```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
data = pd.read_csv("/content/hotel_bookings.csv")
data.head()

missing_values = data.isnull().sum()
print("Missing Value: ")
print(missing_values)

data.dropna(inplace=True)

duplicate_rows = data.duplicated().sum()
print("Duplicated rows: ", duplicate_rows)
data.drop_duplicates(inplace=True)
```

```
Missing Value: 
hotel                                  0
is_canceled                            0
lead_time                              0
arrival_date_year                      0
arrival_date_month                     0
arrival_date_week_number               0
arrival_date_day_of_month              0
stays_in_weekend_nights                0
stays_in_week_nights                   0
adults                                 0
children                               4
babies                                 0
meal                                   0
country                              488
market_segment                         0
distribution_channel                   0
is_repeated_guest                      0
previous_cancellations                 0
previous_bookings_not_canceled         0
reserved_room_type                     0
assigned_room_type                     0
booking_changes                        0
deposit_type                           0
agent                              16340
company                           112593
days_in_waiting_list                   0
customer_type                          0
adr                                    0
required_car_parking_spaces            0
total_of_special_requests              0
reservation_status                     0
reservation_status_date                0
dtype: int64
Duplicated rows:  28
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 189 entries, 2392 to 116451
Data columns (total 32 columns):
 #   Column                          Non-Null Count  Dtype
```

```
---  ------                          --------------  -----
 0   hotel                           189 non-null    object
 1   is_canceled                     189 non-null    int64
 2   lead_time                       189 non-null    int64
 3   arrival_date_year               189 non-null    int64
 4   arrival_date_month              189 non-null    object
 5   arrival_date_week_number        189 non-null    int64
 6   arrival_date_day_of_month       189 non-null    int64
 7   stays_in_weekend_nights         189 non-null    int64
 8   stays_in_week_nights            189 non-null    int64
 9   adults                          189 non-null    int64
 10  children                        189 non-null    float64
 11  babies                          189 non-null    int64
 12  meal                            189 non-null    object
 13  country                         189 non-null    object
 14  market_segment                  189 non-null    object
 15  distribution_channel            189 non-null    object
 16  is_repeated_guest               189 non-null    int64
 17  previous_cancellations          189 non-null    int64
 18  previous_bookings_not_canceled  189 non-null    int64
 19  reserved_room_type              189 non-null    object
 20  assigned_room_type              189 non-null    object
