Predicting Airline Passenger Satisfaction

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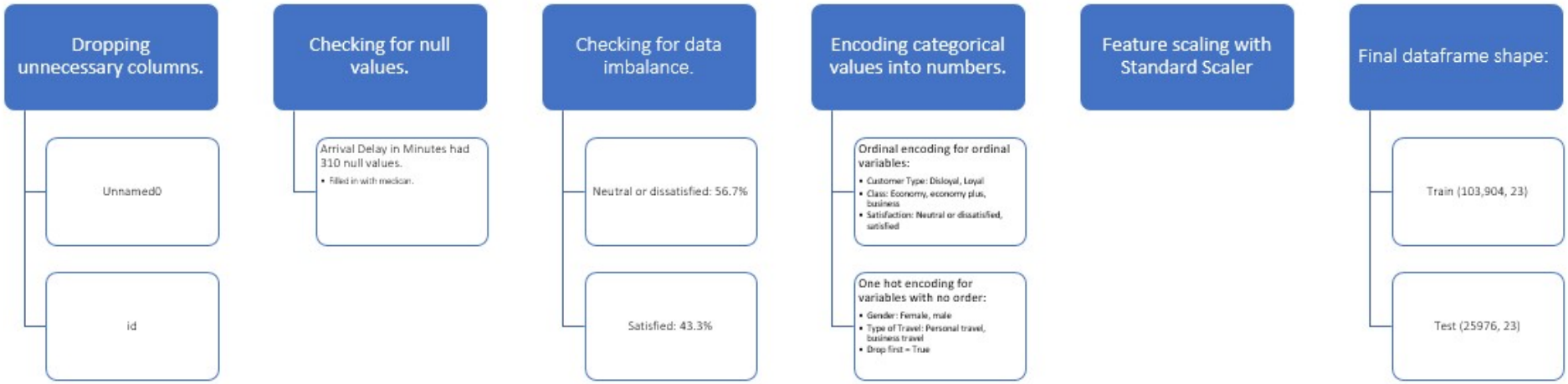
Aim

- Given survey data from an airline, predict customer satisfaction (satisfied or dissatisfied) using ML algorithms.
- Conduct EDA and data visualization to better understand the data.
- Potential business value:
  - Understand which features have the biggest impact on customer satisfaction and work towards improving those features.

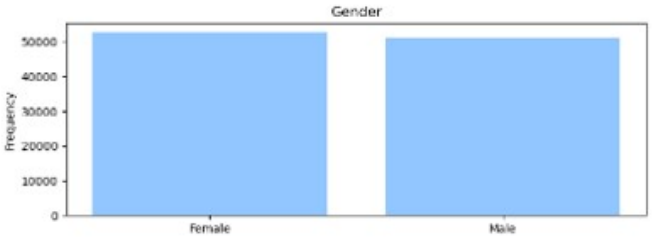
Data Collection

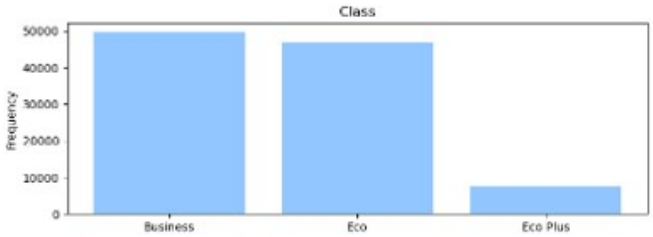
Dataset from Kaggle.	• Already split into train (80% of data) and test (20% of data) files.
Total Dataset: 129,880 records with 25 columns	• Train: 103,904 records • Test: 25,976 records
Categorical variables include:	• Gender, customer type, type of travel, class • Target variable: Satisfaction

