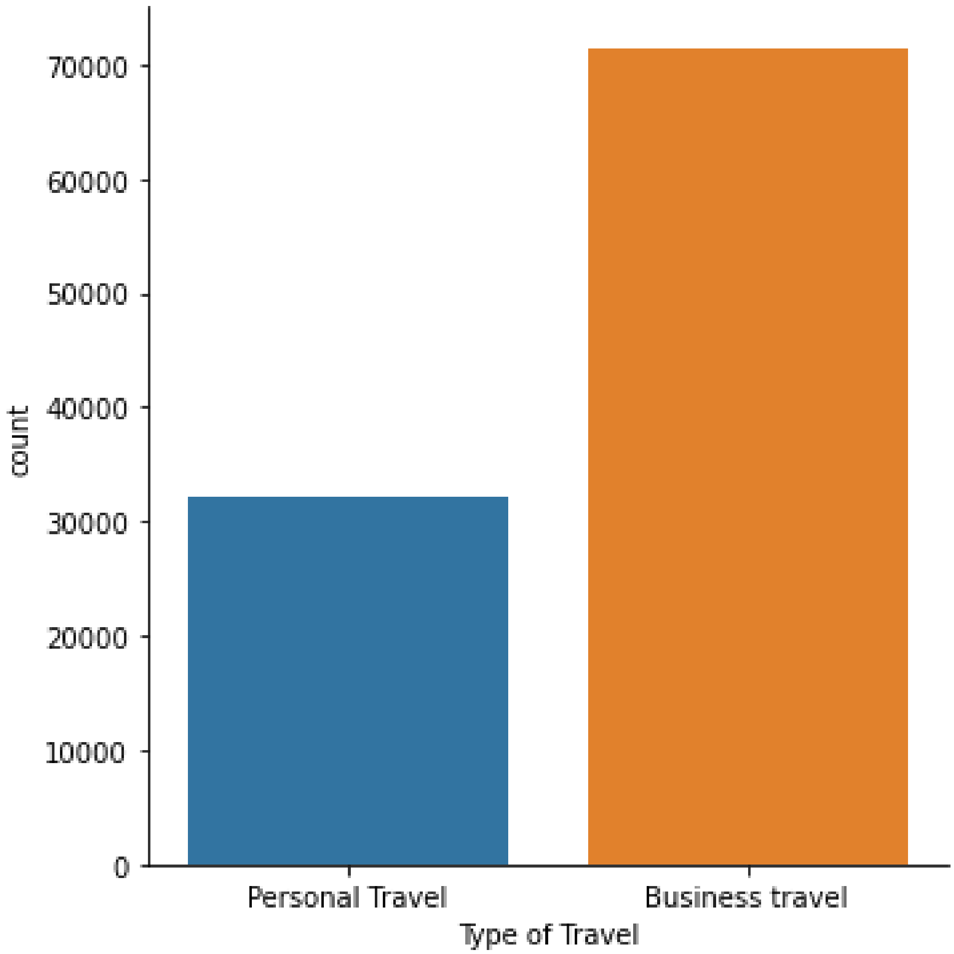
[89]:
```
                 Age  Flight Distance  Inflight wifi service  \
count  103594.000000    103594.000000          103594.000000
mean       39.380466      1189.325202               2.729753
std        15.113125       997.297235               1.327866
min         7.000000        31.000000               0.000000
25%        27.000000       414.000000               2.000000
50%        40.000000       842.000000               3.000000
75%        51.000000      1743.000000               4.000000
max        85.000000      4983.000000               5.000000

       Departure/Arrival time convenient  Ease of Online booking  \
count                      103594.000000           103594.000000
mean                            3.060081                2.756984
std                             1.525233                1.398934
min                             0.000000                0.000000
25%                             2.000000                2.000000
50%                             3.000000                3.000000
```