 21  booking_changes                 189 non-null    int64
 22  deposit_type                    189 non-null    object
 23  agent                           189 non-null    float64
 24  company                         189 non-null    float64
 25  days_in_waiting_list            189 non-null    int64
 26  customer_type                   189 non-null    object
 27  adr                             189 non-null    float64
 28  required_car_parking_spaces     189 non-null    int64
 29  total_of_special_requests       189 non-null    int64
 30  reservation_status              189 non-null    object
 31  reservation_status_date         189 non-null    object
dtypes: float64(4), int64(16), object(12)
memory usage: 48.7+ KB
```

```
data.nunique()
```

```
hotel                              2
is_canceled                        2
lead_time                         50
arrival_date_year                  3
arrival_date_month                12
arrival_date_week_number          38
arrival_date_day_of_month         29
stays_in_weekend_nights            8
stays_in_week_nights              13
adults                             3
children                           3
babies                             1
meal                               4
country                           18
market_segment                     6
distribution_channel               4
is_repeated_guest                  2
previous_cancellations             2
previous_bookings_not_canceled     6
reserved_room_type                 5
assigned_room_type                 9
booking_changes                    7
deposit_type                       3
agent                             28
```

```
company                           46
days_in_waiting_list               1
customer_type                      4
adr                               70
required_car_parking_spaces        2
total_of_special_requests          4
reservation_status                 3
reservation_status_date           76
dtype: int64
```

```
data.dtypes
```

```
hotel                              object
is_canceled                         int64
lead_time                           int64
arrival_date_year                   int64
arrival_date_month                 object
arrival_date_week_number            int64
arrival_date_day_of_month           int64
stays_in_weekend_nights             int64
stays_in_week_nights                int64
adults                              int64
children                          float64
babies                              int64
meal                               object
country                            object
market_segment                     object
distribution_channel               object
is_repeated_guest                   int64
previous_cancellations              int64
previous_bookings_not_canceled      int64
reserved_room_type                 object
assigned_room_type                 object
booking_changes                     int64
deposit_type                       object
agent                             float64
company                           float64
days_in_waiting_list                int64
customer_type                      object
adr                               float64
required_car_parking_spaces         int64
