In [36]:
```
import pandas as pd
from sklearn.preprocessing import OneHotEncoder
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
import numpy as np
```

In [102…
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import train_test_split, cross_val_score, cross_validate
from sklearn.metrics import make_scorer, precision_score, recall_score, f1_score, accu
from sklearn.pipeline import Pipeline
```

In [64]:
```
from sklearn.preprocessing import StandardScaler
from sklearn.feature_selection import SelectFromModel
```

In [2]:
```
df = pd.read_csv("C:/Users/Yash/Desktop/DS_BritishAirways/customer_booking.csv", encod
```

In [3]:
```
df.isna().sum()
```

Out[3]:
```
num_passengers          0
sales_channel           0
trip_type               0
purchase_lead           0
length_of_stay          0
flight_hour             0
flight_day              0
route                   0
booking_origin          0
wants_extra_baggage     0
wants_preferred_seat    0
wants_in_flight_meals   0
flight_duration         0
booking_complete        0
dtype: int64
```

In [4]:
```
#trip type-- One hot encoding
#sales_channel-- One hot encoding
#flight day-- integer coding, data mapping
#route-- frequency encoding
#booking origin-- frequency encoding
```

In [5]:
```
#One Hot Encoding
```

In [6]:
```
one_hot_encoded_data = pd.get_dummies(df, columns = ['trip_type','sales_channel'])
print(one_hot_encoded_data)
```

```
       num_passengers  purchase_lead  length_of_stay  flight_hour flight_day  \
0                   2            262              19            7        Sat
1                   1            112              20            3        Sat
2                   2            243              22           17        Wed
3                   1             96              31            4        Sat
4                   2             68              22           15        Wed
...               ...            ...             ...          ...        ...
49995               2             27               6            9        Sat
49996               1            111               6            4        Sun
49997               1             24               6           22        Sat
49998               1             15               6           11        Mon
49999               1             19               6           10        Thu

        route booking_origin  wants_extra_baggage  wants_preferred_seat  \
0      AKLDEL    New Zealand                    1                     0
1      AKLDEL    New Zealand                    0                     0
2      AKLDEL          India                    1                     1
3      AKLDEL    New Zealand                    0                     0
4      AKLDEL          India                    1                     0
...       ...            ...                  ...                   ...
49995  PERPNH      Australia                    1                     0
49996  PERPNH      Australia                    0                     0
49997  PERPNH      Australia                    0                     0
49998  PERPNH      Australia                    1                     0
49999  PERPNH      Australia                    0                     1

       wants_in_flight_meals  flight_duration  booking_complete  \
0                          0             5.52                 0
1                          0             5.52                 0
2                          0             5.52                 0
3                          1             5.52                 0
4                          1             5.52                 0
...                      ...              ...               ...
49995                      1             5.62                 0
49996                      0             5.62                 0
49997                      1             5.62                 0
49998                      1             5.62                 0
49999                      0             5.62                 0

       trip_type_CircleTrip  trip_type_OneWay  trip_type_RoundTrip  \
0                     False             False                 True
1                     False             False                 True
2                     False             False                 True
3                     False             False                 True
4                     False             False                 True
...                     ...               ...                  ...
49995                 False             False                 True
49996                 False             False                 True
49997                 False             False                 True
49998                 False             False                 True
49999                 False             False                 True

       sales_channel_Internet  sales_channel_Mobile
0                        True                 False
1                        True                 False
2                        True                 False
3                        True                 False
4                        True                 False
...                       ...                   ...
49995                    True                 False
```

```
49996                    True                   False
49997                    True                   False
49998                    True                   False
49999                    True                   False