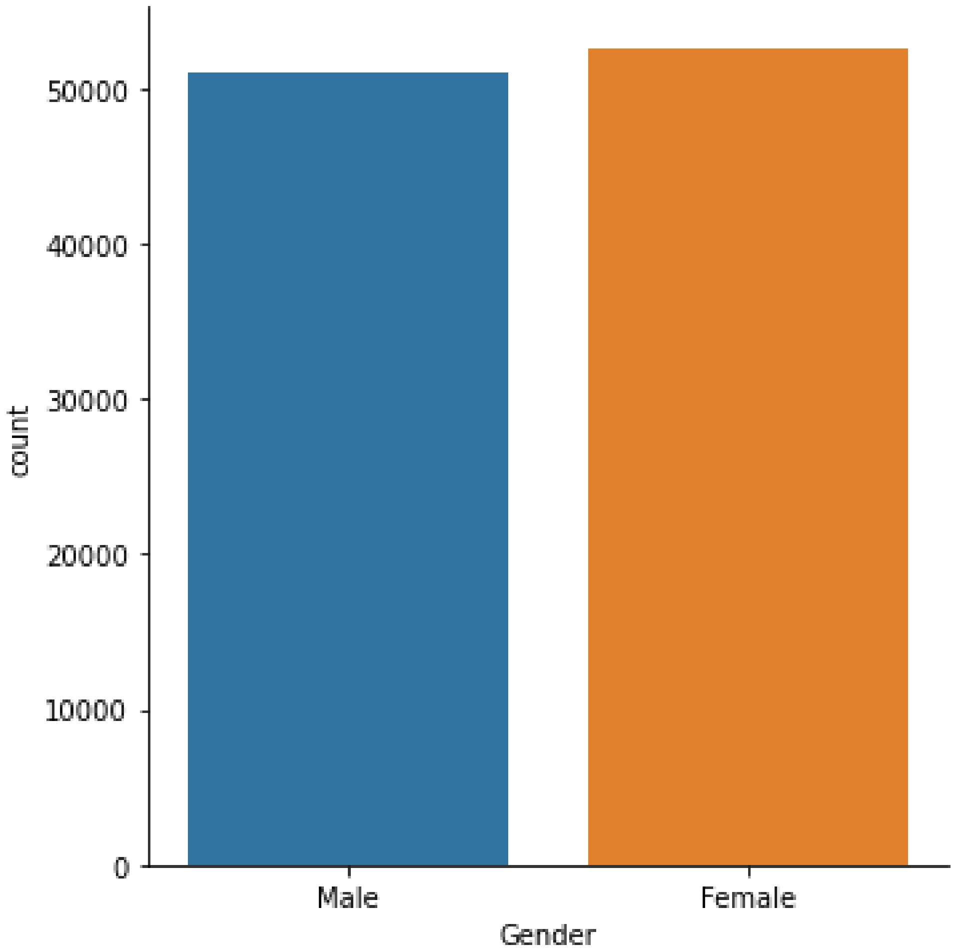
```
75%                                4.000000                 4.000000
max                                5.000000                 5.000000

       Gate location  Food and drink  Online boarding   Seat comfort  \
count  103594.000000   103594.000000    103594.000000  103594.000000
mean        2.977026        3.202126         3.250497       3.439765
std         1.277723        1.329401         1.349433       1.318896
min         0.000000        0.000000         0.000000       0.000000
25%         2.000000        2.000000         2.000000       2.000000
50%         3.000000        3.000000         3.000000       4.000000
75%         4.000000        4.000000         4.000000       5.000000
max         5.000000        5.000000         5.000000       5.000000

       Inflight entertainment  On-board service  Leg room service  \
count           103594.000000     103594.000000     103594.000000
mean                 3.358341          3.382609          3.351401
std                  1.333030          1.288284          1.315409
min                  0.000000          0.000000          0.000000
25%                  2.000000          2.000000          2.000000
50%                  4.000000          4.000000          4.000000
75%                  4.000000          4.000000          4.000000
max                  5.000000          5.000000          5.000000

       Baggage handling  Checkin service  Inflight service    Cleanliness  \
count     103594.000000    103594.000000     103594.000000  103594.000000
mean           3.631687         3.304323          3.640761       3.286397
std            1.181051         1.265396          1.175603       1.312194
min            1.000000         0.000000          0.000000       0.000000
25%            3.000000         3.000000          3.000000       2.000000
50%            4.000000         3.000000          4.000000       3.000000
75%            5.000000         4.000000          5.000000       4.000000
max            5.000000         5.000000          5.000000       5.000000

       Departure Delay in Minutes  Arrival Delay in Minutes
count               103594.000000             103594.000000
mean                    14.747939                 15.178678
std                     38.116737                 38.698682
min                      0.000000                  0.000000
25%                      0.000000                  0.000000
50%                      0.000000                  0.000000
75%                     12.000000                 13.000000
max                   1592.000000               1584.000000
```