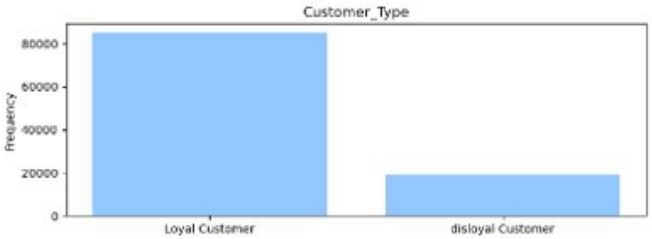
Data Preprocessing

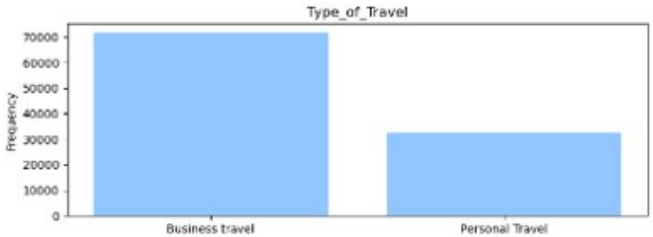


EDA – Categorical Variables Distribution

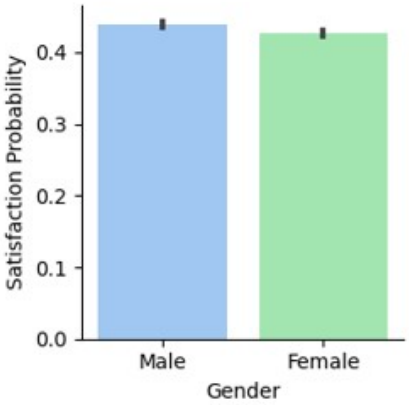




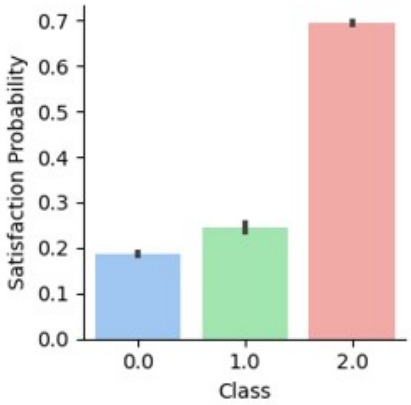




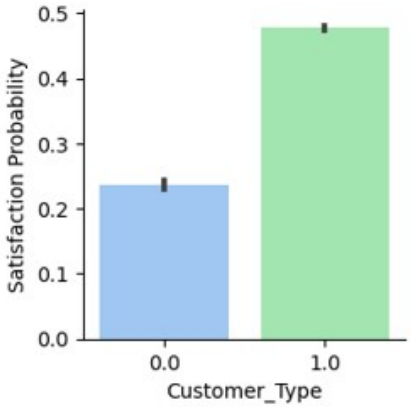
EDA – Relationship with Satisfaction



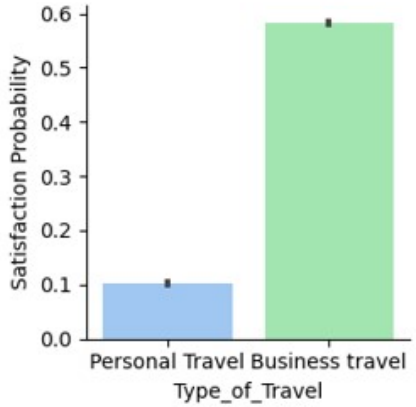
	Gender	satisfaction
1	Male	0.439475
0	Female	0.427371



	Class	satisfaction
2	2.0	0.694251
1	1.0	0.246064
0	0.0	0.186138

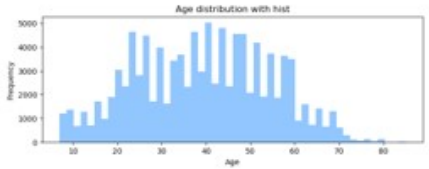


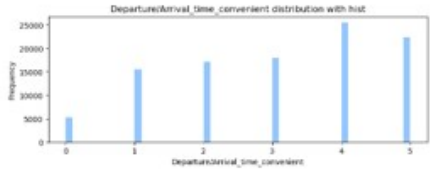
	Customer_Type	satisfaction
1	1.0	0.477291
0	0.0	0.236658