[50000 rows x 17 columns]
```

In [7]:
```
one_hot_encoded_data['trip_type_CircleTrip'] = one_hot_encoded_data['trip_type_CircleT
one_hot_encoded_data['trip_type_OneWay'] = one_hot_encoded_data['trip_type_OneWay'].re
one_hot_encoded_data['trip_type_RoundTrip'] = one_hot_encoded_data['trip_type_RoundTri
one_hot_encoded_data['sales_channel_Internet'] = one_hot_encoded_data['sales_channel_I
one_hot_encoded_data['sales_channel_Mobile'] = one_hot_encoded_data['sales_channel_Mob
```

In [8]:
```
df = one_hot_encoded_data
```

In [9]:
```
df['trip_type_CircleTrip'] = df['trip_type_CircleTrip'].astype(int)
```

In [10]:
```
df['trip_type_OneWay'] = df['trip_type_OneWay'].astype(int)
```

In [11]:
```
df['trip_type_RoundTrip'] = df['trip_type_RoundTrip'].astype(int)
```

In [12]:
```
df['sales_channel_Internet'] = df['sales_channel_Internet'].astype(int)
```

In [13]:
```
df['sales_channel_Mobile'] = df['sales_channel_Mobile'].astype(int)
```

In [14]:
```
df.head()
```

Out[14]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	route	booking_origin	wa
0	2	262	19	7	Sat	AKLDEL	New Zealand	
1	1	112	20	3	Sat	AKLDEL	New Zealand	
2	2	243	22	17	Wed	AKLDEL	India	
3	1	96	31	4	Sat	AKLDEL	New Zealand	
4	2	68	22	15	Wed	AKLDEL	India	

In [15]:
```
#mapping
```

In [16]:
```
mapping = {
    "Mon": 1,
    "Tue": 2,
    "Wed": 3,
    "Thu": 4,
    "Fri": 5,
    "Sat": 6,
    "Sun": 7,
}

df["flight_day"] = df["flight_day"].map(mapping)
```

In [17]:
```
df.head()
```

Out[17]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	route	booking_origin	wa
0	2	262	19	7	6	AKLDEL	New Zealand	
1	1	112	20	3	6	AKLDEL	New Zealand	
2	2	243	22	17	3	AKLDEL	India	
3	1	96	31	4	6	AKLDEL	New Zealand	
4	2	68	22	15	3	AKLDEL	India	

In [18]:
```
df.head()
```

Out[18]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	route	booking_origin	wa
0	2	262	19	7	6	AKLDEL	New Zealand	
1	1	112	20	3	6	AKLDEL	New Zealand	
2	2	243	22	17	3	AKLDEL	India	
3	1	96	31	4	6	AKLDEL	New Zealand	
4	2	68	22	15	3	AKLDEL	India	

In [19]:
```
#frequency encoding
```

In [20]:
```
df['route'].value_counts()
```

Out[20]:
```
route
AKLKUL    2680
PENTPE     924
MELSGN     842
ICNSIN     801
DMKKIX     744
          ...
LBUTPE       1
CXRMEL       1
DELKBR       1
KOSSYD       1
MRUXIY       1
Name: count, Length: 799, dtype: int64
```

In [21]:
```
route_frequency = df['route'].value_counts(normalize=True)
booking_origin_frequency = df['booking_origin'].value_counts(normalize=True)

df['route_frequency_encoded'] = df['route'].map(route_frequency)
df['booking_origin_encoded'] = df['booking_origin'].map(booking_origin_frequency)

print(df)
```

```
       num_passengers  purchase_lead  length_of_stay  flight_hour  flight_day  \
0                   2            262              19            7           6
1                   1            112              20            3           6
2                   2            243              22           17           3
3                   1             96              31            4           6
4                   2             68              22           15           3
...               ...            ...             ...          ...         ...
49995               2             27               6            9           6
49996               1            111               6            4           7
49997               1             24               6           22           6
49998               1             15               6           11           1
49999               1             19               6           10           4

        route booking_origin  wants_extra_baggage  wants_preferred_seat  \
0      AKLDEL    New Zealand                    1                     0
1      AKLDEL    New Zealand                    0                     0
2      AKLDEL          India                    1                     1
3      AKLDEL    New Zealand                    0                     0
4      AKLDEL          India                    1                     0
...       ...            ...                  ...                   ...
49995  PERPNH      Australia                    1                     0
49996  PERPNH      Australia                    0                     0
49997  PERPNH      Australia                    0                     0
49998  PERPNH      Australia                    1                     0
49999  PERPNH      Australia                    0                     1

       wants_in_flight_meals  flight_duration  booking_complete  \
0                          0             5.52                 0
1                          0             5.52                 0
2                          0             5.52                 0
3                          1             5.52                 0
4                          1             5.52                 0
...                      ...              ...               ...
49995                      1             5.62                 0
49996                      0             5.62                 0
49997                      1             5.62                 0
49998                      1             5.62                 0
49999                      0             5.62                 0

       trip_type_CircleTrip  trip_type_OneWay  trip_type_RoundTrip  \
0                         0                 0                    1
1                         0                 0                    1
2                         0                 0                    1
3                         0                 0                    1
4                         0                 0                    1
...                     ...               ...                  ...
49995                     0                 0                    1
49996                     0                 0                    1
49997                     0                 0                    1
49998                     0                 0                    1
49999                     0                 0                    1

       sales_channel_Internet  sales_channel_Mobile  route_frequency_encoded  \
0                           1                     0                  0.00040
1                           1                     0                  0.00040
2                           1                     0                  0.00040
3                           1                     0                  0.00040
4                           1                     0                  0.00040
...                       ...                   ...                      ...
49995                       1                     0                  0.00442
```