2.0.1 Change categorical data to numeric(using one hot encoding):

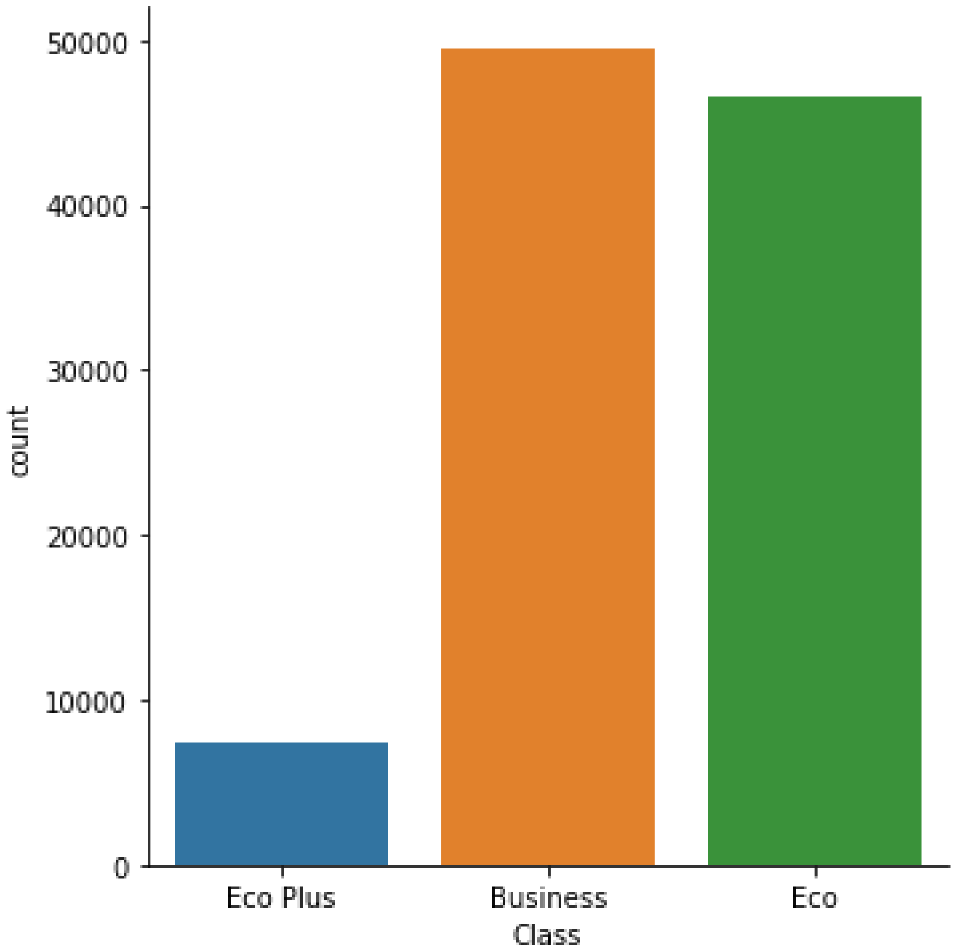
[90]:
```
cat_cols = list(set(data.columns) - set(data._get_numeric_data().columns))
for s in cat_cols:
    sns.catplot(x=s, kind="count", data=data)
```