total_of_special_requests           int64
reservation_status                 object
reservation_status_date            object
dtype: object
```

```
data.describe()
```

	is_canceled	lead_time	arrival_date_year	arrival_date_week_number	arriv
count	189.000000	189.000000	189.000000	189.000000	
mean	0.084656	33.883598	2015.486772	37.555556	
std	0.279109	50.797022	0.740963	13.317854	
min	0.000000	0.000000	2015.000000	1.000000	
25%	0.000000	11.000000	2015.000000	33.000000	
50%	0.000000	24.000000	2015.000000	45.000000	
75%	0.000000	36.000000	2016.000000	46.000000	
max	1.000000	364.000000	2017.000000	53.000000	

```
to_drop = ['country', 'market_segment',
       'distribution_channel', 'reserved_room_type', 'assigned_room_type',
       'deposit_type', 'customer_type', 'reservation_status',
       'reservation_status_date','hotel']
X=data.drop(to_drop,axis=1)
X.head()
```

	is_canceled	lead_time	arrival_date_year	arrival_date_month	arrival_date
2392	0	6	2015	October	
2697	0	24	2015	October	
2867	0	24	2015	November	
2877	0	24	2015	November	
2878	0	24	2015	November	

5 rows × 22 columns

```
cat_cols=X.columns[X.dtypes == "object"]
num_cols=X.columns[(X.dtypes == "float64")|(X.dtypes =="int64")]
```

```
num_cols
```

```
Index(['is_canceled', 'lead_time', 'arrival_date_year',
       'arrival_date_week_number', 'arrival_date_day_of_month',
       'stays_in_weekend_nights', 'stays_in_week_nights', 'adults', 'children',
       'babies', 'is_repeated_guest', 'previous_cancellations',
       'previous_bookings_not_canceled', 'booking_changes', 'agent', 'company',
       'days_in_waiting_list', 'adr', 'required_car_parking_spaces',
       'total_of_special_requests'],
      dtype='object')
```

```
cat_cols
```

```
Index(['arrival_date_month', 'meal'], dtype='object')
```

```
from sklearn import model_selection
y = data['is_canceled']
X_train,X_test,y_train,y_test = model_selection.train_test_split(X,y,test_size=0.25,stratify =
print("train data has"+ str(X_train.shape[0])+"observation with"+ str(X_train.shape[1])+ "feat
print("test data has"+str(X_test.shape[0])+"observation with"+str(X_test.shape[1])+ "features'
```

```
    train data has141observation with22features
    test data has48observation with22features
```

```
data_train.head()
```

	hotel	is_canceled	lead_time	arrival_date_year	arrival_date_month	arrival_
0	Resort Hotel	-0.304997	0.056076	-0.699663	November	
1	Resort Hotel	-0.304997	4.598244	2.003144	June	
2	City Hotel	-0.304997	-0.712968	-0.699663	August	
3	Resort Hotel	-0.304997	-0.592805	2.003144	January	
4	Resort Hotel	-0.304997	-0.688935	0.651741	July	

5 rows × 36 columns

```
from sklearn.preprocessing import OneHotEncoder
def OneHotEncoding(df,enc,categories):
  transformed = pd.DataFrame(enc.transform(df[categories]).toarray(),columns=enc.get_feature_r
  return pd.concat([df.reset_index(drop=True),transformed],axis=1).drop(categories,axis=1)

categories = ["arrival_date_month"]
enc_ohe = OneHotEncoder()
enc_ohe.fit(X_train[categories])

X_train=OneHotEncoding(X_train,enc_ohe,categories)
X_test=OneHotEncoding(X_test,enc_ohe,categories)
```

```
from sklearn.preprocessing import OrdinalEncoder
categories_order = [['FB', 'HB', 'BB','SC']]