```
49996                     1                 0                0.00442
49997                     1                 0                0.00442
49998                     1                 0                0.00442
49999                     1                 0                0.00442

       booking_origin_encoded
0                     0.02148
1                     0.02148
2                     0.02540
3                     0.02148
4                     0.02540
...                       ...
49995                 0.35744
49996                 0.35744
49997                 0.35744
49998                 0.35744
49999                 0.35744

[50000 rows x 19 columns]
```

In [22]:
```
df = df.drop(columns = ['route','booking_origin'])
```

In [23]:
```
df = df.rename(columns = {'route_frequency_encoded':'route','booking_origin_encoded':'
```

In [24]:
```
df.head()
```

Out[24]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	wants_extra_baggage	wants
0	2	262	19	7	6	1	
1	1	112	20	3	6	0	
2	2	243	22	17	3	1	
3	1	96	31	4	6	0	
4	2	68	22	15	3	1	

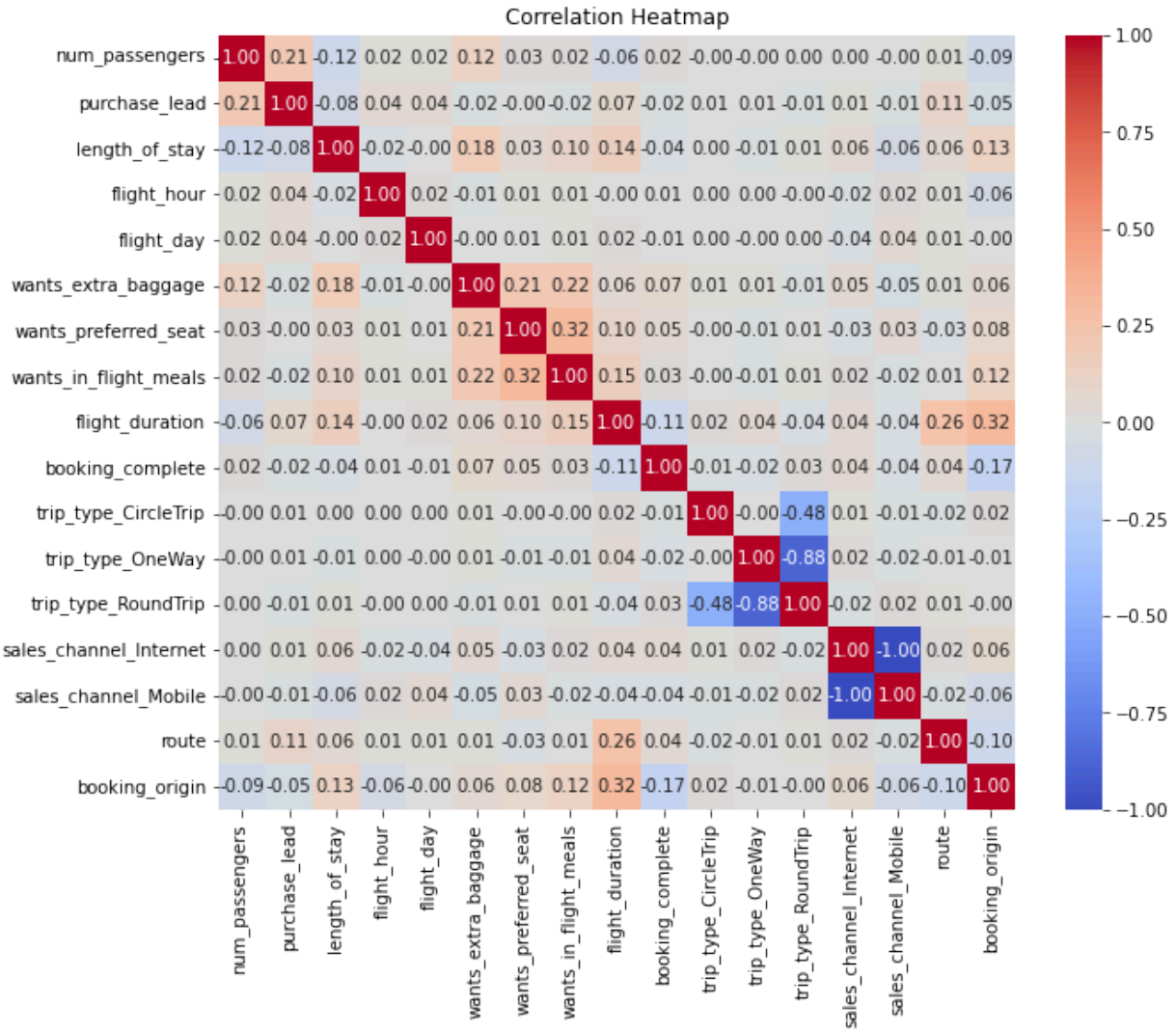
In [25]:
```
df.corr()
```

Out[25]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	wants_e
num_passengers	1.000000	0.212606	-0.115850	0.015607	0.015407	
purchase_lead	0.212606	1.000000	-0.076560	0.035973	0.036531	
length_of_stay	-0.115850	-0.076560	1.000000	-0.024872	-0.000310	
flight_hour	0.015607	0.035973	-0.024872	1.000000	0.024086	
flight_day	0.015407	0.036531	-0.000310	0.024086	1.000000	
wants_extra_baggage	0.120404	-0.022207	0.176757	-0.011434	-0.002503	
wants_preferred_seat	0.028544	-0.004499	0.032264	0.012171	0.005392	
wants_in_flight_meals	0.022943	-0.022653	0.098828	0.013014	0.009281	
flight_duration	-0.063169	0.067866	0.141181	-0.002101	0.018434	
booking_complete	0.024116	-0.022131	-0.042408	0.007127	-0.006986	
trip_type_CircleTrip	-0.001053	0.005519	0.003102	0.000945	0.004074	
trip_type_OneWay	-0.002195	0.006452	-0.013053	0.003050	-0.002426	
trip_type_RoundTrip	0.002435	-0.008327	0.009968	-0.003134	0.000166	
sales_channel_Internet	0.002457	0.013399	0.060352	-0.022375	-0.042095	
sales_channel_Mobile	-0.002457	-0.013399	-0.060352	0.022375	0.042095	
route	0.009803	0.114233	0.056248	0.010762	0.014187	
booking_origin	-0.092794	-0.049196	0.130259	-0.060005	-0.004959	

In [26]:

```
correlation_matrix = df.corr()
plt.figure(figsize=(10,8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Heatmap')
plt.show()
```



In [27]:
```
#num_passengers, purchase_lead, length_of_stay, flight_hour, wants_extra_baggage, want
#flight_duration, booking_complete, sales_channel_Internet, sales_channel_Mobile, rout
```

In [28]:
```
#feature engineering
```

In [33]:
```
X = df.drop(columns = ['booking_complete'], axis=1)
```

In [34]:
```
y = df['booking_complete']
```

In [39]:
```
num_folds = 5

kf = KFold(n_splits = num_folds, shuffle = True, random_state = 42)
```

In [41]:
```
X.describe()
```

Out[41]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	flight_day	wants_extra_baggag
count	50000.000000	50000.000000	50000.00000	50000.00000	50000.000000	50000.00000
mean	1.591240	84.940480	23.04456	9.06634	3.814420	0.66878
std	1.020165	90.451378	33.88767	5.41266	1.992792	0.47065
min	1.000000	0.000000	0.00000	0.00000	1.000000	0.00000
25%	1.000000	21.000000	5.00000	5.00000	2.000000	0.00000
50%	1.000000	51.000000	17.00000	9.00000	4.000000	1.00000
75%	2.000000	115.000000	28.00000	13.00000	5.000000	1.00000
max	9.000000	867.000000	778.00000	23.00000	7.000000	1.00000

In [44]:
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

In [48]:
```
rf_classifier = RandomForestClassifier(n_estimators = 100, random_state=42)
cross_val_scores = cross_val_score(rf_classifier, X_scaled, y, cv=kf)

print("cross validation score: ", cross_val_scores)
```

```
cross validation score:  [0.8537 0.851  0.8488 0.8532 0.8576]
```

In [49]:
```
print("mean cv score: ", np.mean(cross_val_scores))
print("std of cv score: ", np.std(cross_val_scores))
```

