In [16]:
```
#Importing the required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import LabelEncoder
```

In [17]:
```
#import the train and test data set
train = pd.read_csv(r'E:\All\MPS in Analytics, Northeastern University\Acads\Winter 2021\2nd Term\ALY 6040 Data Mining\Final project dataset\dataset\train.csv')
test = pd.read_csv(r'E:\All\MPS in Analytics, Northeastern University\Acads\Winter 2021\2nd Term\ALY 6040 Data Mining\Final project dataset\dataset\test.csv')
```

In [18]:
```
train.shape
```

Out[18]: (103904, 25)

In [19]:
```
train.head(10)
```

Out[19]:

	Unnamed: 0	id	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure time conv
0	0	70172	Male	Loyal Customer	13	Personal Travel	Eco Plus	460	3	
1	1	5047	Male	disloyal Customer	25	Business travel	Business	235	3	
2	2	110028	Female	Loyal Customer	26	Business travel	Business	1142	2	
3	3	24026	Female	Loyal Customer	25	Business travel	Business	562	2	
4	4	119299	Male	Loyal Customer	61	Business travel	Business	214	3	
5	5	111157	Female	Loyal Customer	26	Personal Travel	Eco	1180	3	
6	6	82113	Male	Loyal Customer	47	Personal Travel	Eco	1276	2	
7	7	96462	Female	Loyal Customer	52	Business travel	Business	2035	4	
8	8	79485	Female	Loyal Customer	41	Business travel	Business	853	1	
9	9	65725	Male	disloyal Customer	20	Business travel	Eco	1061	3	

10 rows × 25 columns

In [20]:
```
train=train.drop(["Unnamed: 0","id","Arrival Delay in Minutes"],axis=1)
test=test.drop(["Unnamed: 0","id","Arrival Delay in Minutes"],axis=1)
```

In [21]:
```
train.isnull().sum()
```

Out[21]:
```
Gender                                 0
Customer Type                          0
Age                                    0
Type of Travel                         0
Class                                  0
Flight Distance                        0
Inflight wifi service                  0
Departure/Arrival time convenient      0
Ease of Online booking                 0
Gate location                          0
Food and drink                         0
Online boarding                        0
Seat comfort                           0
Inflight entertainment                 0
On-board service                       0
Leg room service                       0
Baggage handling                       0
Checkin service                        0
Inflight service                       0
Cleanliness                            0
Departure Delay in Minutes             0
satisfaction                           0
dtype: int64
```

In [22]:
```
train.shape
```

Out[22]:
```
(103904, 22)
```

In [24]:
```
test.isnull().sum()
```

Out[24]:
```
Gender                                0
Customer Type                         0
Age                                   0
Type of Travel                        0
Class                                 0
Flight Distance                       0
Inflight wifi service                 0
Departure/Arrival time convenient     0
Ease of Online booking                0
Gate location                         0
Food and drink                        0
Online boarding                       0
Seat comfort                          0
Inflight entertainment                0
On-board service                      0
Leg room service                      0
Baggage handling                      0
Checkin service                       0
Inflight service                      0
Cleanliness                           0
Departure Delay in Minutes            0
satisfaction                          0
dtype: int64
```

In [26]:
```
test.shape
```

Out[26]:
```
(25976, 22)
```

In [27]:
```
# Filtering all Categorical variables
vars_categorical = list(train.select_dtypes(['object']).columns)
print(vars_categorical)
```

```
['Gender', 'Customer Type', 'Type of Travel', 'Class', 'satisfaction']
```

In [28]:
```
le=LabelEncoder()
train["Gender"]=le.fit_transform(train["Gender"])
train["Customer Type"]=le.fit_transform(train['Customer Type'])
train["Type of Travel"]=le.fit_transform(train["Type of Travel"])
train["Class"]=le.fit_transform(train["Class"])
train["satisfaction"]=le.fit_transform(train["satisfaction"])
```

In [29]:
```
train.head(5)
```

Out[29]:

	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure/Arrival time convenient	Ease of Online booking	Gat locatio
0	1	0	13	1	2	460	3	4	3	
1	1	1	25	0	0	235	3	2	3	
2	0	0	26	0	0	1142	2	2	2	
3	0	0	25	0	0	562	2	5	5	
4	1	0	61	0	0	214	3	3	3	

5 rows × 22 columns

In [30]:
```
# Filtering all Categorical variables

vars_categorical = list(test.select_dtypes(['object']).columns)
print(vars_categorical)
```

```
['Gender', 'Customer Type', 'Type of Travel', 'Class', 'satisfaction']
```

In [31]:
```
le=LabelEncoder()
test["Gender"]=le.fit_transform(test["Gender"])
test["Customer Type"]=le.fit_transform(test['Customer Type'])
test["Type of Travel"]=le.fit_transform(test["Type of Travel"])
test["Class"]=le.fit_transform(test["Class"])
test["satisfaction"]=le.fit_transform(test["satisfaction"])
```

In [32]:
```
test.head(5)
```

Out[32]:

	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure/Arrival time convenient	Ease of Online booking	Gat locatio
0	0	0	52	0	1	160	5	4	3	
1	0	0	36	0	0	2863	1	1	3	
2	1	1	20	0	1	192	2	0	2	
3	1	0	44	0	0	3377	0	0	0	
4	0	0	49	0	1	1182	2	3	4	

5 rows × 22 columns

In [35]:
```
#removing the unwated features from the list and keeping remaining
features = ['Gender', 'Customer Type', 'Age', 'Type of Travel', 'Class',
       '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']
target = ['satisfaction']

# Split into test and train
X_train = train[features]
y_train = train[target].to_numpy()
X_test = test[features]
y_test = test[target].to_numpy()
```

In [37]:
```
X_train
```

Out[37]:

	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure/Arrival time convenient	Ease of Online booking	I
0	1	0	13	1	2	460	3	4	3	
1	1	1	25	0	0	235	3	2	3	
2	0	0	26	0	0	1142	2	2	2	
3	0	0	25	0	0	562	2	5	5	
4	1	0	61	0	0	214	3	3	3	
...	...	...	...	...	...	...	...	...	...	
103899	0	1	23	0	1	192	2	1	2	
103900	1	0	49	0	0	2347	4	4	4	
103901	1	1	30	0	0	1995	1	1	1	
103902	0	1	22	0	1	1000	1	1	1	
103903	1	0	27	0	0	1723	1	3	3	

103904 rows × 21 columns

In [39]:
```
# Normalize Features
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.fit_transform(X_test)
```

In [41]:
```
from sklearn.metrics import confusion_matrix,classification_report,accuracy_score,roc_curve,auc,roc_auc_score

def run_model( model, X_train_scaled, y_train, X_test_scaled, y_test):
    model.fit(X_train_scaled,y_train)
    y_pred = model.predict(X_test_scaled)
    acc=accuracy_score(y_test, y_pred)
    print("Accuracy: " + str(acc))
    roc_aucc = roc_auc_score(y_test, y_pred)
    print("ROC_AUC = {}".format(roc_aucc))
    print(classification_report(y_test,y_pred,digits=5))
    print(confusion_matrix(y_test,y_pred))
    sns.heatmap(confusion_matrix(y_test,y_pred),annot=True,fmt="d")

    # Printing ROC curve

    fpr, tpr,  threshold = roc_curve(y_test,y_pred)
    roc_auc = auc(fpr, tpr)
    plt.figure()
    lw=1
    plt.plot(fpr, tpr, color='darkorange', lw=1, label='ROC curve (area = %0.2f)' % roc_auc)
    plt.plot([0, 1], [0, 1], color='navy', lw=lw, linestyle='--')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver operating characteristic')
    plt.legend(loc="lower right")
    plt.show()
    return model,roc_aucc,acc
```

ANN

In [43]:
```
#Neural Networks
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout,LeakyReLU
from tensorflow.keras import backend as K
```

In [45]:
```
model = Sequential()
model.add(Dense(128, input_dim=21, activation= 'relu', kernel_initializer='he_
uniform',dynamic=True))
model.add(Dense(64, activation= 'relu', kernel_initializer='he_uniform',dynami
c=True))
model.add(Dense(32, activation= 'relu', kernel_initializer='he_uniform',dynami
c=True))
model.add(Dense(16, activation= 'relu', kernel_initializer='he_uniform',dynami
c=True))
model.add(Dense(8, activation= 'relu', kernel_initializer='he_uniform',dynamic
=True))
model.add(Dense(1,activation='sigmoid'))
model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_6 (Dense)              (None, 128)               2816
_________________________________________________________________
dense_7 (Dense)              (None, 64)                8256
_________________________________________________________________
dense_8 (Dense)              (None, 32)                2080
_________________________________________________________________
dense_9 (Dense)              (None, 16)                528
_________________________________________________________________
dense_10 (Dense)             (None, 8)                 136
_________________________________________________________________
dense_11 (Dense)             (None, 1)                 9
=================================================================
Total params: 13,825
Trainable params: 13,825
Non-trainable params: 0
_________________________________________________________________
```

In [47]:
```
model.compile(loss='binary_crossentropy', optimizer='Adam', metrics=['accurac
y'])
```

In [49]:
```
X_train.shape
```

Out[49]:
```
(103904, 21)
```

In [52]:
```
epochs_hist=model.fit(X_train_scaled, y_train, epochs=5, batch_size=34)
```

```
Epoch 1/5
3056/3056 [==============================] - 58s 19ms/step - loss: 0.0789 - a
ccuracy: 0.9655
Epoch 2/5
3056/3056 [==============================] - 59s 19ms/step - loss: 0.0776 - a
ccuracy: 0.9660
Epoch 3/5
3056/3056 [==============================] - 58s 19ms/step - loss: 0.0766 - a
ccuracy: 0.9669
Epoch 4/5
3056/3056 [==============================] - 42s 14ms/step - loss: 0.0758 - a
ccuracy: 0.9670
Epoch 5/5
3056/3056 [==============================] - 39s 13ms/step - loss: 0.0743 - a
ccuracy: 0.9673
```

In [53]:
```
y_pred=model.predict(X_test_scaled)
y_pred
```

Out[53]:
```
array([[9.9955928e-01],
       [1.0000000e+00],
       [3.0978434e-05],
       ...,
       [5.7881454e-07],
       [1.0000000e+00],
       [3.1335614e-07]], dtype=float32)
```

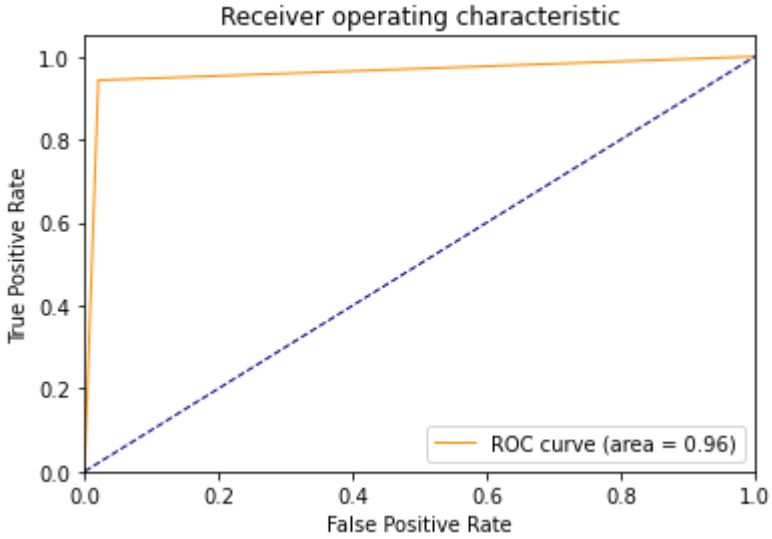
In [54]:
```
# Converting y_pred to binary
y_pred = (y_pred > 0.5)
```

In [55]:
```
acc_nn=accuracy_score(y_pred,y_test)
acc_nn
```

Out[55]:
```
0.9634277794887589
```

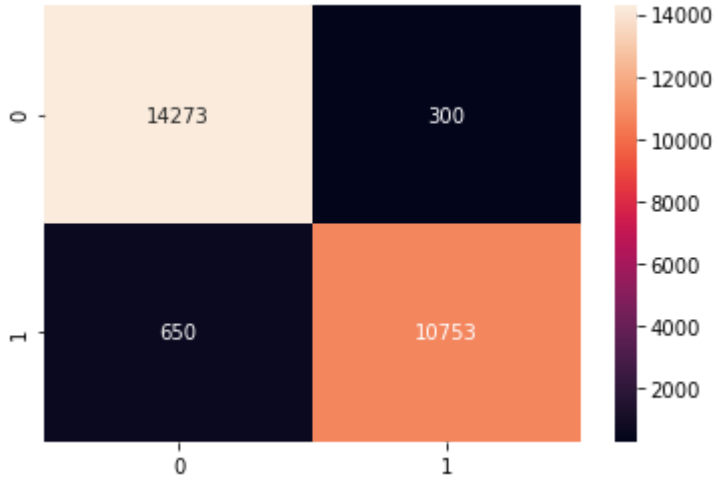
In [56]:
```
# Printing ROC curve

fpr, tpr,  threshold = roc_curve(y_test,y_pred)
roc_auc = auc(fpr, tpr)
plt.figure()
lw=1
plt.plot(fpr, tpr, color='darkorange', lw=1, label='ROC curve (area = %0.2f)'
% roc_auc)
plt.plot([0, 1], [0, 1], color='navy', lw=lw, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show()
```



In [57]:
```
sns.heatmap(confusion_matrix(y_test,y_pred),annot=True,fmt="d")
```

Out[57]: <matplotlib.axes._subplots.AxesSubplot at 0x28ef8ca4190>



In [62]:
```
print('Accuracy for ANN model:\n{:.3f}\n'.format(acc_nn))
```

```
Accuracy for ANN model:
0.963
```

In [ ]:
```

```