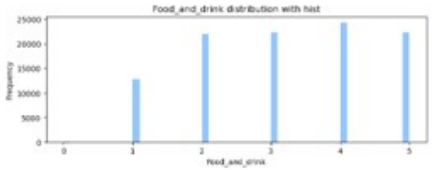


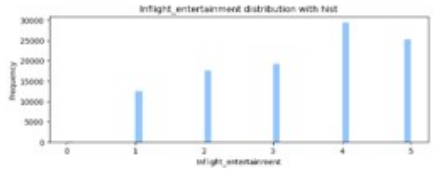
	Type_of_Travel	satisfaction
0	Business travel	0.582597
1	Personal Travel	0.101678

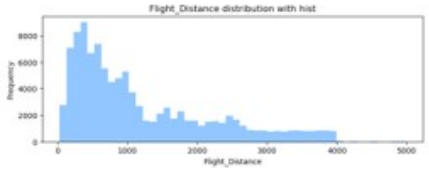
EDA – Numerical Variables Distribution

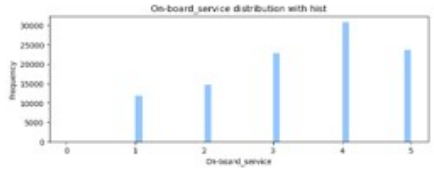


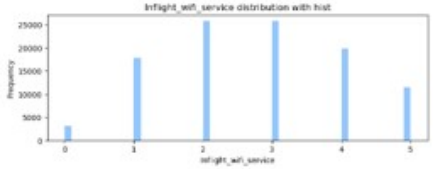


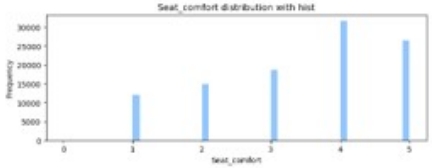


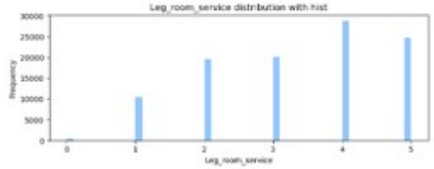


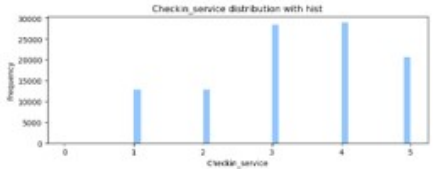


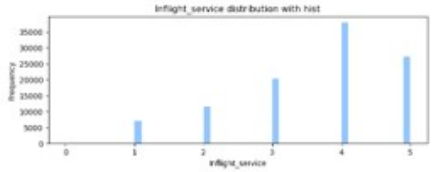


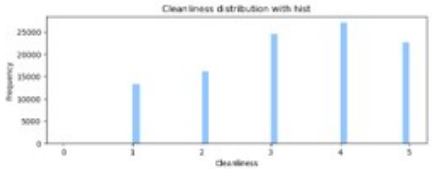


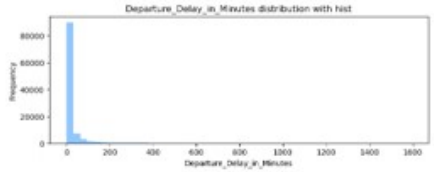


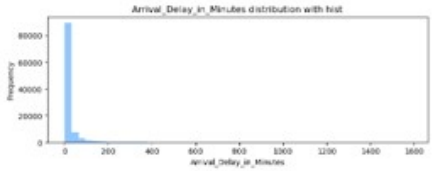






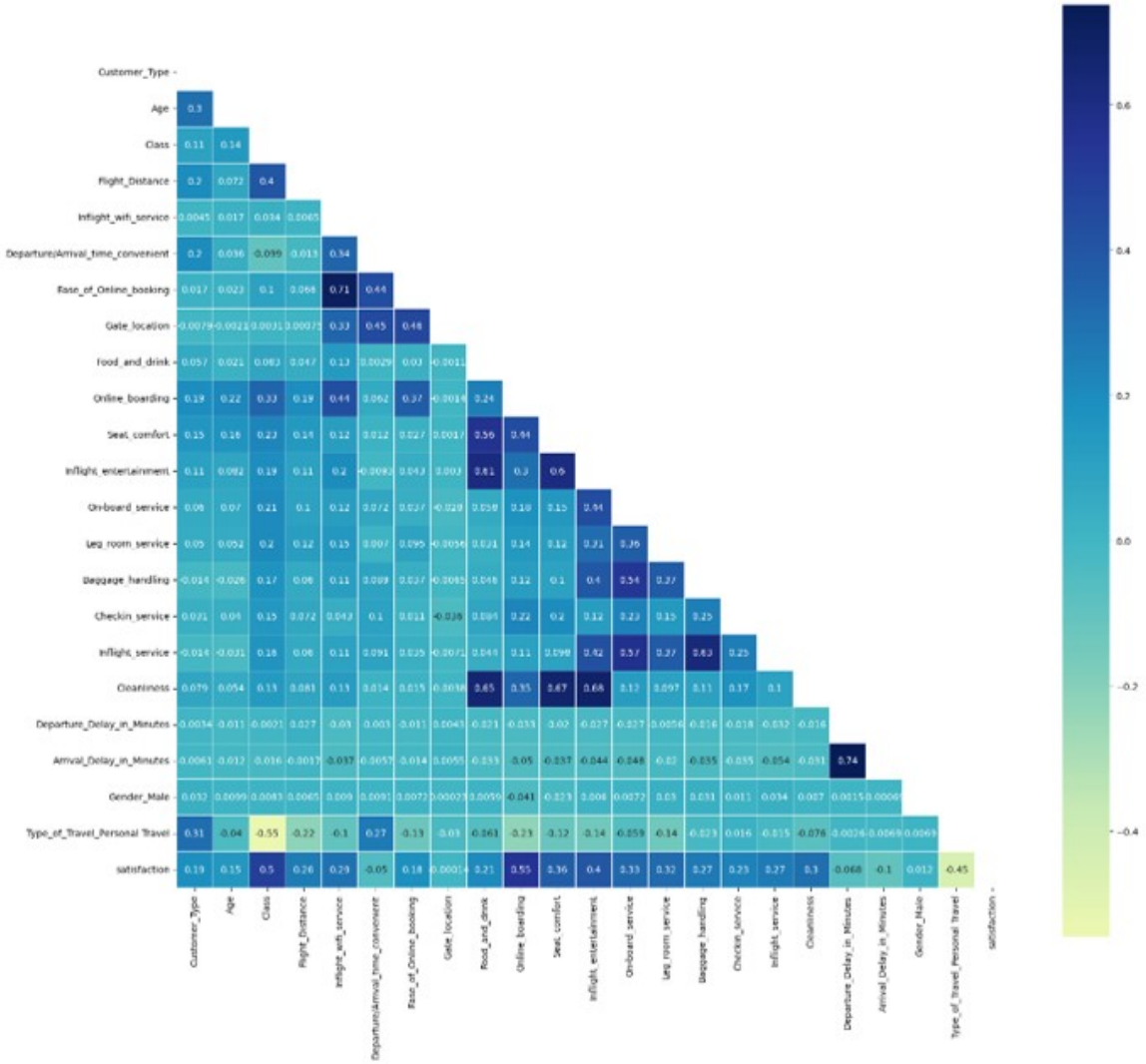




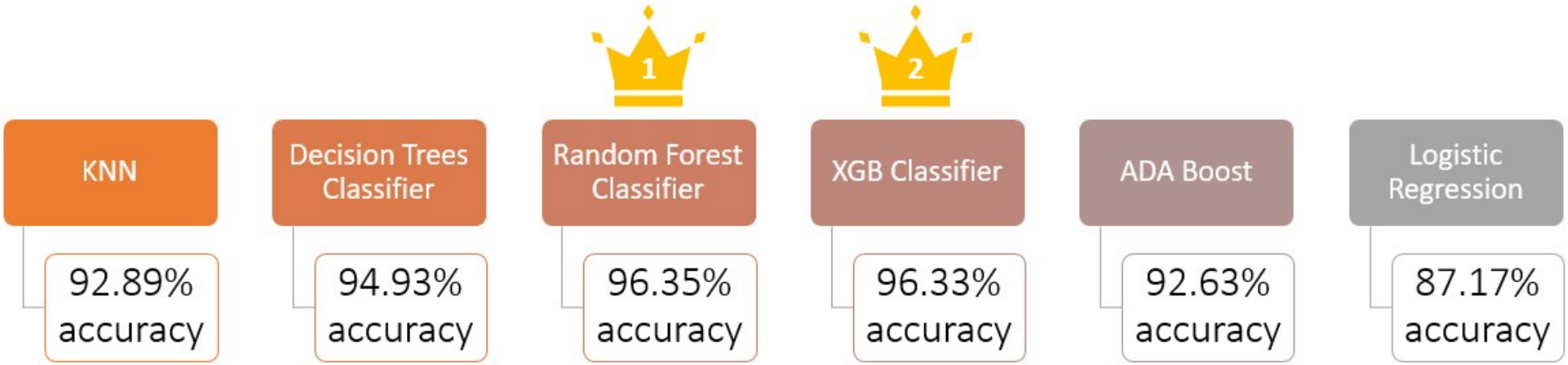


EDA - Correlation Heat Map

- Shows which features correlate well with customer satisfaction.
- Best features