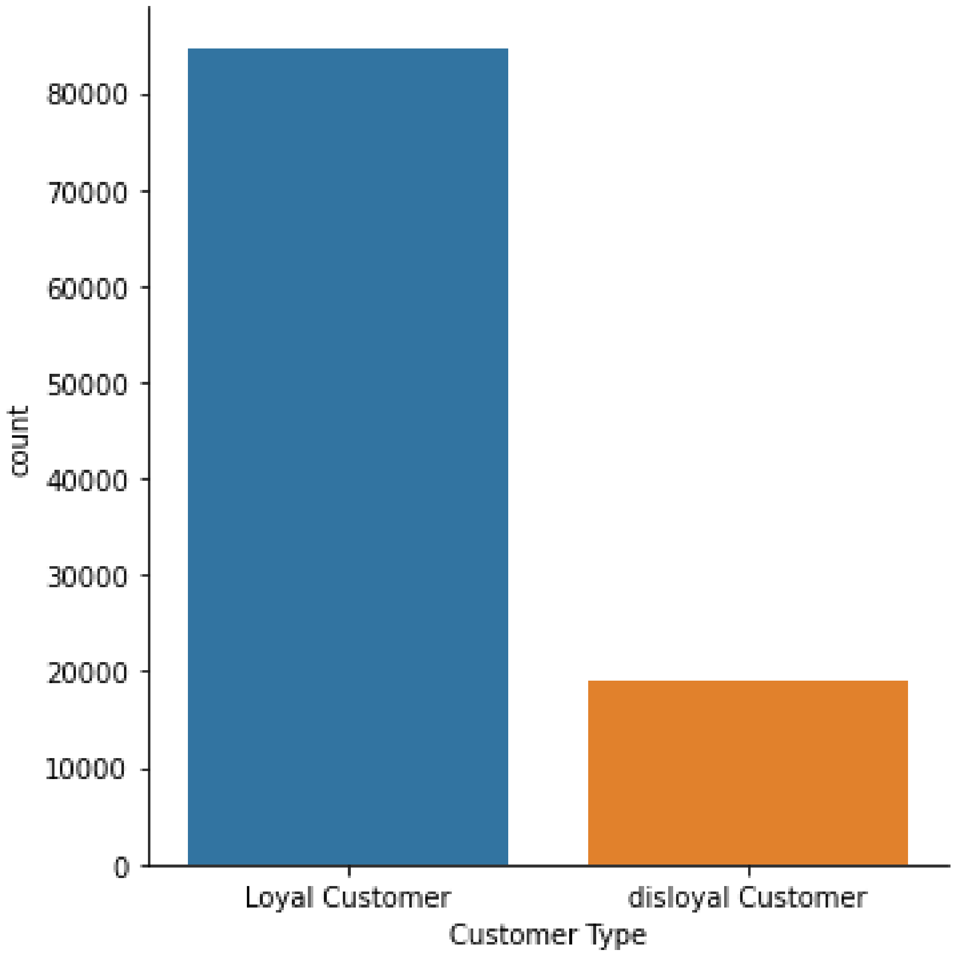



70000
60000
50000
40000
30000
20000
10000
0
count
Personal Travel
Business travel
Type of Travel



50000
40000
30000
20000
10000
0
count
Male
Female
Gender


50000
40000
30000
20000
10000
0
count
Eco Plus
Business
Eco
Class



[91]:
```
encd_data = pd.get_dummies(data, columns =␣
↪list(set(cat_cols)-set(['satisfaction'])))
encd_data['satisfaction'].replace(['neutral or dissatisfied', 'satisfied'], [0,␣
↪1], inplace=True)

print(encd_data.columns)
```

```
Index(['Age', 'Flight Distance', 'Inflight wifi service',
       'Departure/Arrival time convenient', 'Ease of Online booking',
       'Gate location', 'Food and drink', 'Online boarding', 'Seat comfort',
       'Inflight entertainment', 'On-board service', 'Leg room service',
       'Baggage handling', 'Checkin service', 'Inflight service',
       'Cleanliness', 'Departure Delay in Minutes', 'Arrival Delay in Minutes',
       'satisfaction', 'Gender_Female', 'Gender_Male',
       'Type of Travel_Business travel', 'Type of Travel_Personal Travel',
       'Class_Business', 'Class_Eco', 'Class_Eco Plus',
       'Customer Type_Loyal Customer', 'Customer Type_disloyal Customer'],
```

```
    dtype='object')
```

[92]:
```
encd_data.describe()
```

[92]:
```
                  Age  Flight Distance  Inflight wifi service  \
count   103594.000000    103594.000000          103594.000000
mean        39.380466      1189.325202               2.729753
std         15.113125       997.297235               1.327866
min          7.000000        31.000000               0.000000
25%         27.000000       414.000000               2.000000
50%         40.000000       842.000000               3.000000
75%         51.000000      1743.000000               4.000000
max         85.000000      4983.000000               5.000000

       Departure/Arrival time convenient  Ease of Online booking  \
count                      103594.000000           103594.000000
mean                            3.060081                2.756984
std                             1.525233                1.398934
min                             0.000000                0.000000
25%                             2.000000                2.000000
50%                             3.000000                3.000000
75%                             4.000000                4.000000
max                             5.000000                5.000000

       Gate location  Food and drink  Online boarding   Seat comfort  \
count  103594.000000   103594.000000    103594.000000  103594.000000
mean        2.977026        3.202126         3.250497       3.439765
std         1.277723        1.329401         1.349433       1.318896
min         0.000000        0.000000         0.000000       0.000000
25%         2.000000        2.000000         2.000000       2.000000
50%         3.000000        3.000000         3.000000       4.000000
75%         4.000000        4.000000         4.000000       5.000000
max         5.000000        5.000000         5.000000       5.000000

       Inflight entertainment  …   satisfaction  Gender_Female  \
count           103594.000000  …  103594.000000  103594.000000
mean                 3.358341  …       0.433394       0.507520
std                  1.333030  …       0.495546       0.499946
min                  0.000000  …       0.000000       0.000000
25%                  2.000000  …       0.000000       0.000000
50%                  4.000000  …       0.000000       1.000000
75%                  4.000000  …       1.000000       1.000000
max                  5.000000  …       1.000000       1.000000

         Gender_Male  Type of Travel_Business travel  \
count  103594.000000                   103594.000000
mean        0.492480                        0.689857
```

```
std         0.499946                         0.462554
min         0.000000                         0.000000
25%         0.000000                         0.000000
50%         0.000000                         1.000000
75%         1.000000                         1.000000
max         1.000000                         1.000000

       Type of Travel_Personal Travel  Class_Business      Class_Eco  \
count                   103594.000000   103594.000000  103594.000000
mean                         0.310143        0.478145       0.449765
std                          0.462554        0.499525       0.497472
min                          0.000000        0.000000       0.000000
25%                          0.000000        0.000000       0.000000
50%                          0.000000        0.000000       0.000000
75%                          1.000000        1.000000       1.000000
max                          1.000000        1.000000       1.000000

       Class_Eco Plus  Customer Type_Loyal Customer  \
count   103594.000000                 103594.000000
mean         0.072089                      0.817248
std          0.258637                      0.386465
min          0.000000                      0.000000
25%          0.000000                      1.000000
50%          0.000000                      1.000000
75%          0.000000                      1.000000
max          1.000000                      1.000000

       Customer Type_disloyal Customer
count                    103594.000000
mean                          0.182752
std                           0.386465
min                           0.000000
25%                           0.000000
50%                           0.000000
75%                           0.000000
max                           1.000000

[8 rows x 28 columns]
```

2.0.2 Normalize, using min max scaling:

[93]:
```python
def min_max_scaling(series):
    return (series - series.min()) / (series.max() - series.min())

for col in encd_data.drop(['satisfaction'], axis=1).columns:
    encd_data[col] = min_max_scaling(encd_data[col])
```

```
encd_data.describe()
```

[93]:

```
                 Age  Flight Distance  Inflight wifi service  \
count  103594.000000    103594.000000          103594.000000
mean        0.415134         0.233911               0.545951
std         0.193758         0.201393               0.265573
min         0.000000         0.000000               0.000000
25%         0.256410         0.077342               0.400000
50%         0.423077         0.163772               0.600000
75%         0.564103         0.345719               0.800000
max         1.000000         1.000000               1.000000

       Departure/Arrival time convenient  Ease of Online booking  \
count                      103594.000000           103594.000000
mean                            0.612016                0.551397
std                             0.305047                0.279787
min                             0.000000                0.000000
25%                             0.400000                0.400000
50%                             0.600000                0.600000
75%                             0.800000                0.800000
max                             1.000000                1.000000

       Gate location  Food and drink  Online boarding   Seat comfort  \
count  103594.000000   103594.000000    103594.000000  103594.000000
mean        0.595405        0.640425         0.650099       0.687953
std         0.255545        0.265880         0.269887       0.263779
min         0.000000        0.000000         0.000000       0.000000
25%         0.400000        0.400000         0.400000       0.400000
50%         0.600000        0.600000         0.600000       0.800000
75%         0.800000        0.800000         0.800000       1.000000
max         1.000000        1.000000         1.000000       1.000000

       Inflight entertainment  …   satisfaction  Gender_Female  \
count           103594.000000  …  103594.000000  103594.000000
mean                 0.671668  …       0.433394       0.507520
std                  0.266606  …       0.495546       0.499946
min                  0.000000  …       0.000000       0.000000
25%                  0.400000  …       0.000000       0.000000
50%                  0.800000  …       0.000000       1.000000
75%                  0.800000  …       1.000000       1.000000
max                  1.000000  …       1.000000       1.000000

         Gender_Male  Type of Travel_Business travel  \
count  103594.000000                   103594.000000
mean        0.492480                        0.689857
std         0.499946                        0.462554
min         0.000000                        0.000000
```

```
25%         0.000000                              0.000000
50%         0.000000                              1.000000
75%         1.000000                              1.000000
max         1.000000                              1.000000

       Type of Travel_Personal Travel  Class_Business      Class_Eco  \
count                   103594.000000   103594.000000  103594.000000
mean                         0.310143        0.478145       0.449765
std                          0.462554        0.499525       0.497472
min                          0.000000        0.000000       0.000000
25%                          0.000000        0.000000       0.000000
50%                          0.000000        0.000000       0.000000
75%                          1.000000        1.000000       1.000000
max                          1.000000        1.000000       1.000000

       Class_Eco Plus  Customer Type_Loyal Customer  \
count   103594.000000                 103594.000000
mean         0.072089                      0.817248
std          0.258637                      0.386465
min          0.000000                      0.000000
25%          0.000000                      1.000000
50%          0.000000                      1.000000
75%          0.000000                      1.000000
max          1.000000                      1.000000

       Customer Type_disloyal Customer
count                    103594.000000
mean                          0.182752
std                           0.386465
min                           0.000000
25%                           0.000000
50%                           0.000000
75%                           0.000000
max                           1.000000

[8 rows x 28 columns]
```