enc_oe = OrdinalEncoder(categories=categories_order)
enc_oe.fit(X_train[["meal"]])

X_train["meal_encoded"] = enc_oe.transform(X_train[["meal"]])
X_test["meal_encoded"] = enc_oe.transform(X_test[["meal"]])
```

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaler.fit(data_train[num_cols])
data_train[num_cols] = scaler.transform(data_train[num_cols])
data_test[num_cols] = scaler.transform(data_test[num_cols])
```

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
classifier_logistic = LogisticRegression()
classifier_KNN = KNeighborsClassifier()
classifier_RF = RandomForestClassifier()
```

```
data_train_encoded = pd.get_dummies(data_train, columns=["arrival_date_month","meal"])
data_test_encoded = pd.get_dummies(data_test, columns=["arrival_date_month","meal"])
encoded_columns = data_train_encoded.columns
print(encoded_columns)
```

```
Index(['hotel', 'is_canceled', 'lead_time', 'arrival_date_year',
       'arrival_date_week_number', 'arrival_date_day_of_month',
       'stays_in_weekend_nights', 'stays_in_week_nights', 'adults', 'children',
       'babies', 'country', 'distribution_channel', 'is_repeated_guest',
       'previous_cancellations', 'previous_bookings_not_canceled',
       'reserved_room_type', 'assigned_room_type', 'booking_changes',
       'deposit_type', 'agent', 'company', 'days_in_waiting_list',
       'customer_type', 'adr', 'required_car_parking_spaces',
       'total_of_special_requests', 'reservation_status',
       'reservation_status_date', 'market_segment_Complementary',
       'market_segment_Corporate', 'market_segment_Direct',
       'market_segment_Offline TA/TO', 'market_segment_Online TA',
       'arrival_date_month_April', 'arrival_date_month_August',
       'arrival_date_month_December', 'arrival_date_month_February',
       'arrival_date_month_January', 'arrival_date_month_July',
       'arrival_date_month_June', 'arrival_date_month_March',
       'arrival_date_month_May', 'arrival_date_month_November',
       'arrival_date_month_October', 'arrival_date_month_September', 'meal_BB',
       'meal_HB', 'meal_SC'],
      dtype='object')
```

```
from sklearn.linear_model import LogisticRegression
classifier_logistic = LogisticRegression()
classifier_logistic.fit(X_train_processed, y_train)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_logistic.py:458: C
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regressic
  n_iter_i = _check_optimize_result(
▾ LogisticRegression
LogisticRegression()
```

```
X_test_processed = X_test.drop(columns=['meal'])
predictions = classifier_logistic.predict(X_test_processed)
```

```
X_test_processed = X_test.drop(columns=['meal'])
score = classifier_logistic.score(X_test_processed, y_test)
print("Accuracy on test set:", score)
```

```
    Accuracy on test set: 0.8541666666666666
```

```
from sklearn.model_selection import GridSearchCV
def print_grid_search_metrics(gs):
  print("Best score:"+str(gs.best_score_))
  print("Best parameters set:")
  best_parameters = gs.best_params_
  for param_name in sorted(best_parameters.keys()):
    print(param_name+":"+str(best_parameters[param_name]))
```

```
parameters = {
    'penalty':('l2','l1'),
    'C':(0.01, 0.05, 0.1, 0.2, 1)
}