  - Online Booking, Class, and Inflight Entertainment
- Worst features
  - Type of Travel, Arrival Delay in Minutes, Departure/Arrival time convenient



Machine Learning Algorithms

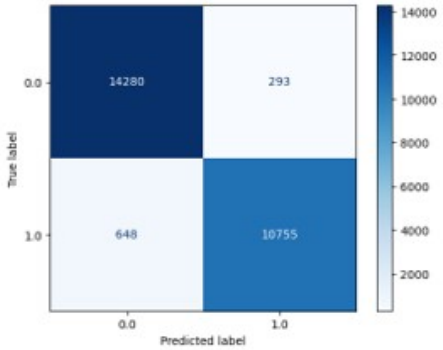


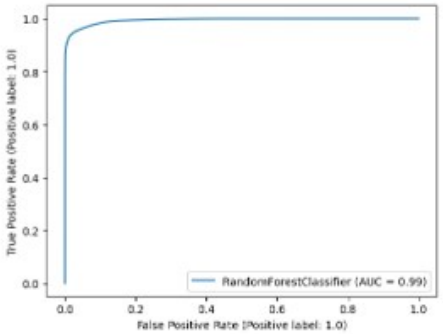
Model 1

Random Forest Classifier

Accuracy: 96.35%

Next steps: PCA, Grid Search





	precision	recall	f1-score	support
0.0	0.96	0.98	0.97	14573
1.0	0.97	0.94	0.96	11403
accuracy			0.96	25976
macro avg	0.96	0.96	0.96	25976
weighted avg	0.96	0.96	0.96	25976

Model 1: Dimensionality Reduction PCA

First PCA application

- PCA(n_components = 5)
- Accuracy = 89.01%

Second PCA application

- PCA(0.95)
- Accuracy = 93.28%

Proceeded with the original X_train and X_test value.

Grid Search

In [177]:
```
param_grid = {
    'n_estimators' : [int(x) for x in np.linspace(start = 800, stop = 1600, num = 3)],
    'max_features' : ['auto', 'sqrt'],
    'max_depth' : [int(x) for x in np.linspace(10, 110, num = 3)],
    'min_samples_split' : [5, 10],
    'min_samples_leaf' : [2, 4],
    'bootstrap' : [True, False]
}
```

In [178]:
```
print(param_grid)
```

```
{'n_estimators': [800, 1200, 1600], 'max_features': ['auto', 'sqrt'], 'max_depth': [10, 60, 110], 'mi
n_samples_split': [5, 10], 'min_samples_leaf': [2, 4], 'bootstrap': [True, False]}
```

In [179]:
```
# Create a based model
rf_gd = RandomForestClassifier()
```

In [180]:
```
grid_search = GridSearchCV(estimator = rf_gd, param_grid = param_grid,
                           cv = 2, n_jobs = -1, verbose = 2)
```

Model 1: Grid Search

6 parameters were tuned.

There were a total of 144 combinations.

Fitted 2 folds, creating 288 fits in total.