[94]:

```
# a function to do preprocessing
def preprocess(df):
    df = df.drop(['id', 'Unnamed: 0'], axis=1)
    df = df.dropna(axis=0)
    cat_cols = list(set(df.columns) - set(df._get_numeric_data().columns))
    encd_data = pd.get_dummies(df, columns =␣
↪list(set(cat_cols)-set(['satisfaction'])))
    encd_data['satisfaction'].replace(['neutral or dissatisfied', 'satisfied'],
                                [0, 1], inplace=True)
```

```
    for col in encd_data.drop(['satisfaction'], axis=1).columns:
        encd_data[col] = min_max_scaling(encd_data[col])

    return encd_data
```

3 Perceptron

[95]:
```
from sklearn.linear_model import Perceptron
```

[96]:
```
X = encd_data.drop('satisfaction', axis=1)
y = encd_data['satisfaction']

perceptron = Perceptron(eta0=0.4, tol=None, max_iter= 1500)
# eta0 -> learing rate
# tol  -> The stopping criterion. If it is not None, the iterations will stop␣
↪when (loss > previous_loss - tol).
# max_iterint -> The maximum number of passes over the training data (aka␣
↪epochs)
perceptron.fit(X, y)
```

[96]:
```
Perceptron(eta0=0.4, max_iter=1500, tol=None)
```

[97]:
```
training_data_accuracy = perceptron.score(X, y)
training_data_accuracy
# Returns the mean accuracy on the given test data and labels.
```

[97]:
```
0.8305886441299689
```

3.0.1 Test data:

[98]:
```
test_data = pd.read_csv('data/test.csv')

encd_test_data = preprocess(test_data)

X_test = encd_test_data.drop('satisfaction', axis=1)
y_test = encd_test_data['satisfaction']

testing_data_accuracy = perceptron.score(X_test, y_test)
testing_data_accuracy
```

[98]:
```
0.8335843664310818
```

4 Kernel trick using feature maps:

4.1 RBF feature mapping:

- Feature mapping explained
- rbf feature mapping
- rbf sampler
- Kernel perceptron

[99]:
```
from sklearn.kernel_approximation import RBFSampler

rbf_feature = RBFSampler(n_components=3200, gamma=1/40, random_state=1)
X_rbf_mapping = rbf_feature.fit_transform(X)
```

[100]:
```
X_rbf_mapping.shape
```

[100]:
```
(103594, 3200)
```

[101]:
```
clf = Perceptron(eta0=0.1, tol=1e-3)
clf.fit(X_rbf_mapping, y)
clf.score(X_rbf_mapping, y)
```

[101]:
```
0.9166457516844605
```

[102]:
```
test_data = pd.read_csv('data/test.csv')

encd_test_data = preprocess(test_data)

X_test = encd_test_data.drop('satisfaction', axis=1)
y_test = encd_test_data['satisfaction']

X_test_rbf = rbf_feature.transform(X_test)
clf.score(X_test_rbf, y_test)
```

[102]:
```
0.9197852701502337
```