Grid_LR = GridSearchCV(LogisticRegression(solver='liblinear'),parameters, cv=5)
Grid_LR.fit(X_test_processed, y_test)
```

```
    /usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_split.py:700: l
      warnings.warn(
```

```
▸         GridSearchCV
▸ estimator: LogisticRegression
     ▸ LogisticRegression
```

```
print_grid_search_metrics(Grid_LR)
```

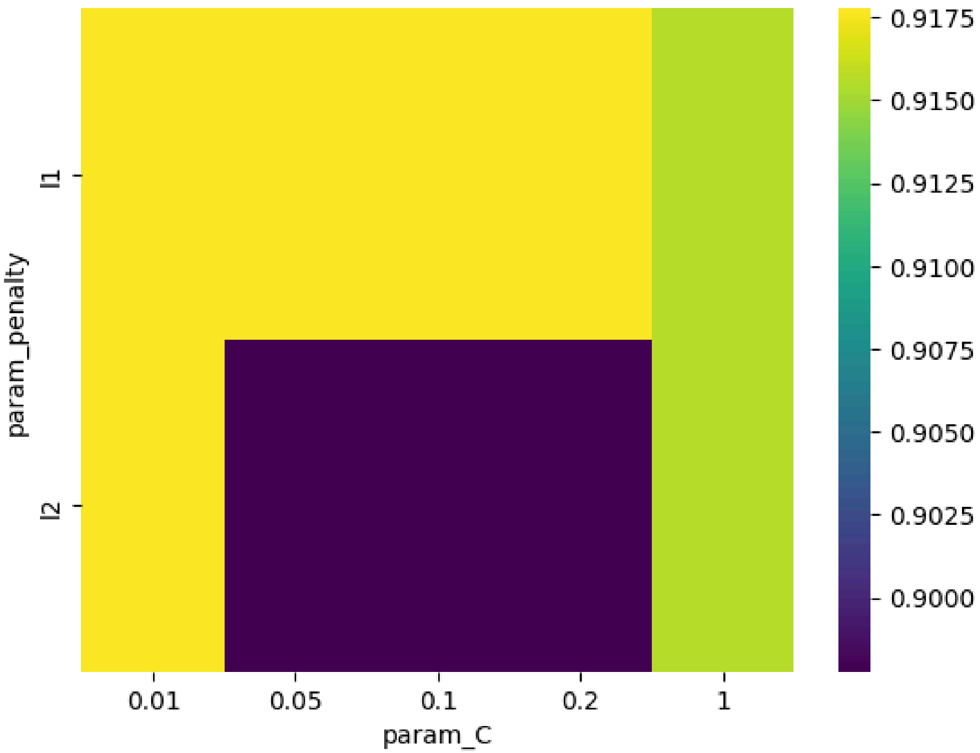
```
    Best score:0.9177777777777777
    Best parameters set:
    C:0.01
    penalty:l2
```

```
best_LR_model = Grid_LR.best_estimator_
```

```
best_LR_model.score(X_test_processed,y_test)
```

```
    0.9166666666666666
```

```
LR_models = pd.DataFrame(Grid_LR.cv_results_)
res = (LR_models.pivot(index="param_penalty",columns="param_C",values="mean_test_score")
          )
_ =sns.heatmap(res, cmap="viridis",color="red")
```



```
parameters = {
    "n_neighbors":[1,3,5,7,9]
}
Grid_KNN = GridSearchCV(KNeighborsClassifier(),parameters,cv=5)
X_train_processed = X_train.drop(columns=['meal'])
Grid_KNN.fit(X_train_processed,y_train)
```

```
▸          GridSearchCV
▸ estimator: KNeighborsClassifier
     ▸ KNeighborsClassifier
```

```
print_grid_search_metrics(Grid_KNN)
```

```
Best score:0.9150246305418721
Best parameters set:
n_neighbors:7
```

```
best_KNN_model=Grid_KNN.best_estimator_
```

```
parameters = {
    "n_estimators":[60,80,100],
    "max_depth":[1,5,10]
}
Grid_RF = GridSearchCV(RandomForestClassifier(),parameters,cv=5)
Grid_RF.fit(X_train_processed,y_train)
```

```
▸           GridSearchCV
▸ estimator: RandomForestClassifier
      ▸ RandomForestClassifier
```

```
print_grid_search_metrics(Grid_RF)
```

```
Best score:0.9647783251231526
Best parameters set:
max_depth:5
n_estimators:60
```

```
best_RF_model = Grid_RF.best_estimator_
```

```
best_RF_model
```

```
▾                RandomForestClassifier
RandomForestClassifier(max_depth=5, n_estimators=60)
```

```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

def cal_evaluation(classifier,cm):
  tn=cm[0][0]
  fp=cm[0][1]
  fn=cm[1][0]
  tp=cm[1][1]
  accuracy = (tp+tn)/(tp+fp+fn+tn+0.0)
  precision = tp/(tp+fp+0.0)
  recall= tp/(tp+fn+0.0)
  print(classifier)
  print("Accuracy is" + str(accuracy))
  print("precision is" + str(precision))
  print("recall is " + str(recall))
  print()


def draw_confusion_matrices(confusion_matricies):
    class_names = ['Not','Churn']
    for cm in confusion_matrices:
        classifier, cm = cm[0], cm[1]
        cal_evaluation(classifier, cm)
```

```
confusion_matrices = [
    ("Random Forest", confusion_matrix(y_test,best_RF_model.predict(X_test_processed))),
    ("Logistic Regression", confusion_matrix(y_test,best_LR_model.predict(X_test_processed))),
    ("K nearest neighbor", confusion_matrix(y_test, best_KNN_model.predict(X_test_processed)))
]

draw_confusion_matrices(confusion_matrices)
```

```
Random Forest
Accuracy is0.9791666666666666
precision is1.0
recall is 0.75

Logistic Regression
Accuracy is0.9166666666666666
precision isnan
recall is 0.0

K nearest neighbor
Accuracy is0.9166666666666666
precision isnan
recall is 0.0

<ipython-input-328-ac5c1f3f75c2>:12: RuntimeWarning: invalid value encountered in scalar d
  precision = tp/(tp+fp+0.0)
```