Model 1:

Grid Search Results

```
best_grid = grid_search.best_estimator_
grid_accuracy = evaluate(best_grid, X_train, y_train)
```

```
Model Performance
Accuracy is: 99.92300585155527 %
```

```
base_model = RandomForestClassifier(n_estimators = 1000)
base_model.fit(X_train, y_train)
base_accuracy = evaluate(base_model, X_test, y_test)
```

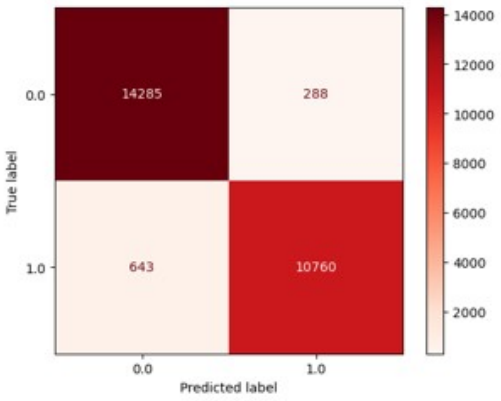
```
Model Performance
Accuracy is: 96.34662765629812 %
```

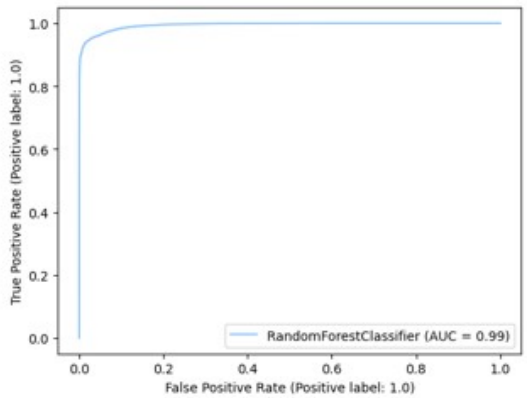
```
print('Improvement of {:0.2f}%.'.format( 100 * (grid_accuracy - base_accuracy) / base_accuracy))
```

```
Improvement of 3.71%.
```

```
best_grid
```

```
RandomForestClassifier(bootstrap=False, max_depth=60, min_samples_leaf=2,
                       min_samples_split=5, n_estimators=1600)
```



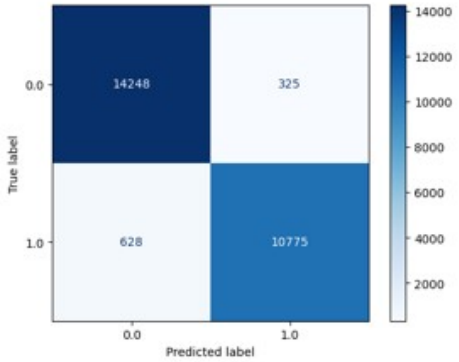


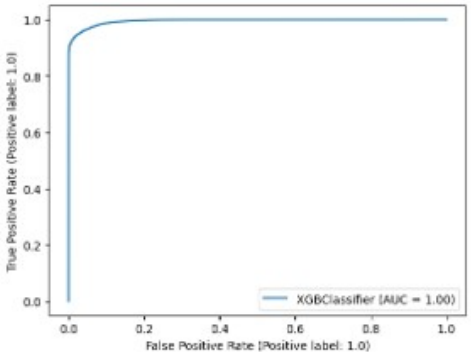
Model 2

XGB Classifier

Accuracy: 96.33%

Next steps: PCA,
Randomized Search





	precision	recall	f1-score	support
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1.0	0.97	0.94	0.96	11403
accuracy			0.96	25976
macro avg	0.96	0.96	0.96	25976
weighted avg	0.96	0.96	0.96	25976

Model 2: Dimensionality Reduction PCA

First PCA application

- PCA(n_components = 5)
- Accuracy = 88.36%

Second PCA application

- PCA(0.95)
- Accuracy = 93.81%

Proceeded with the original X_train and X_test value.

Randomized Search CV

In [200]:
```
from sklearn.model_selection import RandomizedSearchCV
```

In [205]:
```
classifier_xgb = xgb.XGBClassifier()
```

In [206]:
```
params_rs_xgb = {
    'learning_rate' : [0.05,0.10,0.15,0.20,0.25,0.30],
    'max_depth' : [ 3, 4, 5, 6, 8, 10, 12, 15],
    'min_child_weight' : [ 1, 3, 5, 7 ],
    'gamma': [ 0.0, 0.1, 0.2 , 0.3, 0.4 ],
    'colsample_bytree' : [ 0.3, 0.4, 0.5 , 0.7 ]
}
```

In [207]:
```
rs_model = RandomizedSearchCV(classifier_xgb,param_distributions=params_rs_xgb,n_iter=5,scoring='roc_au
```

In [208]:
```
#model fitting
rs_model.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 5 candidates, totalling 25 fits
```

Model 1: Randomized Search

5 parameters were tuned.

Fitted 5 folds for each of the 5 candidates

Total = 25 fits

Model 2:

Randomized Search Results

```
base_model_xgb = xgb.XGBClassifier()
base_model_xgb.fit(X_train, y_train)
base_accuracy_xgb = evaluate(base_model_xgb, X_test, y_test)
```

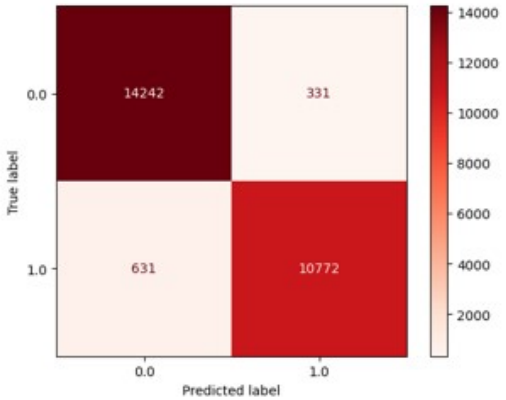
```
Model Performance
Accuracy is: 96.33122882660918 %
```

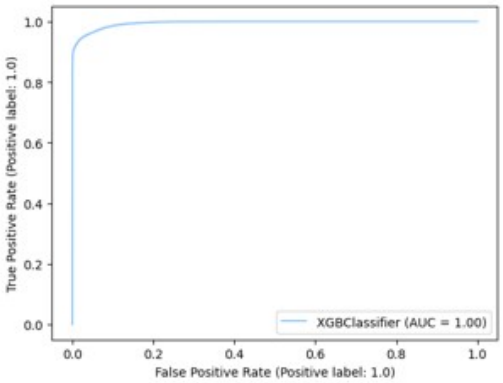
```
best_random = rs_model.best_estimator_
print(best_random)
random_accuracy = evaluate(best_random, X_test, y_test)
```

```
XGBClassifier(base_score=None, booster=None, callbacks=None,
              colsample_bylevel=None, colsample_bynode=None,
              colsample_bytree=0.7, early_stopping_rounds=None,
              enable_categorical=False, eval_metric=None, feature_types=None,
              gamma=0.1, gpu_id=None, grow_policy=None, importance_type=None,
              interaction_constraints=None, learning_rate=0.3, max_bin=None,
              max_cat_threshold=None, max_cat_to_onehot=None,
              max_delta_step=None, max_depth=8, max_leaves=None,
              min_child_weight=5, missing=nan, monotone_constraints=None,
              n_estimators=100, n_jobs=None, num_parallel_tree=None,
              predictor=None, random_state=None, ...)
Model Performance
Accuracy is: 96.29658145980905 %
```

```
print('Improvement of {:0.2f}%.'.format( 100 * (random_accuracy - base_accuracy_xgb) / base_accuracy_xg
```

```
Improvement of -0.04%.
```





Modelling Conclusions

- Model 1 – Random Forest Classifier with Grid Search worked best (99.92% accuracy achieved).
- Even though PCA was conducted, I still proceeded with using the original X_train and X_test value.
- Randomized search also did not help Model 2.
  - Perhaps there were too few iterations.
  - Can try to increase the iterations next time to have more fits, which could help with the accuracy.

Insights & Conclusions

- Ease of online booking, class, inflight entertainment had the most impact on satisfaction.
  - Some potential business strategies may include:
    - Improve mobile app and website to make it accessible and easy to book flights.
    - Ensure that inflight entertainment are up-to-date with what is popular amongst the crowd in their 20s to 50s.
    - Business class were mostly satisfied, whilst eco and eco plus need significant improvement in general.