```
mean cv score:  0.85286
std of cv score:  0.0029404761519182692
```

In [127…
```
rf_classifier = RandomForestClassifier(n_estimators = 100, random_state=42)
cross_val_scores = cross_val_score(rf_classifier, X, y, cv=kf)

print("cross validation score: ", cross_val_scores)
```

```
cross validation score:  [0.8423 0.8432 0.8351 0.8403 0.8477]
```

In [128…
```
print("mean cv score: ", np.mean(cross_val_scores))
print("std of cv score: ", np.std(cross_val_scores))
```

```
mean cv score:  0.8417199999999999
std of cv score:  0.0041019019978541784
```

In [54]:
```
rf_classifier.fit(X_scaled, y)
feature_importances = rf_classifier.feature_importances_
feature_names = X.columns

importance_df = pd.DataFrame({'Feature': feature_names, 'Importance':feature_importanc
importance_df = importance_df.sort_values(by='Importance', ascending=False)

print(importance_df)
```

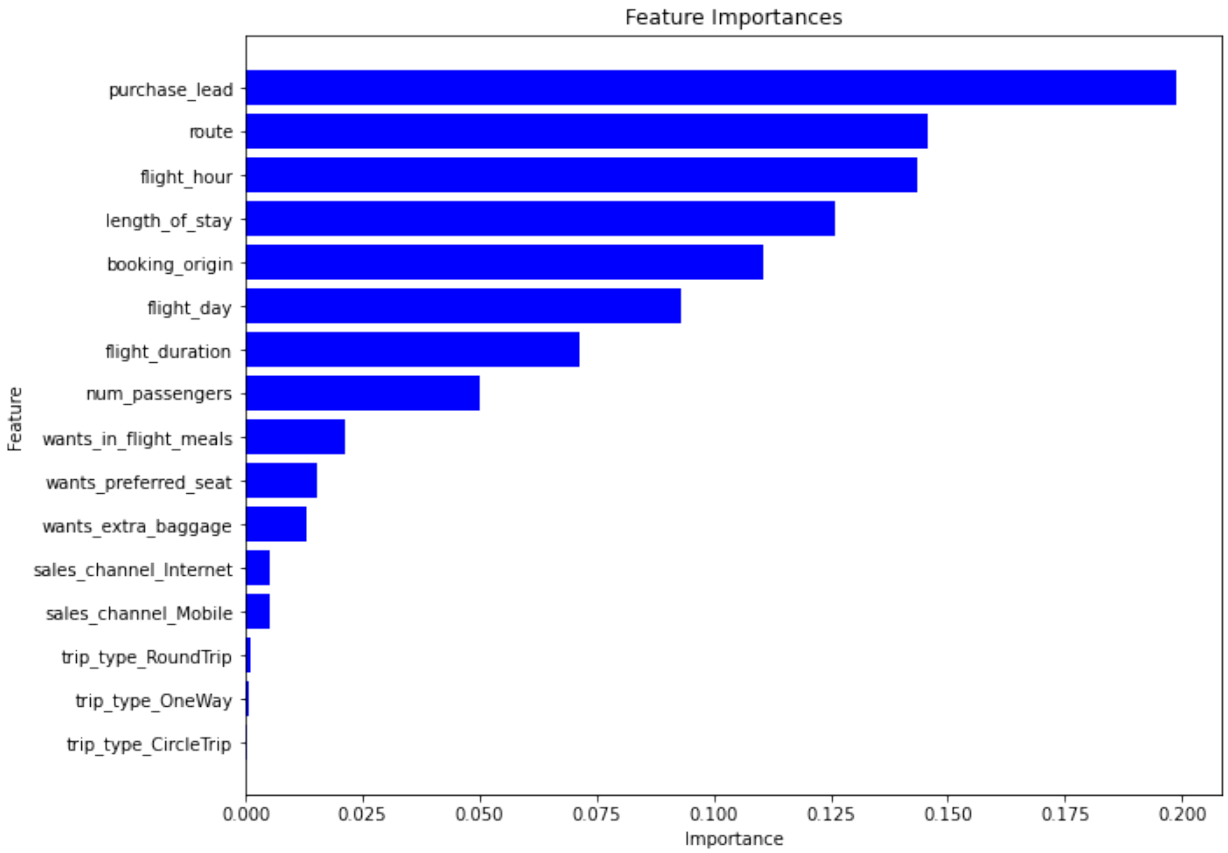
	Feature	Importance
1	purchase_lead	0.198668
14	route	0.145564
3	flight_hour	0.143403
2	length_of_stay	0.125766
15	booking_origin	0.110759
4	flight_day	0.093147
8	flight_duration	0.071233
0	num_passengers	0.049911
7	wants_in_flight_meals	0.021119
6	wants_preferred_seat	0.015259
5	wants_extra_baggage	0.013052
12	sales_channel_Internet	0.005052
13	sales_channel_Mobile	0.004972
11	trip_type_RoundTrip	0.000956
10	trip_type_OneWay	0.000783
9	trip_type_CircleTrip	0.000354

In [126…