```
def draw_confusion_matrices(confusion_matricies):
  class_names = ["Not","Churn"]
  for cm in confusion_matrices:
    classifier, cm = cm[0],cm[1]
    cal_evaluation(classifier,cm)
```

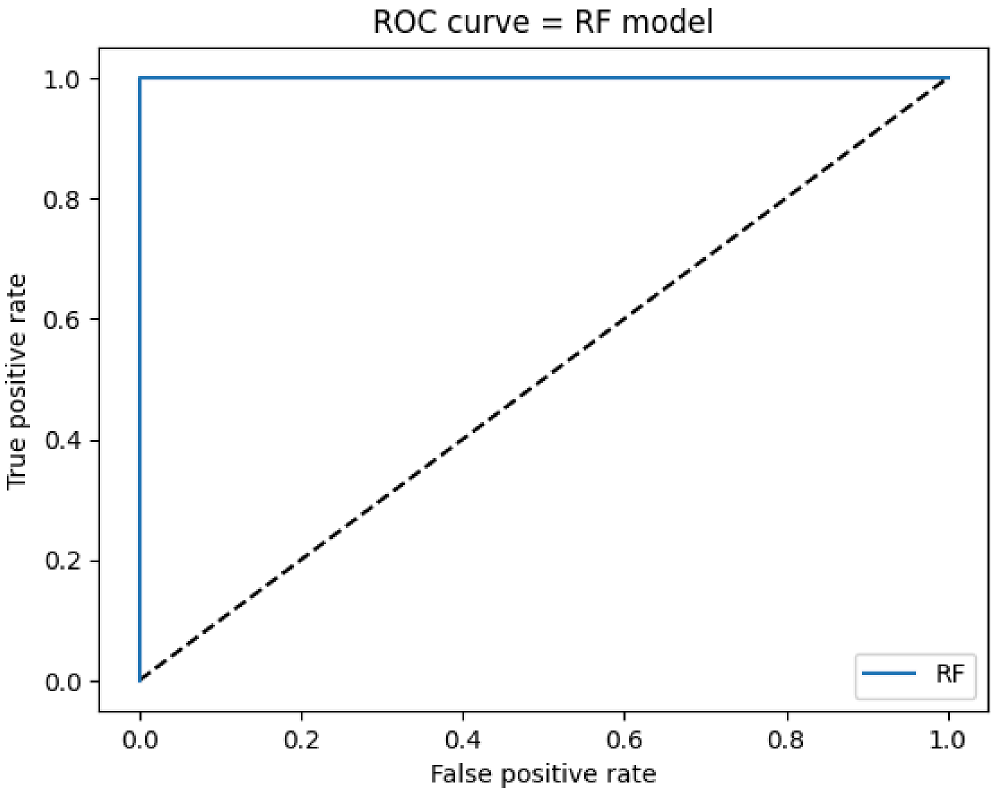
```
from sklearn.metrics import roc_curve
from sklearn import metrics

y_pred_rf = best_RF_model.predict_proba(X_test_processed)[:, 1]
fpr_rf, tpr_rf, _ = roc_curve(y_test, y_pred_rf)
```

```
best_RF_model.predict_proba(X_test_processed)
```

```
array([[0.99583158, 0.00416842],
       [0.89324314, 0.10675686],
       [0.89944444, 0.10055556],
       [0.91198423, 0.08801577],
       [0.95608406, 0.04391594],
       [0.95608406, 0.04391594],
       [0.96303186, 0.03696814],
       [0.99764023, 0.00235977],
       [0.98088384, 0.01911616],
       [0.9890599 , 0.0109401 ],
       [0.97832574, 0.02167426],
       [0.96108197, 0.03891803],
       [0.98050505, 0.01949495],
       [0.98143764, 0.01856236],
       [0.9393484 , 0.0606516 ],
       [0.99155579, 0.00844421],
       [0.97608753, 0.02391247],
       [0.92858362, 0.07141638],
       [0.29974248, 0.70025752],
       [0.82808141, 0.17191859],
       [0.99027581, 0.00972419],
       [0.45463654, 0.54536346],
       [0.9133699 , 0.0866301 ],
       [0.91104847, 0.08895153],
       [0.99504294, 0.00495706],
       [0.98799129, 0.01200871],
       [0.90027343, 0.09972657],
       [0.98013954, 0.01986046],
       [0.92435516, 0.07564484],
       [0.97970684, 0.02029316],
       [0.95664744, 0.04335256],
       [0.4126695 , 0.5873305 ],
       [0.9268484 , 0.0731516 ],
       [0.97534126, 0.02465874],
       [0.96238517, 0.03761483],
       [0.95646262, 0.04353738],
       [0.50668129, 0.49331871],
       [0.94534272, 0.05465728],
       [0.99323185, 0.00676815],
       [0.91743779, 0.08256221],
       [0.93949134, 0.06050866],
       [0.98106061, 0.01893939],
       [0.97192086, 0.02807914],
       [0.89324314, 0.10675686],
       [0.90729167, 0.09270833],
       [0.90506298, 0.09493702],
       [0.99146873, 0.00853127],
       [0.93401533, 0.06598467]])
```

```
import matplotlib.pyplot as plt
plt.figure(1)
plt.plot([0,1],[0,1],"k--")
plt.plot(fpr_rf, tpr_rf,label="RF")
plt.xlabel("False positive rate")
plt.ylabel("True positive rate")
plt.title("ROC curve = RF model")
plt.legend(loc = "best")
plt.show()
```



```
from sklearn import metrics
metrics.auc(fpr_rf,tpr_rf)
```

```
1.0
```

```
y_pred_lr=best_LR_model.predict_proba(X_test_processed)[:,1]
fpr_lr,tpr_lr, thresh = roc_curve(y_test, y_pred_lr)
```

```
best_LR_model.predict_proba(X_test_processed)
```

```
array([[9.87239133e-01, 1.27608671e-02],
       [8.47691625e-01, 1.52308375e-01],
       [8.94441465e-01, 1.05558535e-01],
       [9.77802243e-01, 2.21977574e-02],
       [8.64704627e-01, 1.35295373e-01],
       [8.64704627e-01, 1.35295373e-01],
       [9.80547171e-01, 1.94528286e-02],
       [9.13940659e-01, 8.60593412e-02],
       [9.05397922e-01, 9.46020783e-02],
       [9.46861640e-01, 5.31383598e-02],
       [8.91401040e-01, 1.08598960e-01],
       [8.46372308e-01, 1.53627692e-01],
       [9.21034863e-01, 7.89651375e-02],
       [9.41192245e-01, 5.88077548e-02],
       [9.35711095e-01, 6.42889049e-02],
       [9.65349997e-01, 3.46500032e-02],
       [9.34013106e-01, 6.59868936e-02],
       [9.38334315e-01, 6.16656848e-02],
       [8.25637381e-01, 1.74362619e-01],
       [8.43723225e-01, 1.56276775e-01],
       [9.10683645e-01, 8.93163547e-02],
       [8.96863190e-01, 1.03136810e-01],
       [8.57051100e-01, 1.42948900e-01],
       [8.61150640e-01, 1.38849360e-01],
       [9.61546009e-01, 3.84539910e-02],
       [9.17038174e-01, 8.29618262e-02],
       [8.99207055e-01, 1.00792945e-01],
       [9.80184073e-01, 1.98159265e-02],
       [9.84855251e-01, 1.51447488e-02],
       [9.51013173e-01, 4.89868271e-02],
       [9.49128956e-01, 5.08710441e-02],
       [8.17197296e-01, 1.82802704e-01],
       [9.34439821e-01, 6.55601795e-02],
       [9.32979522e-01, 6.70204783e-02],
       [8.75432402e-01, 1.24567598e-01],
       [8.86008026e-01, 1.13991974e-01],
       [9.17893951e-01, 8.21060489e-02],
       [8.62235968e-01, 1.37764032e-01],
       [9.68257237e-01, 3.17427635e-02],
       [9.99355235e-01, 6.44764749e-04],
       [9.43561460e-01, 5.64385404e-02],
       [9.57346750e-01, 4.26532503e-02],
       [9.35292082e-01, 6.47079177e-02],
       [8.47691625e-01, 1.52308375e-01],
       [9.95317997e-01, 4.68200265e-03],
       [8.30706734e-01, 1.69293266e-01],
       [9.69221505e-01, 3.07784955e-02],
       [9.32373291e-01, 6.76267090e-02]])
```

```
plt.figure(1)
plt.plot([0,1],[0,1],"k--")
plt.plot(fpr_lr,tpr_lr,label = "LR")
plt.xlabel("False positive rate")
plt.ylabel("True positive rate")
plt.title("ROC curve - LR Model")
plt.legend(loc="best")
plt.show()
```

```
metrics.auc(fpr_lr,tpr_lr)
```

```
    0.8125
```

```
forest = RandomForestClassifier()
forest.fit(X_train_processed, y_train)

importances = forest.feature_importances_

indices = np.argsort(importances)[::-1]

print("Feature importance ranking by Random Forest Model:")
for ind in range(X.shape[1]):
  print ("{0} : {1}".format(X_train_processed.columns[indices[ind]],round(importances[indices
```

```
    Feature importance ranking by Random Forest Model:
    is_canceled : 0.5446
    lead_time : 0.0924
    agent : 0.0475
    arrival_date_week_number : 0.0375
    stays_in_weekend_nights : 0.0329
    booking_changes : 0.0322
    arrival_date_day_of_month : 0.0316
    adr : 0.0275
    adults : 0.027
    stays_in_week_nights : 0.0217
    arrival_date_month_April : 0.0181
    company : 0.0159
    meal_encoded : 0.0149
    arrival_date_month_June : 0.0103
    is_repeated_guest : 0.0082
    arrival_date_month_May : 0.0076
    arrival_date_year : 0.0064
    arrival_date_month_November : 0.0056
    required_car_parking_spaces : 0.0049
    total_of_special_requests : 0.0033
    arrival_date_month_January : 0.0029
    previous_bookings_not_canceled : 0.0025
```

```
import matplotlib.pyplot as plt
top_features = 10
feature_names = X_train_processed.columns[indices][:top_features]
importances = importances[:top_features]

plt.figure(figsize=(10, 6))
plt.bar(range(len(importances)), importances, color='skyblue', align='center')
plt.xticks(range(len(importances)), feature_names, rotation=45)
plt.xlabel('Feature')
plt.ylabel('Importance')
plt.title('Top 10 Feature Importance by Random Forest Model')
plt.tight_layout()
```