```
import matplotlib.pyplot as plt

# Sort importance_df by Importance in descending order
importance_df = importance_df.sort_values(by='Importance', ascending=True)

# Create horizontal bar plot
plt.figure(figsize=(10, 8))
plt.barh(importance_df['Feature'], importance_df['Importance'], color='blue')
plt.xlabel('Importance')
plt.ylabel('Feature')
plt.title('Feature Importances')
plt.show()
```



In [55]:

```
sel_features = importance_df['Feature'].head(8)
```

In [58]:
```
X = X[sel_features]
```

In [60]:
```
X.describe()
```

Out[60]:

	purchase_lead	route	flight_hour	length_of_stay	booking_origin	flight_day	flight_
count	50000.000000	50000.000000	50000.00000	50000.00000	50000.000000	50000.000000	5000
mean	84.940480	0.008099	9.06634	23.04456	0.174742	3.814420	
std	90.451378	0.011836	5.41266	33.88767	0.141094	1.992792	
min	0.000000	0.000020	0.00000	0.00000	0.000020	1.000000	
25%	21.000000	0.001620	5.00000	5.00000	0.047380	2.000000	
50%	51.000000	0.004540	9.00000	17.00000	0.143480	4.000000	
75%	115.000000	0.009300	13.00000	28.00000	0.357440	5.000000	
max	867.000000	0.053600	23.00000	778.00000	0.357440	7.000000	

In [62]:
```
X_scaled = scaler.fit_transform(X)
```

In [71]:
```
rf_classifier = RandomForestClassifier(n_estimators = 100, random_state=42)
cross_val_scores = cross_val_score(rf_classifier, X_scaled, y, cv=kf)

print("cross validation score: ", cross_val_scores)
```

```
cross validation score:  [0.8521 0.8477 0.8495 0.8498 0.8527]
```

In [72]:
```
print("mean cv score: ", np.mean(cross_val_scores))
print("std of cv score: ", np.std(cross_val_scores))
```

```
mean cv score:  0.85036
std of cv score:  0.0018238420984284713
```

In [76]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=
```

In [77]:
```
rf_classifier = RandomForestClassifier(n_estimators=100, random_state=42)
rf_classifier.fit(X_train, y_train)
```

Out[77]:

RandomForestClassifier

```
RandomForestClassifier(random_state=42)
```

In [78]:
```
cv_scores = cross_val_score(rf_classifier, X, y, cv=5)  # 5-fold cross-validation
print(f'Cross-validation scores: {cv_scores}')
print(f'Average cross-validation score: {cv_scores.mean()}')
```

```
Cross-validation scores: [0.8498 0.7948 0.7157 0.3801 0.6353]
Average cross-validation score: 0.6751400000000001
```

In [81]:
```
y_pred = rf_classifier.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
conf_matrix = confusion_matrix(y_test, y_pred)
class_report = classification_report(y_test, y_pred)
```

```
print(f'Accuracy: {accuracy}')
print(f'Confusion Matrix:\n{conf_matrix}')
print(f'Classification Report:\n{class_report}')
```

```
Accuracy: 0.8563
Confusion Matrix:
[[8387  133]
 [1304  176]]
Classification Report:
              precision    recall  f1-score   support

           0       0.87      0.98      0.92      8520
           1       0.57      0.12      0.20      1480

    accuracy                           0.86     10000
   macro avg       0.72      0.55      0.56     10000
weighted avg       0.82      0.86      0.81     10000
```

Dropping all Categorical values

In [113…
```
df = pd.read_csv("C:/Users/Yash/Desktop/DS_BritishAirways/customer_booking.csv", encoc
```

In [114…
```
df
```

Out[114]:

	num_passengers	sales_channel	trip_type	purchase_lead	length_of_stay	flight_hour	flight_da
0	2	Internet	RoundTrip	262	19	7	Sa
1	1	Internet	RoundTrip	112	20	3	Sa
2	2	Internet	RoundTrip	243	22	17	We
3	1	Internet	RoundTrip	96	31	4	Sa
4	2	Internet	RoundTrip	68	22	15	We
...	...	...	...	...	...	...	
49995	2	Internet	RoundTrip	27	6	9	Sa
49996	1	Internet	RoundTrip	111	6	4	Su
49997	1	Internet	RoundTrip	24	6	22	Sa
49998	1	Internet	RoundTrip	15	6	11	Mo
49999	1	Internet	RoundTrip	19	6	10	Th

50000 rows × 14 columns

In [115…
```
df = df.select_dtypes(exclude = ['object','category'])
```

In [116…
```
df
```

Out[116]:

	num_passengers	purchase_lead	length_of_stay	flight_hour	wants_extra_baggage	wants_prefe
0	2	262	19	7	1	
1	1	112	20	3	0	
2	2	243	22	17	1	
3	1	96	31	4	0	
4	2	68	22	15	1	
...	...	...	...	...	...	
49995	2	27	6	9	1	
49996	1	111	6	4	0	
49997	1	24	6	22	0	
49998	1	15	6	11	1	
49999	1	19	6	10	0	

50000 rows × 9 columns

In [117…
```
X = df.drop(columns = ['booking_complete'], axis=1)
y = df['booking_complete']
```

In [89]:
```
pipeline = Pipeline([('scaler',StandardScaler()),
                     ('classifier',RandomForestClassifier(n_estimators=100, random_stat
```

In [98]:
```
scoring = {
    'accuracy': 'accuracy',
    'precision': make_scorer(precision_score, average='macro'),
    'recall': make_scorer(recall_score, average='macro'),
    'f1': make_scorer(f1_score, average='macro')
}
```

In [104…
```
cv_results = cross_validate(pipeline, X, y, cv = 5, scoring=scoring)
```

In [106…
```
print("Cross-validation scores for each fold:")
print(f"Accuracy: {cv_results['test_accuracy']}")
print(f"Precision: {cv_results['test_precision']}")
print(f"Recall: {cv_results['test_recall']}")
print(f"F1 Score: {cv_results['test_f1']}")

print("\nAverage cross-validation scores:")
print(f"Average Accuracy: {np.mean(cv_results['test_accuracy'])}")
print(f"Average Precision: {np.mean(cv_results['test_precision'])}")
print(f"Average Recall: {np.mean(cv_results['test_recall'])}")
print(f"Average F1 Score: {np.mean(cv_results['test_f1'])}")
```

```
Cross-validation scores for each fold:
Accuracy: [0.8489 0.8247 0.7669 0.3841 0.3697]
Precision: [0.6114247  0.53067838 0.42581213 0.36191791 0.57935518]
Recall: [0.50539954 0.5101931  0.4542106  0.2296909  0.61150682]
F1 Score: [0.47380795 0.49897152 0.43904284 0.27932065 0.36527454]

Average cross-validation scores:
Average Accuracy: 0.63886
Average Precision: 0.5018376608356034
Average Recall: 0.46220019281266894
Average F1 Score: 0.4112834979108788
```

In [118…
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=
```

In [119…
```
#X_train_scaled = scaler.fit_transform(X_train)
#X_test_scaled = scaler.fit_transform(X_test)
```

In [120…
```
rf_classifier = RandomForestClassifier(n_estimators = 100, random_state= 42)
```

In [121…
```
rf_classifier.fit(X_train, y_train)
```

Out[121]:
```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

In [122…
```
y_pred = rf_classifier.predict(X_test)
```

In [123…
```
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='macro')
recall = recall_score(y_test, y_pred, average='macro')
f1 = f1_score(y_test, y_pred, average='macro')

# Print evaluation metrics
print(f'Accuracy: {accuracy}')
print(f'Precision: {precision}')
print(f'Recall: {recall}')
print(f'F1 Score: {f1}')
```

```
Accuracy: 0.8411
Precision: 0.5963429348357308
Recall: 0.5243100494861058
F1 Score: 0.5171316318316188
```

In [ ]: