#AviaKompaniya (portfolio)

Yo`lovchilarning parvozdan qoniqish darajasini bashorat qilish

Yo'lovchi doim aviakompaniya uchun eng yaxshi mijozlar guruhidir, chunki ular kompaniyaning asosiy daromadlaridan biridir.

Ularning fikr-mulohazalarini tahlil qilish aviakompaniyalarga yo'lovchiga aynan nima kerakligini tushunishga yordam beradi. Shu bilan Aviakompaniya qaysi jihatlarni yaxshilash kerakligini bilib olish mumkin.

Eng muhimi, yo'lovchilarning qoniqishini bashorat qilish ham aviakompaniyalarda CRMga yordam beradi...

Reja:

- Yo'lovchilarni qoniqishi va boshqa barcha xususiyatlar o'rtasida bog`liqlikni aniqlash.
- Yo'lovchilar qoniqishini bashorat qilish uchun eng yaxshi `bashorat modellar` ni tanlash
- ajoyib ishlash modellari orqali yuqori korrelyatsiya omillarini baholash.

Kerakli Kutubxonalarni chaqiramiz:

```
import pandas as pd
import numpy as np
import sklearn
import seaborn as sns
import matplotlib.pyplot as plt

%matplotlib inline

import tensorflow as tf
from keras.models import Sequential
from keras.layers import Dense
import warnings
```

```
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import LabelEncoder
from sklearn.impute import KNNImputer

from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from xgboost import XGBClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from sklearn.naive_bayes import GaussianNB

from sklearn.metrics import confusion_matrix,plot_roc_curve, roc_curve, precision_score

warnings.filterwarnings("ignore")
```

##Train dataset:

```
# train data
df_train = pd.read_csv('/content/train_dataset.csv', index_col=0)
# test data
df_test = pd.read_csv('/content/test_dataset.csv', index_col=0)
# sample_submission data
ss_df = pd.read_csv('/content/sample_submission.csv', index_col=0)
```

Quyidagi datasetda yo`lovchilarning ma'lum bir xizmatlardan qoniqish darajasi keltirilgan. Bizning vazifamiz ushbu ma'lumotlardan foydalangan holda ularning parvozdan qoniqish darajasini aniqlash (bashorat qilish).

Tarkib:

`Gender` : yo'lovchilarning jinsi (ayol, erkak)

`Customer Type` : mijoz turi (sodiq mijoz, ishonchsiz mijoz)

`Age` : yo'lovchilarning haqiqiy yoshi

`Type of Travel` : yo'lovchilar parvozining maqsadi (shaxsiy sayohat, biznes sayohat)

`Class` : yo'lovchilar samolyotida sayohat klassi (Business, Eco, Eco Plus)

`Flight distance` : Ushbu sayohatning parvoz masofasi

`Inflight wifi service` : Parvoz ichidagi Wi-Fi xizmatidan qoniqish darajasi (0: Tegishli emas; 1-5)

`Departure/Arrival time convenient` : Ketish/Kelish vaqtining qoniqish darajasi

`Ease of Online booking` : Onlayn bron qilishdan qoniqish darajasi

`Gate location` : Darvoza joylashuvidan qoniqish darajasi

`Food and drink` : Oziq-ovqat va ichimlikdan qoniqish darajasi

`Online boarding` : Onlayn bortdan qoniqish darajasi

`Seat comfort` : O'rindiqning qulayligidan qoniqish darajasi

`Inflight entertainment` : Parvoz ichidagi o'yin-kulgidan qoniqish darajasi

`On-board service` : Bort xizmatidan qoniqish darajasi

`Leg room service` : oyoq xonasi xizmatidan qoniqish darajasi

`Baggage handling` : bagajni tashishdan qoniqish darajasi

`Check-in service` : Ro'yxatdan o'tish xizmatidan qoniqish darajasi

`Inflight service` : Parvoz ichidagi xizmatdan qoniqish darajasi

`Cleanliness` : Tozalikdan qoniqish darajasi

`Arrival Delay in Minutes` : kechikish

Ma`lumotlarni o'rganamiz

`df_train` haqida:

```
df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10000 entries, 1 to 10000
Data columns (total 23 columns):
 #   Column                            Non-Null Count  Dtype
---  ------                            --------------  -----
 0   Gender                            10000 non-null  object
 1   Customer Type                     10000 non-null  object
 2   Age                               10000 non-null  int64
 3   Type of Travel                    10000 non-null  object
 4   Class                             10000 non-null  object
 5   Flight Distance                   10000 non-null  int64
 6   Inflight wifi service             10000 non-null  int64
 7   Departure/Arrival time convenient 10000 non-null  int64
 8   Ease of Online booking            10000 non-null  int64
 9   Gate location                     10000 non-null  int64
 10  Food and drink                    10000 non-null  int64
 11  Online boarding                   10000 non-null  int64
 12  Seat comfort                      10000 non-null  int64
 13  Inflight entertainment            10000 non-null  int64
 14  On-board service                  10000 non-null  int64
 15  Leg room service                  10000 non-null  int64
 16  Baggage handling                  10000 non-null  int64
 17  Checkin service                   10000 non-null  int64
```

```
 18  Inflight service                   10000 non-null  int64
 19  Cleanliness                        10000 non-null  int64
 20  Departure Delay in Minutes         10000 non-null  int64
 21  Arrival Delay in Minutes           9972 non-null   float64
 22  satisfaction                       10000 non-null  int64
dtypes: float64(1), int64(18), object(4)
memory usage: 1.8+ MB
```

Matnli ustunlar tarkibi:

```
# matnli va raqamli ustunlarni ajratib olamiz:

# num columns:
numerical_columns = [k for k in df_train.columns if df_train[k].dtype.name != 'object']
numerical_columns.remove('satisfaction')

# obj columns:
categorical_columns = [k for k in df_train.columns if df_train[k].dtype.name == 'object
df_train_describe = df_train.describe(include = 'object')
```

```
df_train.describe(include = 'object')
```

	Gender	Customer Type	Type of Travel	Class
count	10000	10000	10000	10000
unique	2	2	2	3
top	Female	Loyal Customer	Business travel	Business
freq	5169	8307	7079	5048

```
binary_columns = [k for k in categorical_columns if df_train_describe[k]['unique'] == 2
nonbinary_columns = [k for k in categorical_columns if df_train_describe[k]['unique'] >
print(binary_columns, nonbinary_columns)
```

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

Keling, har bir ikkilik Columnlar uchun takrorlanmas qiymatlarni ko'rib chiqaylik:

```
for col in binary_columns:
    print(col, ': ', end = '')
    for uniq in df_train[col].unique():
        if uniq == df_train[col].unique()[-1]:
            print(uniq, end = '.')
        else:
            print(uniq, end = ', ')
    print()
```

```
Gender : Male, Female.
Customer Type : disloyal Customer, Loyal Customer.
```

`Type of Travel : Business travel, Personal Travel.`

Ularning sonini ko`ramiz:

```
for col in binary_columns:
    k = 0
    for uniq in df_train[col].unique():
        df_train.at[df_train[col] == uniq, col] = k
        k +=1
for col in binary_columns:
    print(df_train[col].describe(), end = '\n\n')
```

```
count     10000
unique        2
top           1
freq       5169
Name: Gender, dtype: int64

count     10000
unique        2
top           1
freq       8307
Name: Customer Type, dtype: int64

count     10000
unique        2
top           0
freq       7079
Name: Type of Travel, dtype: int64
```

Matnli ustunlarni raqamliga o'zgartiramiz.

Buning uchun yoki `sklearn` tarkibidagi `LabelEncoder` va `replace` dan foydalanish mumkin.

`.replace`

```
Gender = {'Female': 0, 'Male':1}
travelType = {'Business travel':1,'Personal Travel':0}
Class = {'Business':2,'Eco Plus': 1,'Eco':0}
CustType = {'Loyal Customer':1,'disloyal Customer':0}

# train data uchun:
df_train['Gender'].replace(Gender, inplace=True)
df_train['Type of Travel'].replace(travelType, inplace=True)
df_train['Customer Type'].replace(CustType, inplace=True)
df_train['Class'].replace(Class, inplace=True)
```

```
# test data uchun
df_test['Gender'].replace(Gender, inplace=True)
df_test['Type of Travel'].replace(travelType, inplace=True)
df_test['Customer Type'].replace(CustType, inplace=True)
df_test['Class'].replace(Class, inplace=True)
```

```
df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10000 entries, 1 to 10000
Data columns (total 23 columns):
 #   Column                            Non-Null Count  Dtype  
---  ------                            --------------  -----  
 0   Gender                            10000 non-null  int64  
 1   Customer Type                     10000 non-null  int64  
 2   Age                               10000 non-null  int64  
 3   Type of Travel                    10000 non-null  int64  
 4   Class                             10000 non-null  int64  
 5   Flight Distance                   10000 non-null  int64  
 6   Inflight wifi service             10000 non-null  int64  
 7   Departure/Arrival time convenient  10000 non-null  int64  
 8   Ease of Online booking            10000 non-null  int64  
 9   Gate location                     10000 non-null  int64  
 10  Food and drink                    10000 non-null  int64  
 11  Online boarding                   10000 non-null  int64  
 12  Seat comfort                      10000 non-null  int64  
 13  Inflight entertainment            10000 non-null  int64  
 14  On-board service                  10000 non-null  int64  
 15  Leg room service                  10000 non-null  int64  
 16  Baggage handling                  10000 non-null  int64  
 17  Checkin service                   10000 non-null  int64  
 18  Inflight service                  10000 non-null  int64  
 19  Cleanliness                       10000 non-null  int64  
 20  Departure Delay in Minutes        10000 non-null  int64  
 21  Arrival Delay in Minutes          9972 non-null   float64
 22  satisfaction                      10000 non-null  int64  
dtypes: float64(1), int64(22)
memory usage: 2.1 MB
```

Korrelyatsiya(foizda):

```
df_train.corrwith(df_train['satisfaction']).abs().sort_values(ascending=False)*100
```

```
satisfaction                      100.000000
Class                              51.893105
```

```
Online boarding                    50.498562
Type of Travel                     48.226628
Inflight entertainment             40.089954
Seat comfort                       34.229377
On-board service                   32.642642
Leg room service                   32.436790
Cleanliness                        31.033803
Flight Distance                    29.870298
Inflight wifi service              27.739521
Baggage handling                   24.796452
Inflight service                   24.058363
Checkin service                    23.235876
Food and drink                     20.785353
Customer Type                      18.159192
Ease of Online booking             16.466159
Age                                14.430214
Departure/Arrival time convenient   6.763835
Arrival Delay in Minutes            4.864993
Departure Delay in Minutes          4.296014
Gate location                       0.716950
Gender                              0.260149
dtype: float64
```

```
corr_matrix = df_train.corr().abs()
corr_matrix.style.background_gradient(cmap='coolwarm')
```

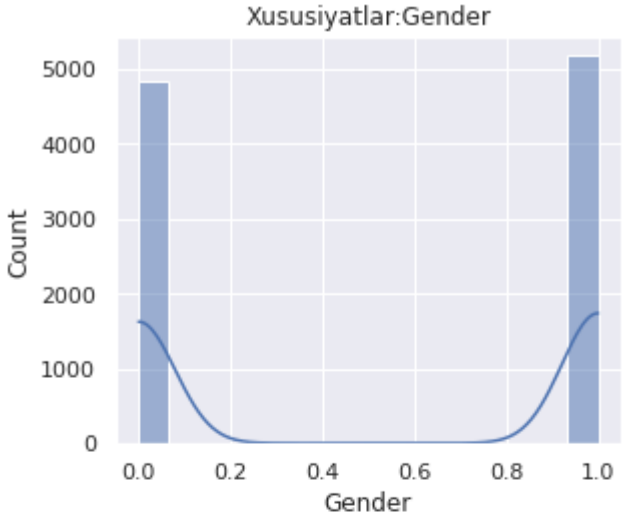
	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure/Arrival time convenient	Eas On book
Gender	1.000000	0.025020	0.004407	0.021504	0.001256	0.017786	0.010111	0.016445	0.007
Customer Type	0.025020	1.000000	0.291192	0.280023	0.123456	0.226549	0.003499	0.196112	0.018
Age	0.004407	0.291192	1.000000	0.075133	0.163603	0.110823	0.020904	0.036071	0.026
Type of Travel	0.021504	0.280023	0.075133	1.000000	0.557850	0.276756	0.099728	0.243037	0.114
Class	0.001256	0.123456	0.163603	0.557850	1.000000	0.453539	0.025290	0.091019	0.089
Flight Distance	0.017786	0.226549	0.110823	0.276756	0.453539	1.000000	0.002341	0.021320	0.052
Inflight wifi service	0.010111	0.003499	0.020904	0.099728	0.025290	0.002341	1.000000	0.362355	0.730
Departure/Arrival time convenient	0.016445	0.196112	0.036071	0.243037	0.091019	0.021320	0.362355	1.000000	0.456
Ease of Online booking	0.007580	0.018328	0.026964	0.114107	0.089416	0.052807	0.730731	0.456498	1.000
Gate location	0.017967	0.000866	0.012077	0.035903	0.007877	0.017513	0.362702	0.479002	0.476
Food and drink	0.004991	0.072036	0.021971	0.077951	0.095619	0.065939	0.119807	0.001982	0.017
Online boarding	0.045786	0.195554	0.215613	0.241535	0.336912	0.213859	0.438034	0.046456	0.388
Seat comfort	0.045933	0.174279	0.169291	0.150680	0.245338	0.170203	0.107020	0.002102	0.016
Inflight entertainment	0.009528	0.126166	0.097421	0.186244	0.226036	0.150573	0.198351	0.007094	0.043
On-board service	0.004277	0.061039	0.073412	0.080640	0.224167	0.115167	0.133511	0.071368	0.053

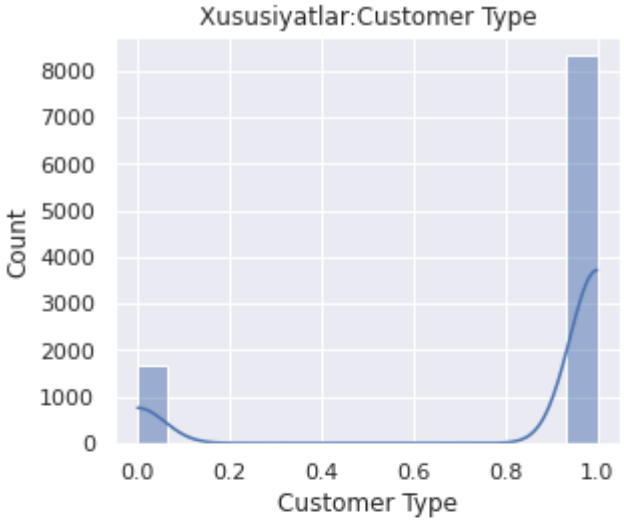
	Gender	Customer Type	Age	Type of Travel	Class	Flight Distance	Inflight wifi service	Departure/Arrival time convenient	Eas On book
Leg room service	0.019076	0.071066	0.060124	0.153127	0.221653	0.140509	0.172526	0.027487	0.116
Baggage handling	0.039071	0.014837	0.040368	0.035709	0.179048	0.073161	0.123695	0.072969	0.044
Checkin service	0.019710	0.032102	0.038761	0.006062	0.165677	0.066881	0.039923	0.078166	0.013
Inflight service	0.048099	0.026231	0.036921	0.038847	0.158066	0.058939	0.113467	0.062814	0.032
Cleanliness	0.008535	0.101625	0.062409	0.110651	0.153413	0.100705	0.119484	0.001172	0.007
Departure Delay in Minutes	0.032548	0.008944	0.015618	0.007013	0.001794	0.011425	0.019843	0.010846	0.001
Arrival Delay in Minutes	0.027431	0.006917	0.019086	0.007061	0.005113	0.002901	0.023086	0.008985	0.003
satisfaction	0.002601	0.181592	0.144302	0.482266	0.518931	0.298703	0.277395	0.067638	0.164

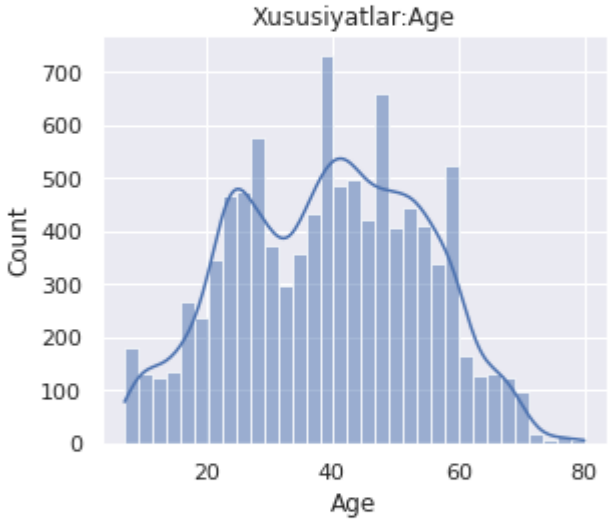
Vizualizatsiya

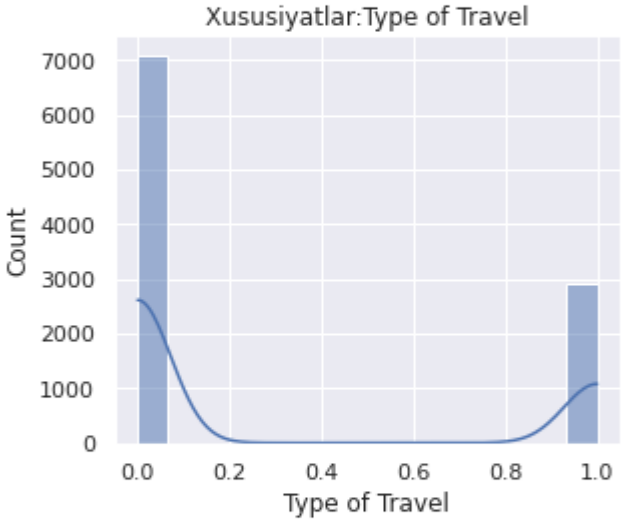
```
numerics = ['int64','float64']

train_con_col = df_train.select_dtypes(include = numerics).columns # df_trainni ichidan
train_cat_col = df_train.select_dtypes(include = "object").columns # vahokazo....
test_con_col = df_test.select_dtypes(include = numerics).columns
test_cat_col = df_test.select_dtypes(include = "object").columns
```

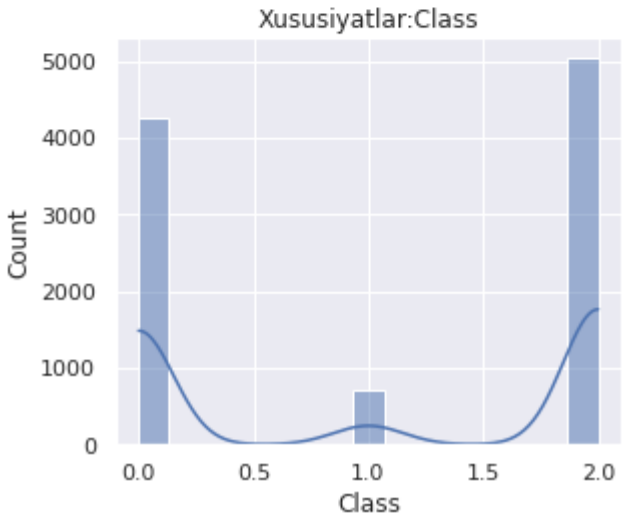
```
fig, axs = plt.subplots(9, 2, figsize=(10, 35))
fig.tight_layout(pad=4.0) # yozuvlarni tugri joylashuvi uchun

for f,ax in zip(train_con_col,axs.ravel()):
    sns.set(font_scale = 1)
    ax=sns.histplot(ax=ax,data=df_train,x=df_train[f], kde=True)
    ax.set_title('Xususiyatlar:'+ f)
```

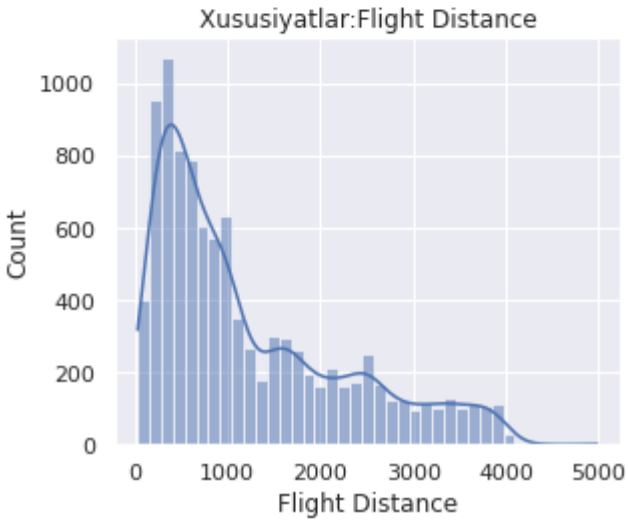

Xususiyatlar:Gender
Count
Gender
0
1000
2000
3000
4000
5000
0.0
0.2
0.4
0.6
0.8
1.0

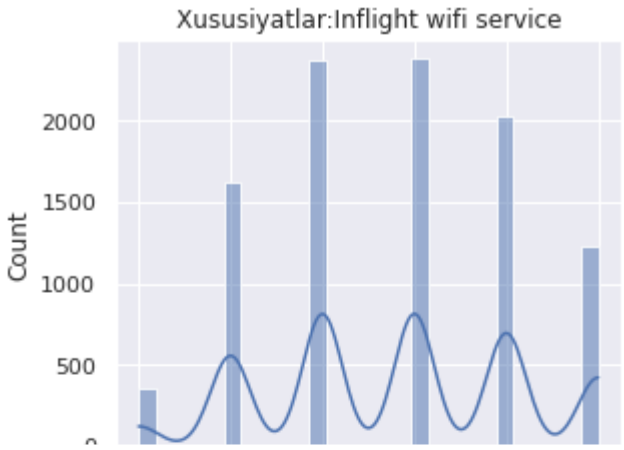

Xususiyatlar:Customer Type
Count
Customer Type
0
1000
2000
3000
4000
5000
6000
7000
8000
0.0
0.2
0.4
0.6
0.8
1.0

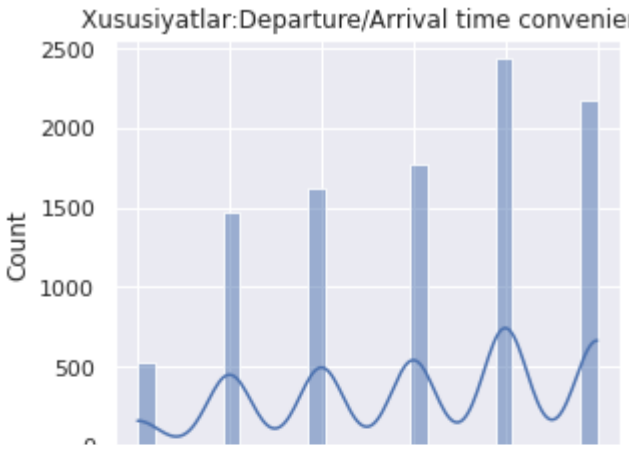

Xususiyatlar:Age
Count
Age
0
100
200
300
400
500
600
700
20
40
60
80

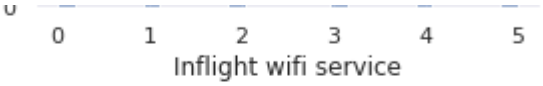

Xususiyatlar:Type of Travel
Count
Type of Travel
0
1000
2000
3000
4000
5000
6000
7000
0.0
0.2
0.4
0.6
0.8
1.0

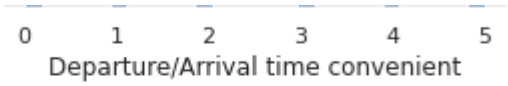

Xususiyatlar:Class
Count
Class
0
1000
2000
3000
4000
5000
0.0
0.5
1.0
1.5
2.0

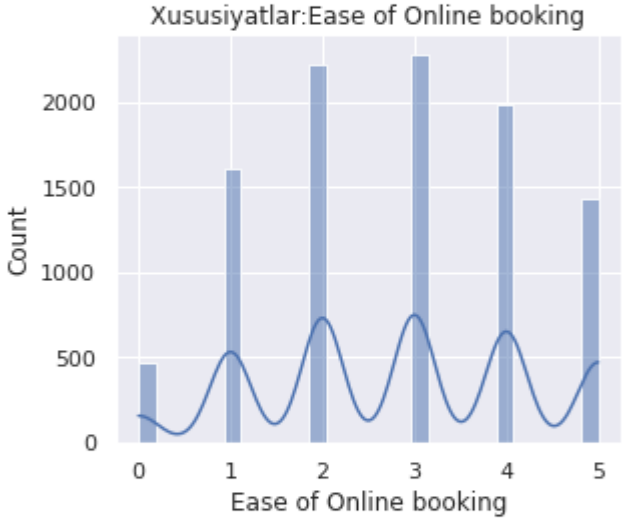

Xususiyatlar:Flight Distance
Count
Flight Distance
0
200
400
600
800
1000
0
1000
2000
3000
4000
5000

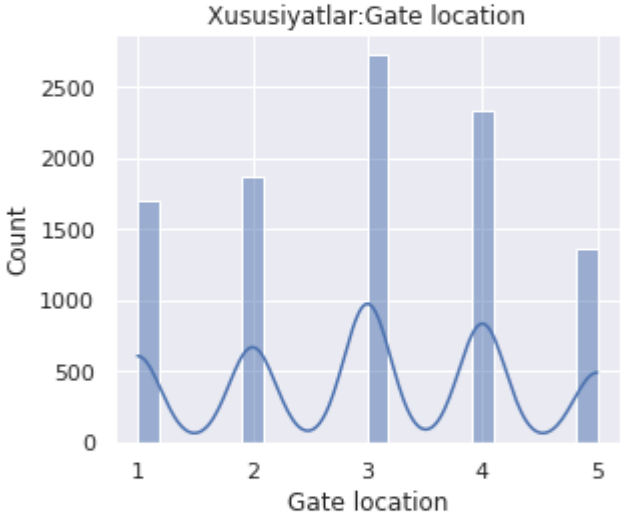

Xususiyatlar:Inflight wifi service
Count
0
500
1000
1500
2000

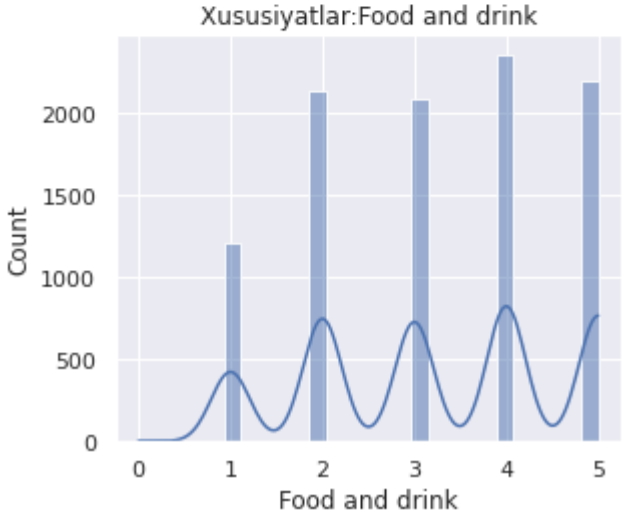

Xususiyatlar:Departure/Arrival time convenient
Count
0
500
1000
1500
2000
2500

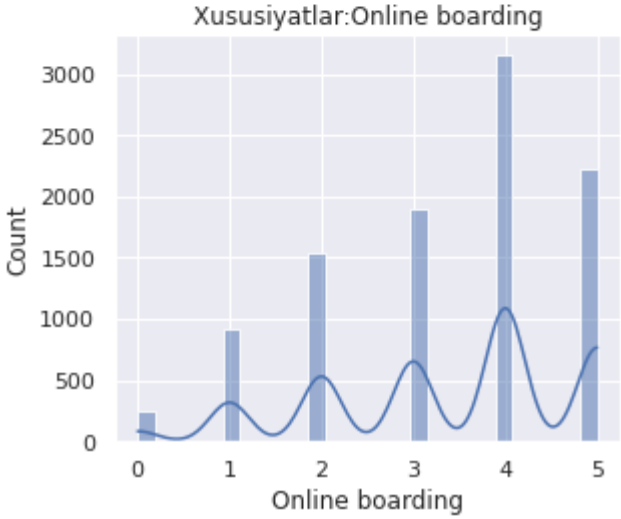

0
1
2
3
4
5
Inflight wifi service

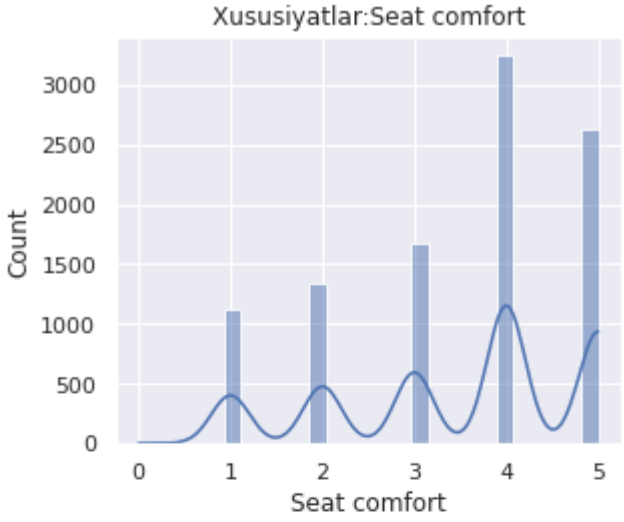

0
1
2
3
4
5
Departure/Arrival time convenient

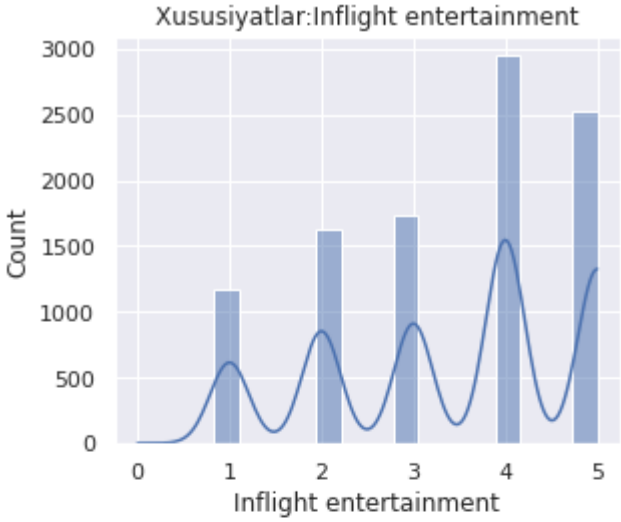

Xususiyatlar:Ease of Online booking
Count
0
500
1000
1500
2000
0
1
2
3
4
5
Ease of Online booking

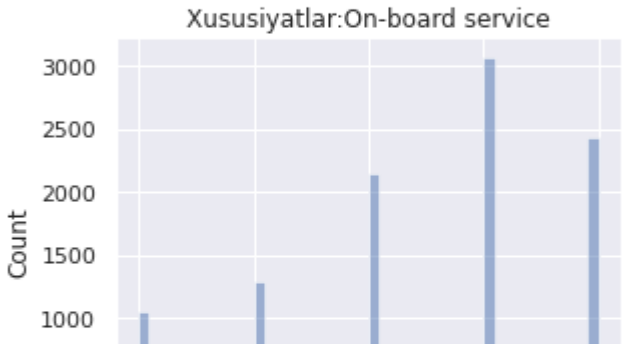

Xususiyatlar:Gate location
Count
0
500
1000
1500
2000
2500
1
2
3
4
5
Gate location

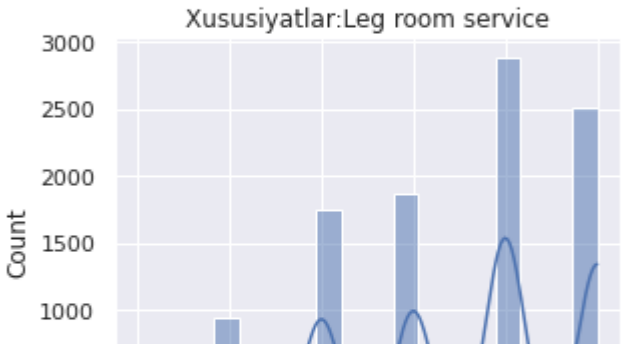

Xususiyatlar:Food and drink
Count
0
500
1000
1500
2000
0
1
2
3
4
5
Food and drink

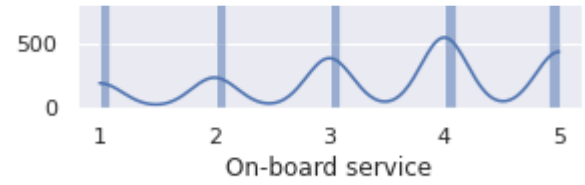

Xususiyatlar:Online boarding
Count
0
500
1000
1500
2000
2500
3000
0
1
2
3
4
5
Online boarding

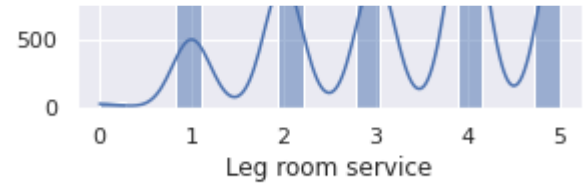

Xususiyatlar:Seat comfort
Count
0
500
1000
1500
2000
2500
3000
0
1
2
3
4
5
Seat comfort

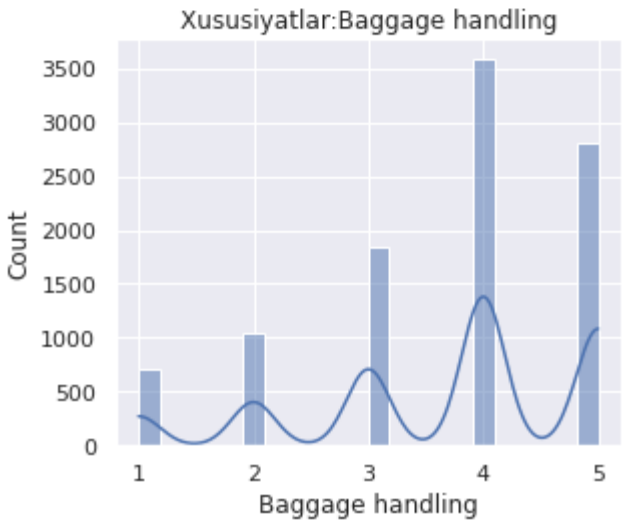

Xususiyatlar:Inflight entertainment
Count
0
500
1000
1500
2000
2500
3000
0
1
2
3
4
5
Inflight entertainment

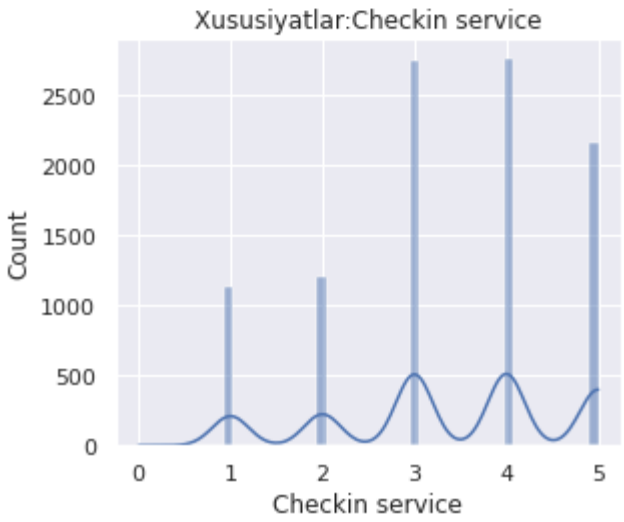

Xususiyatlar:On-board service
Count
1000
1500
2000
2500
3000


Xususiyatlar:Leg room service
Count
1000
1500
2000
2500
3000

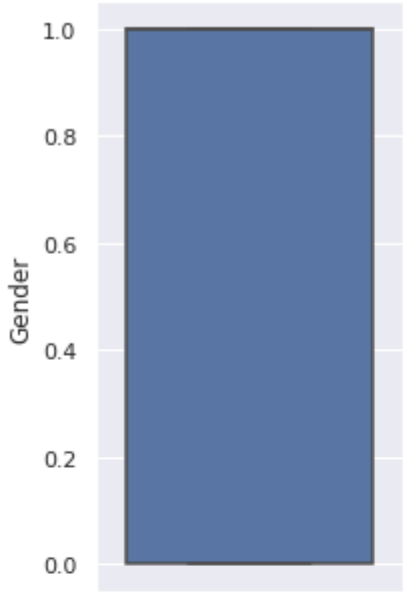


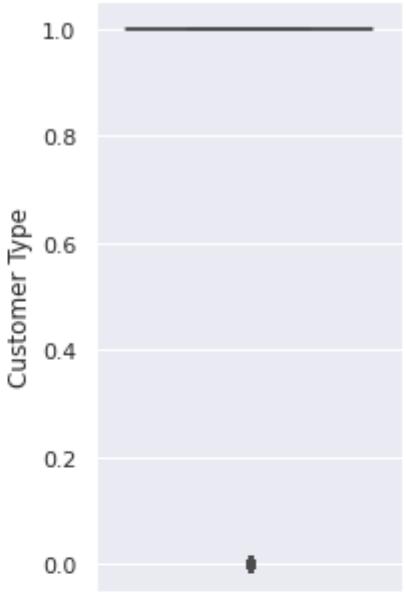


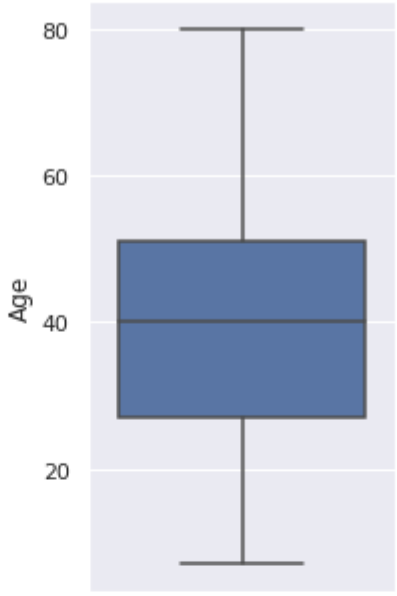


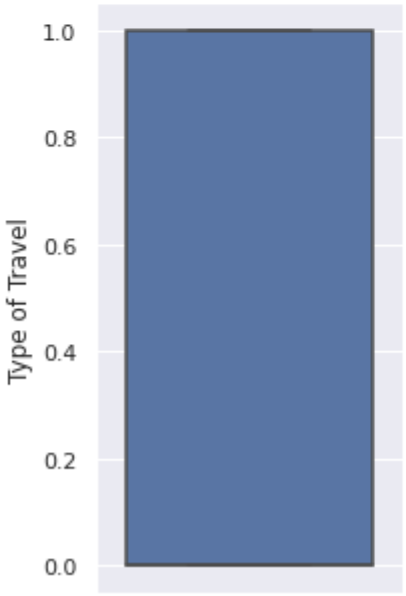


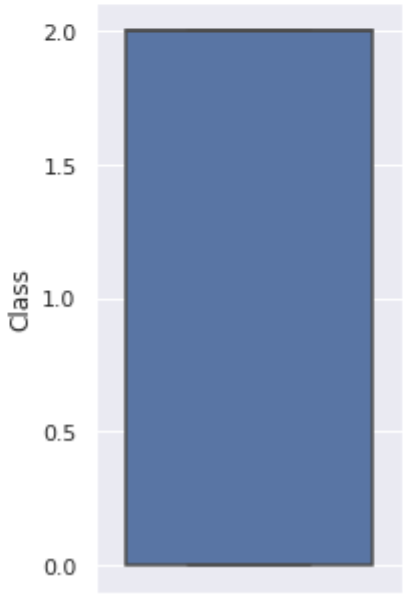

```
fig, axs = plt.subplots(6, 3, figsize=(10,30))
fig.tight_layout(pad=3.0)

for f,ax in zip(train_con_col,axs.ravel()):
    sns.set(font_scale = 2)
    ax=sns.boxplot(ax=ax,data=df_train,y=df_train[f])
```

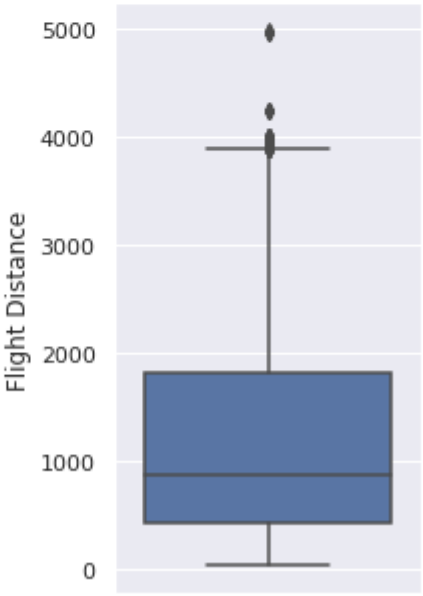

Gender
1.0
0.8
0.6
0.4
0.2
0.0

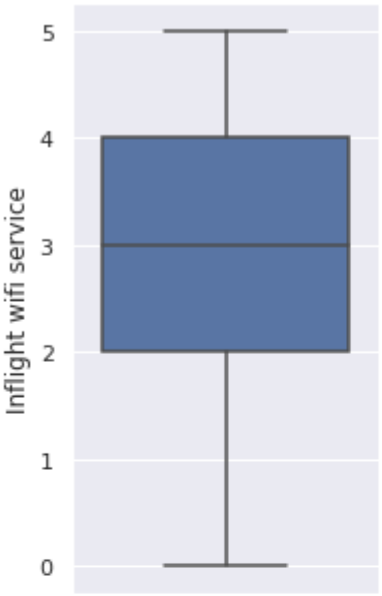

Customer Type
1.0
0.8
0.6
0.4
0.2
0.0

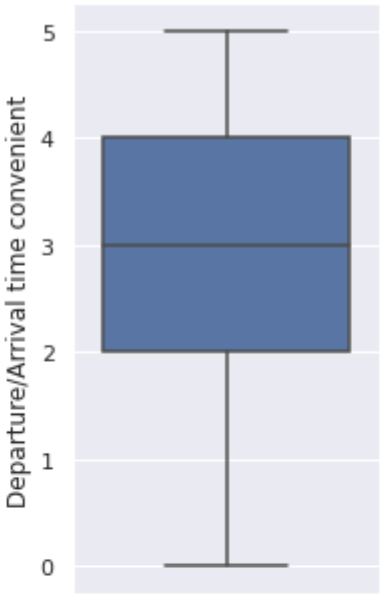

Age
80
60
40
20

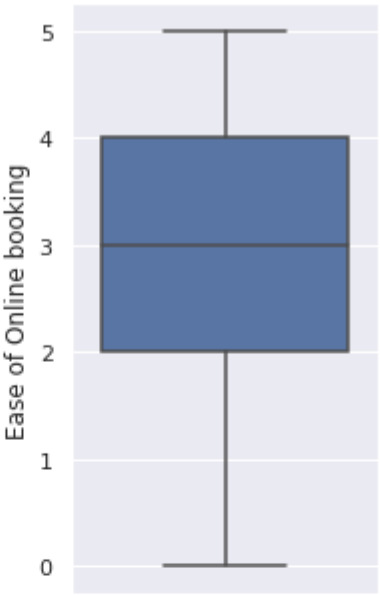

Type of Travel
1.0
0.8
0.6
0.4
0.2
0.0

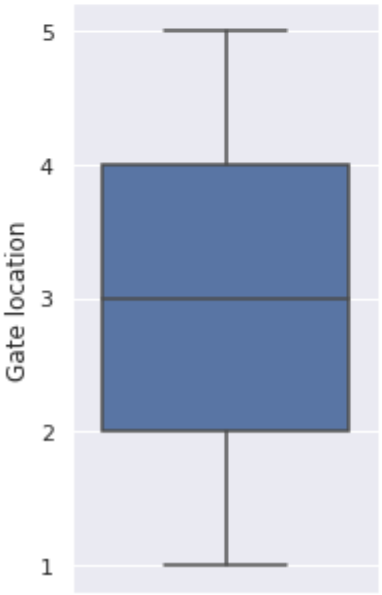

Class
2.0
1.5
1.0
0.5
0.0

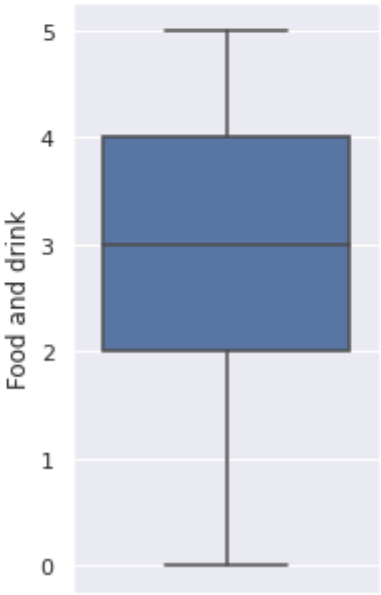

Flight Distance
5000
4000
3000
2000
1000
0

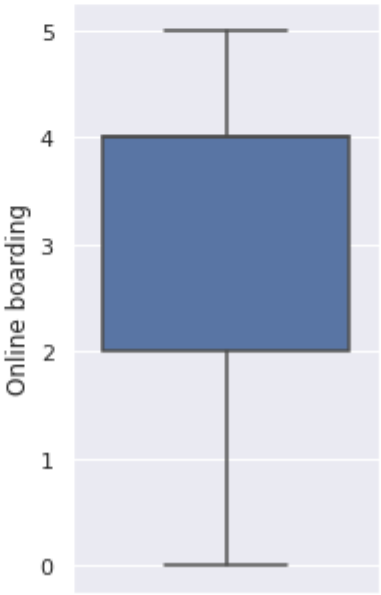

Inflight wifi service
5
4
3
2
1
0

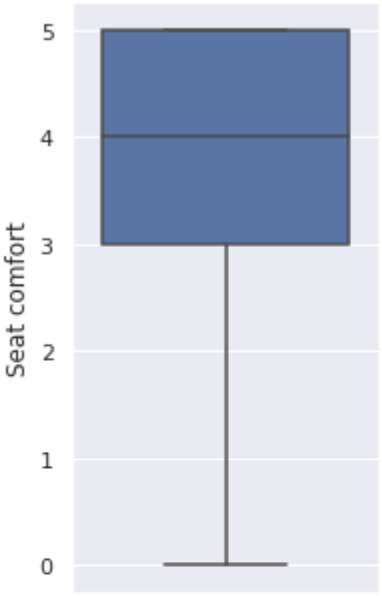

Departure/Arrival time convenient
5
4
3
2
1
0

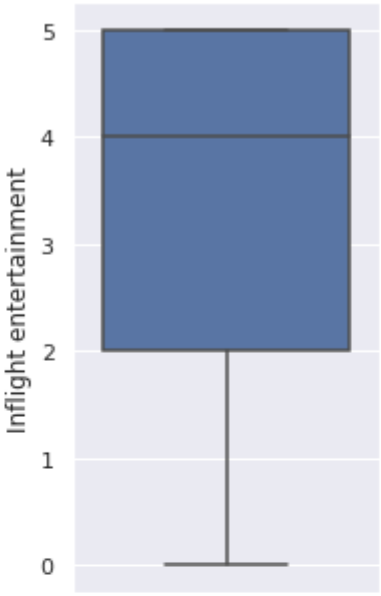

Ease of Online booking
5
4
3
2
1
0

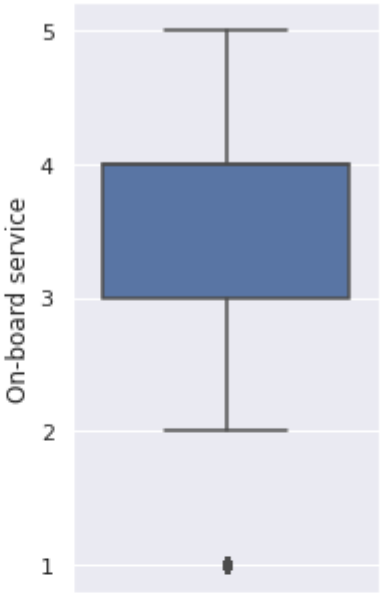

Gate location
5
4
3
2
1

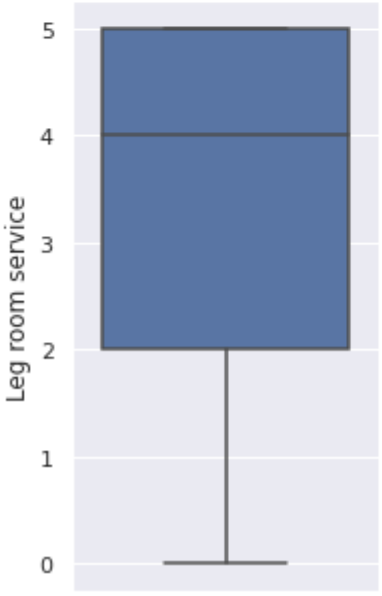

Food and drink
5
4
3
2
1
0

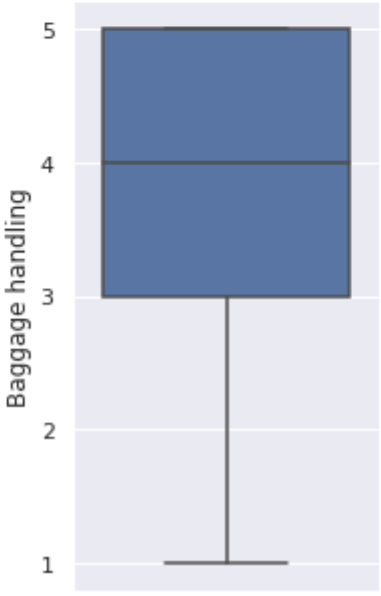

Online boarding
5
4
3
2
1
0

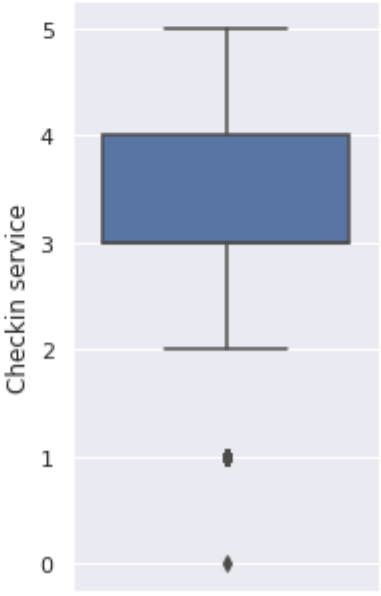

Seat comfort
5
4
3
2
1
0


Inflight entertainment
5
4
3
2
1
0

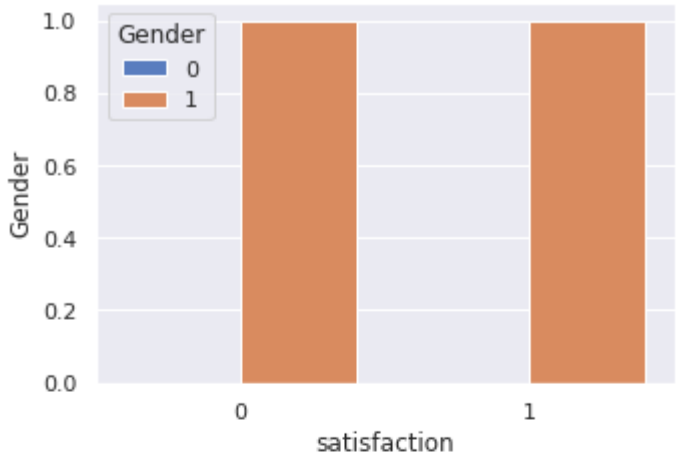

On-board service
5
4
3
2
1

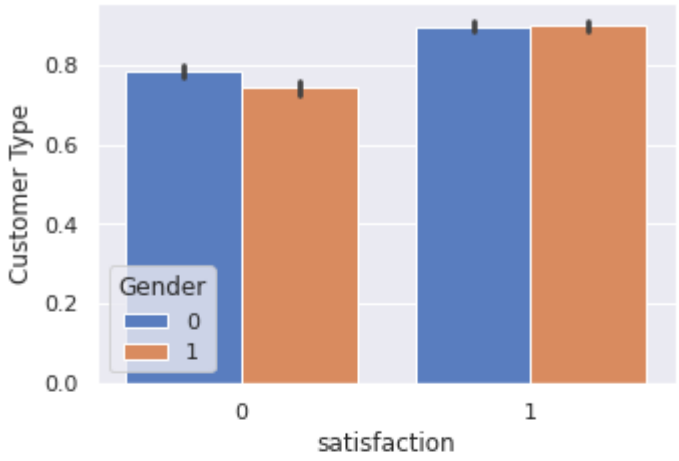

Leg room service
5
4
3
2
1
0

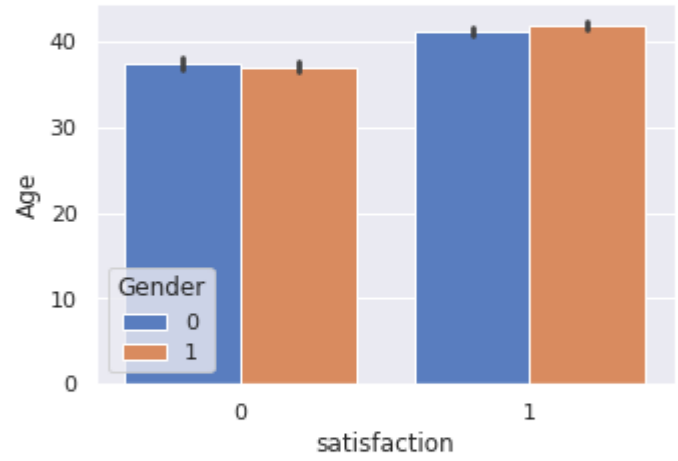

Baggage handling
5
4
3
2
1

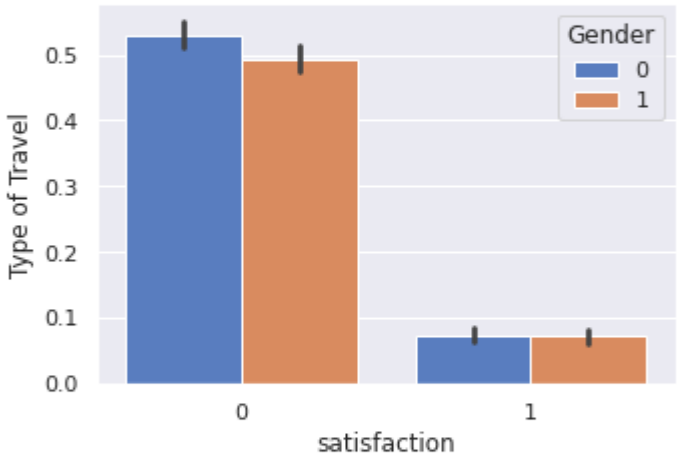

Checkin service
5
4
3
2
1
0

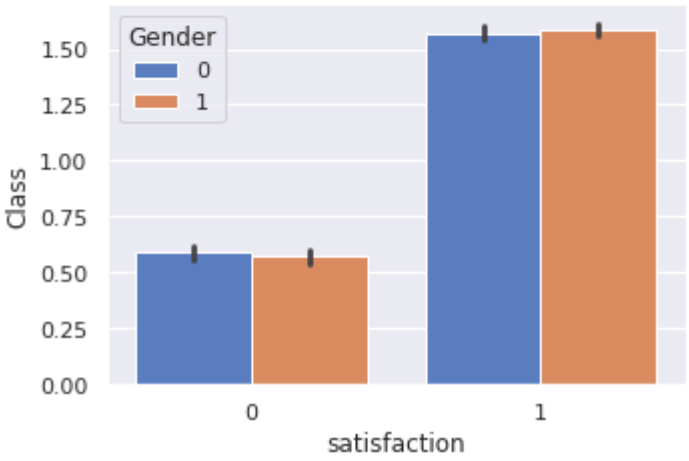
```
def detail_barplot(category):
    fig, axs = plt.subplots(9, 2, figsize=(10,30))
    sns.set(font_scale=1)
    fig.tight_layout(pad=2.0)
    for feature,ax in zip(train_con_col,axs.ravel()):
        ax = sns.barplot(ax=ax,x="satisfaction", y=feature, hue=category,palette= 'mute

detail_barplot("Gender")
```

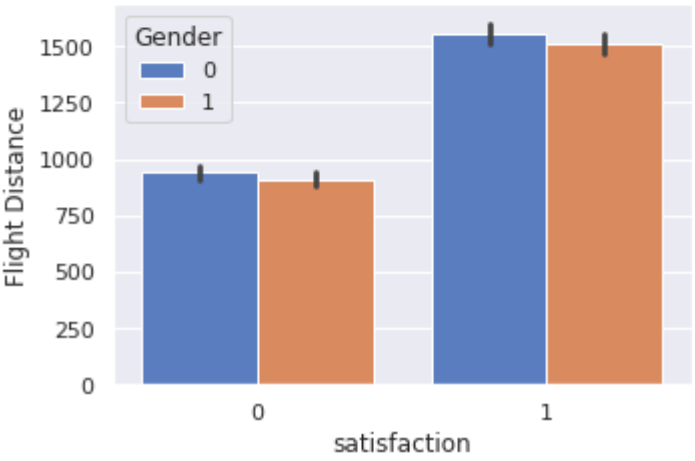

Gender
0
1
Gender
0.0
0.2
0.4
0.6
0.8
1.0
0
1
satisfaction

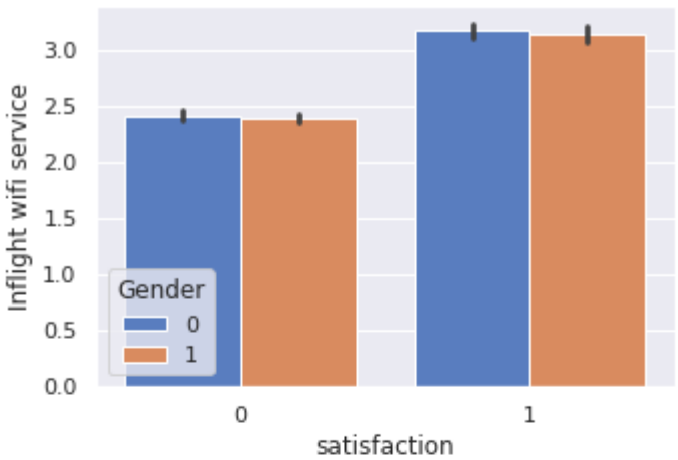

Gender
0
1
Customer Type
0.0
0.2
0.4
0.6
0.8
0
1
satisfaction

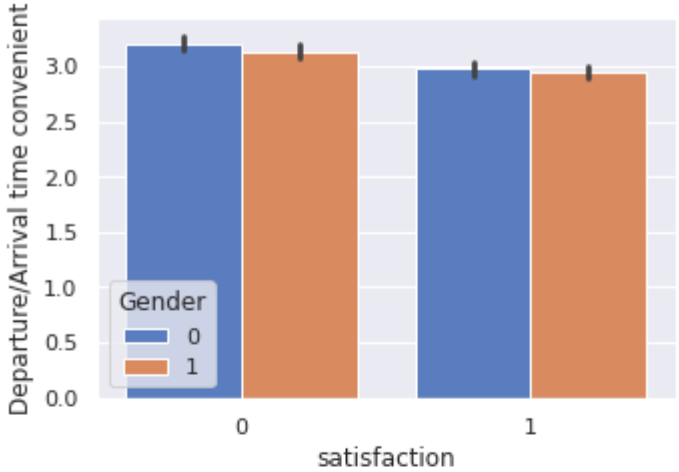

Gender
0
1
Age
0
10
20
30
40
0
1
satisfaction

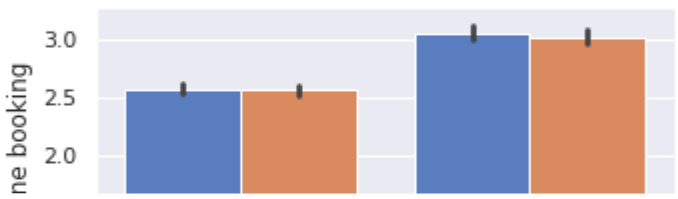

Gender
0
1
Type of Travel
0.0
0.1
0.2
0.3
0.4
0.5
0
1
satisfaction

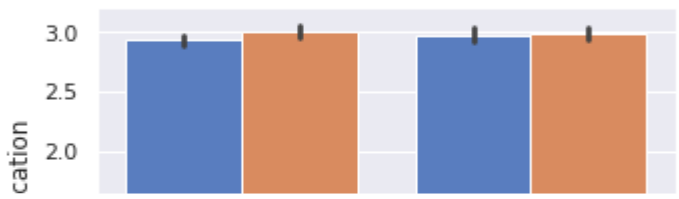

Gender
0
1
Class
0.00
0.25
0.50
0.75
1.00
1.25
1.50
0
1
satisfaction

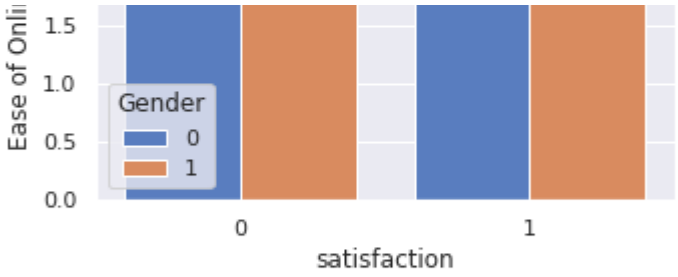

Gender
0
1
Flight Distance
0
250
500
750
1000
1250
1500
0
1
satisfaction

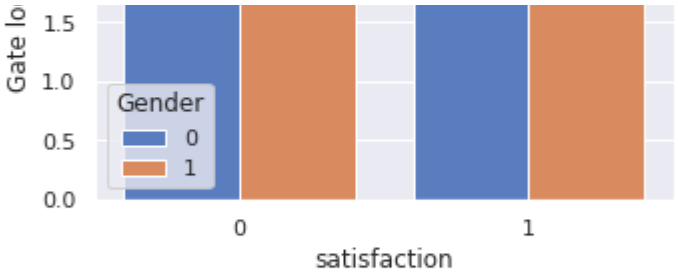

Gender
0
1
Inflight wifi service
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
1
satisfaction

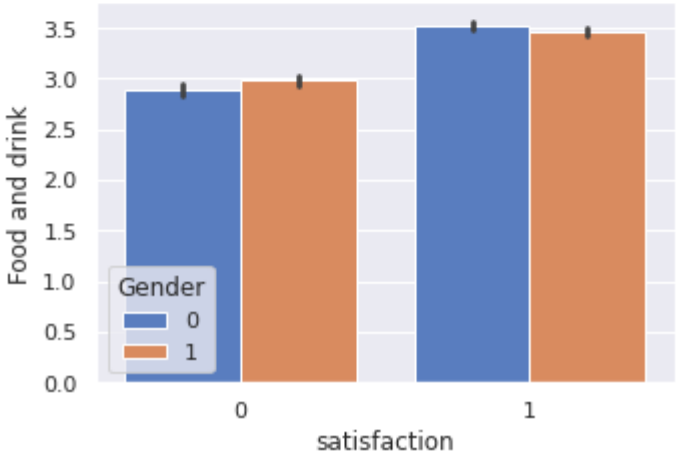

Gender
0
1
Departure/Arrival time convenient
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
1
satisfaction

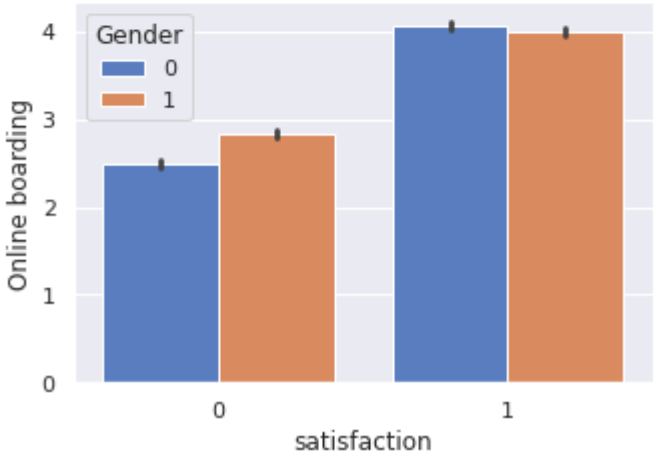

ne booking
2.0
2.5
3.0

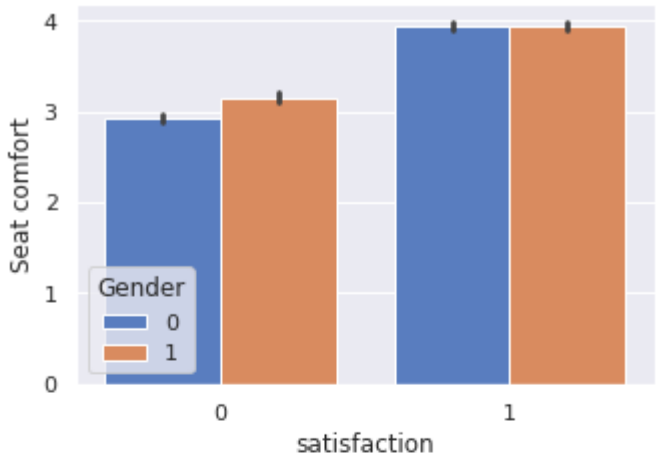

cation
2.0
2.5
3.0

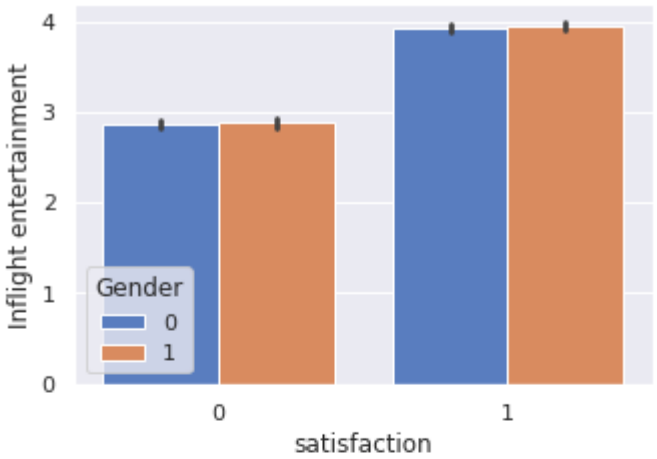

Ease of Onli
Gender
0
1
satisfaction

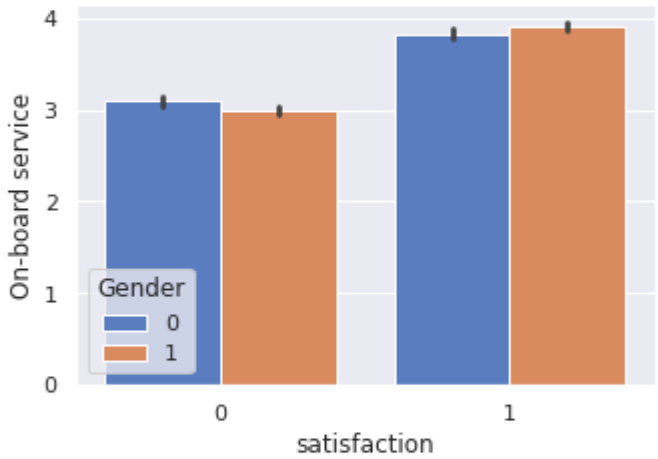

Gate lo
Gender
0
1
satisfaction

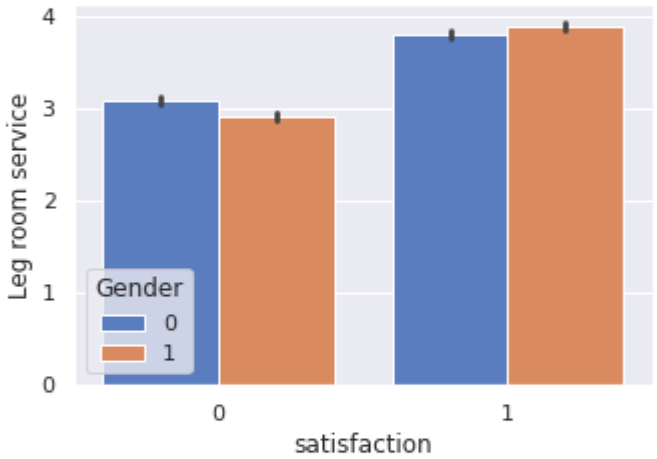

Food and drink
Gender
0
1
satisfaction

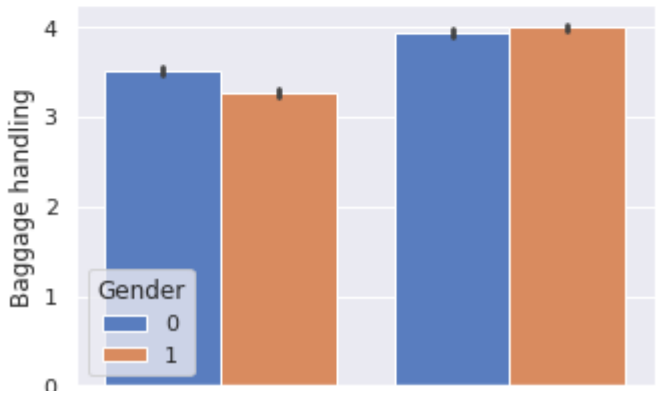

Online boarding
Gender
0
1
satisfaction

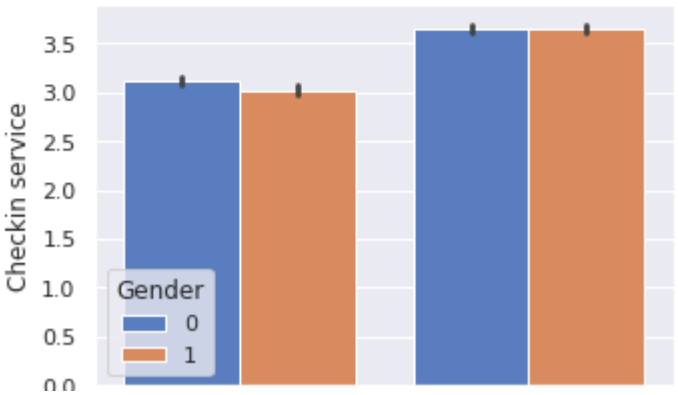

Seat comfort
Gender
0
1
satisfaction


Inflight entertainment
Gender
0
1
satisfaction


On-board service
Gender
0
1
satisfaction


Leg room service
Gender
0
1
satisfaction


Baggage handling
Gender
0
1


Checkin service
Gender
0
1

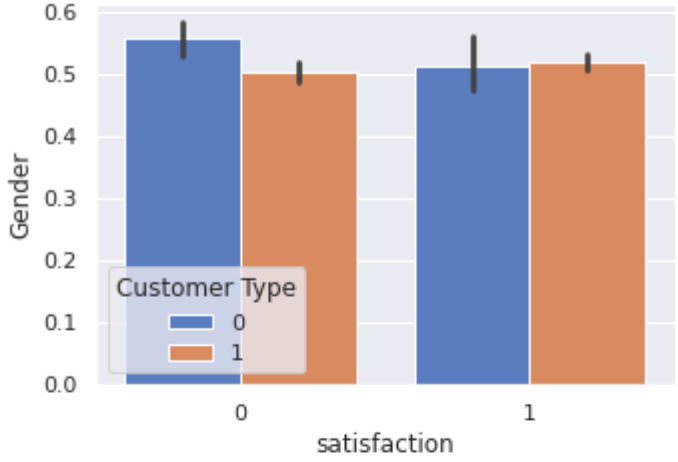
Gender bo'yicha natijalarga asoslanib:

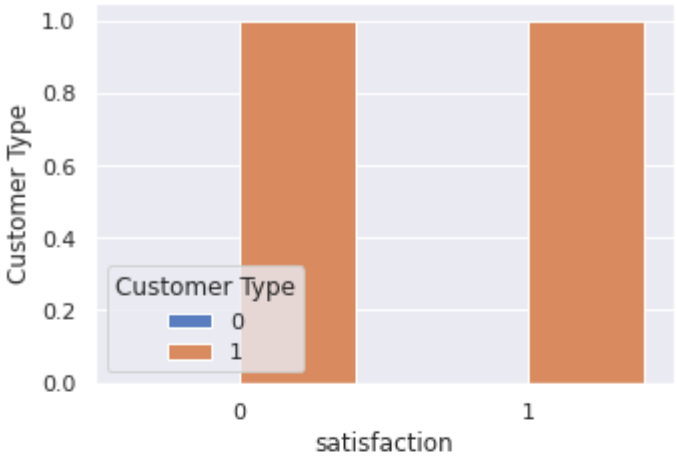
-uzoq parvoz masofasi ularni sayohatni qondirish ehtimolini oshiradi.

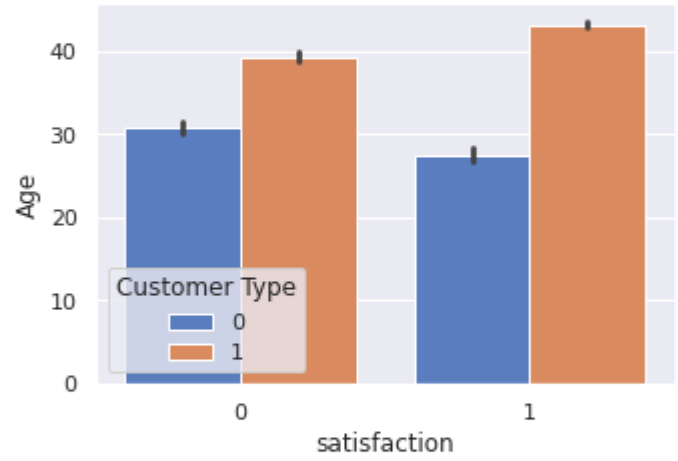
-Ammo o'rtacha kechikish vaqti, vaqt 12,5 daqiqadan yuqori bo'lsa, ular qoniqtirmasligi mumkin.

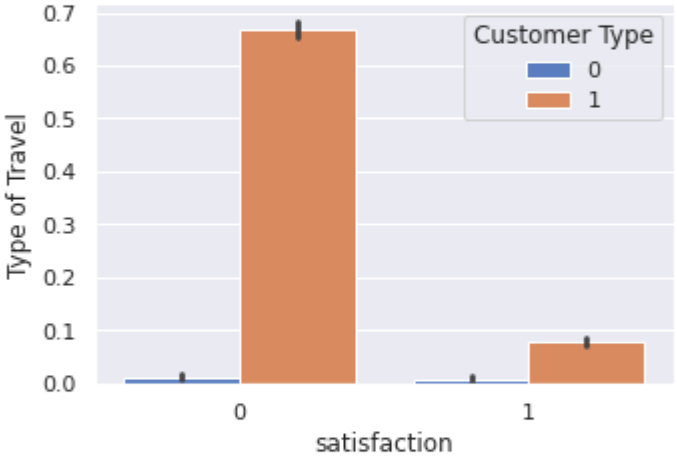
-Erkak va ayol o'rtasida sezilarli farqlar yo'q.

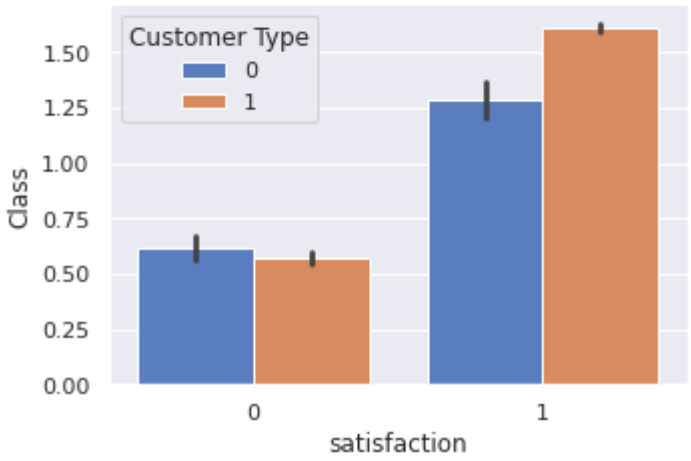
```
detail_barplot("Customer Type")
```

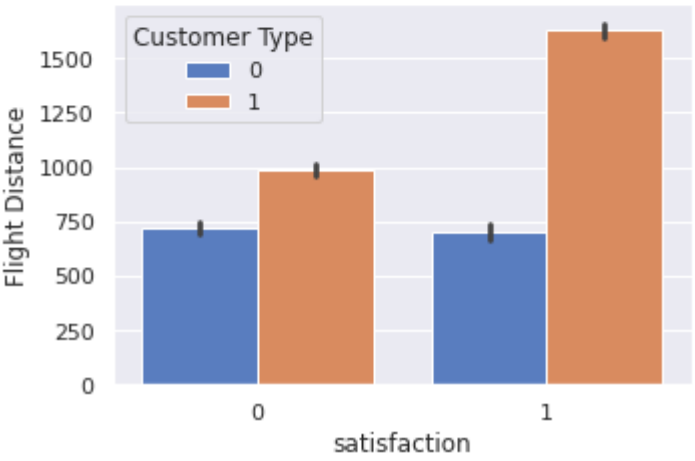

Gender
satisfaction
Customer Type
0
1

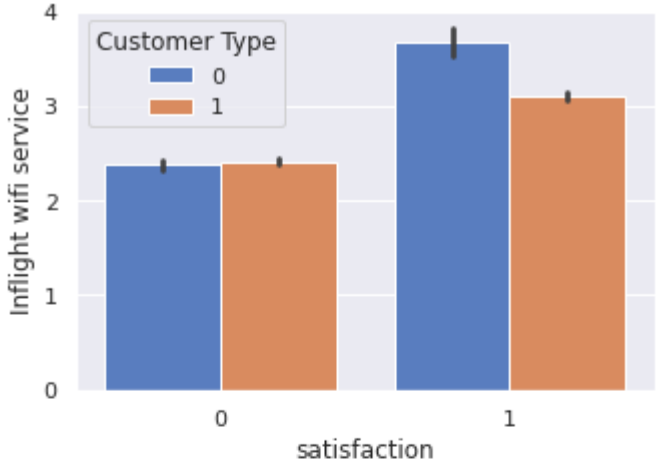

Customer Type
satisfaction
Customer Type
0
1

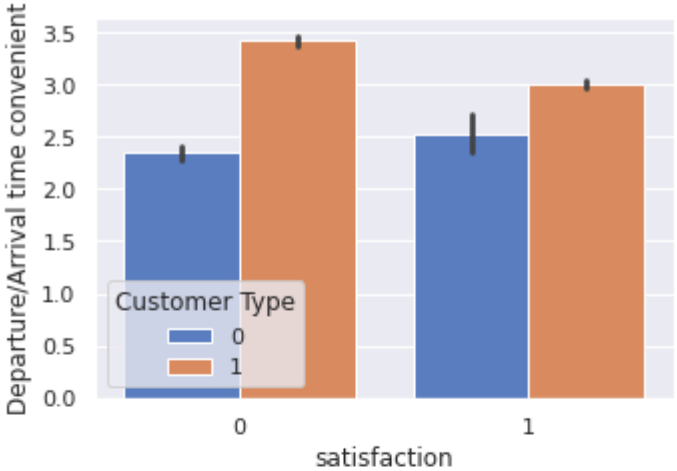

Age
satisfaction
Customer Type
0
1


Type of Travel
satisfaction
Customer Type
0
1

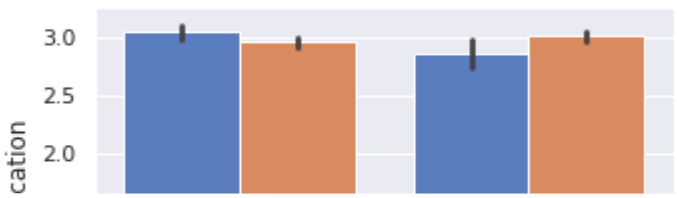

Class
satisfaction
Customer Type
0
1

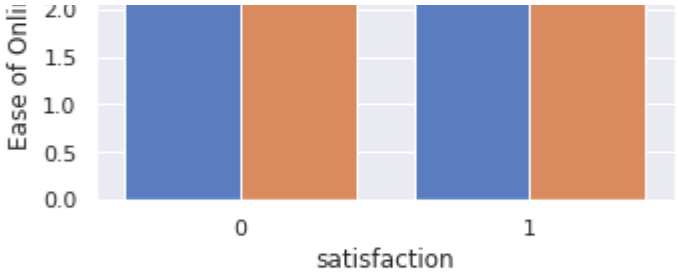

Flight Distance
satisfaction
Customer Type
0
1


Inflight wifi service
satisfaction
Customer Type
0
1

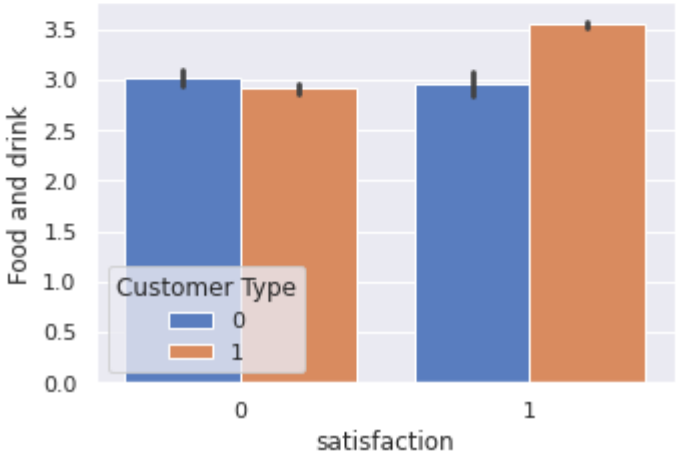

Departure/Arrival time convenient
satisfaction
Customer Type
0
1

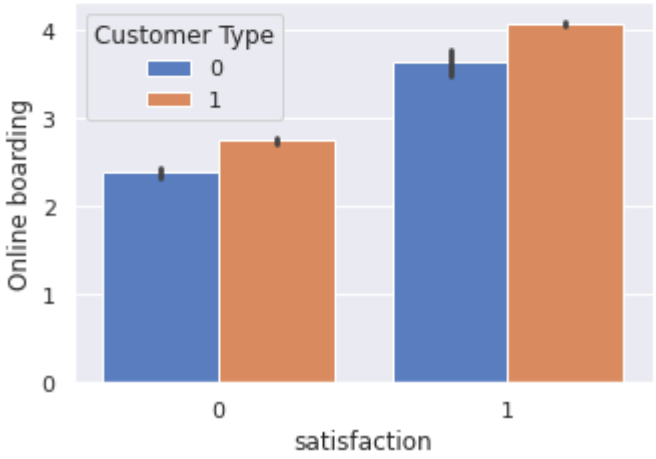

Customer Type
0
1

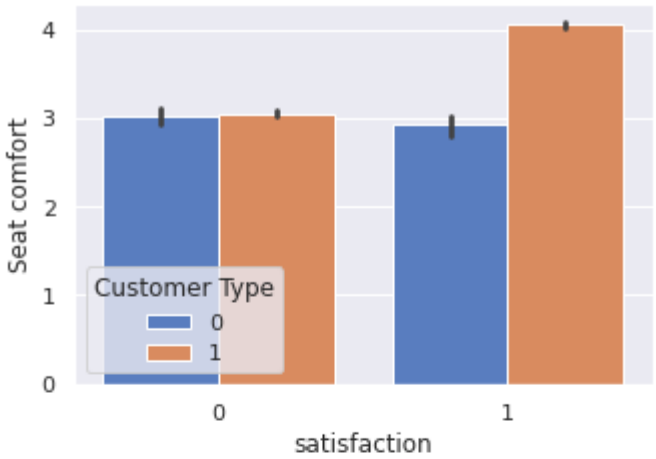


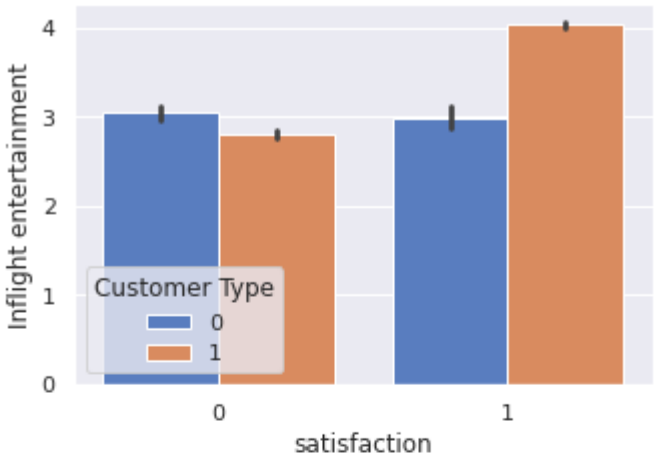

Ease of Onli
2.0
1.5
1.0
0.5
0.0
0
1
satisfaction

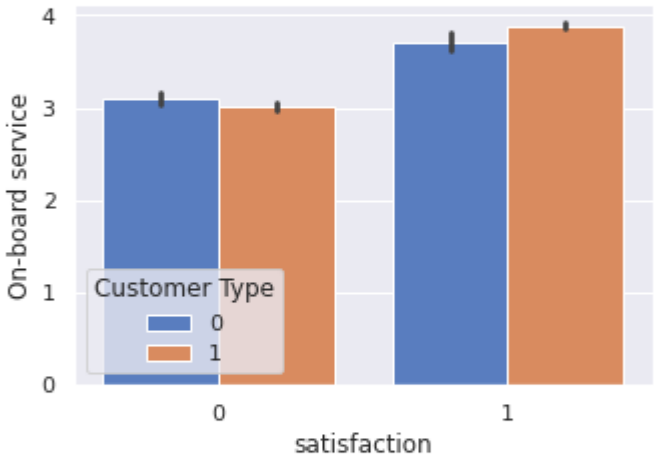

Gate lo
1.5
1.0
0.5
0.0
Customer Type
0
1
0
1
satisfaction

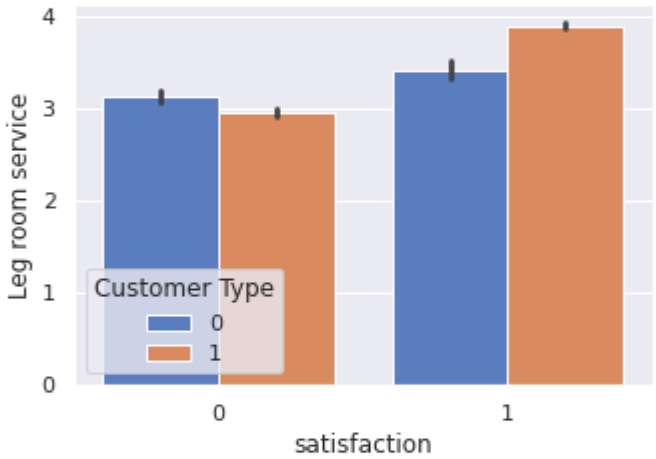

Food and drink
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Customer Type
0
1
0
1
satisfaction

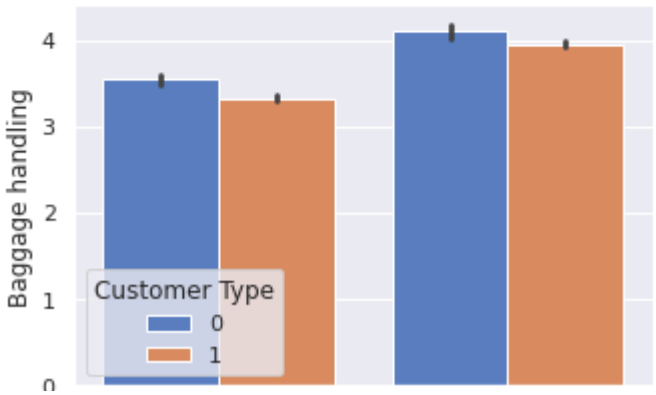

Online boarding
4
3
2
1
0
Customer Type
0
1
0
1
satisfaction


Seat comfort
4
3
2
1
0
Customer Type
0
1
0
1
satisfaction


Inflight entertainment
4
3
2
1
0
Customer Type
0
1
0
1
satisfaction


On-board service
4
3
2
1
0
Customer Type
0
1
0
1
satisfaction


Leg room service
4
3
2
1
0
Customer Type
0
1
0
1
satisfaction


Baggage handling
4
3
2
1
0
Customer Type
0
1

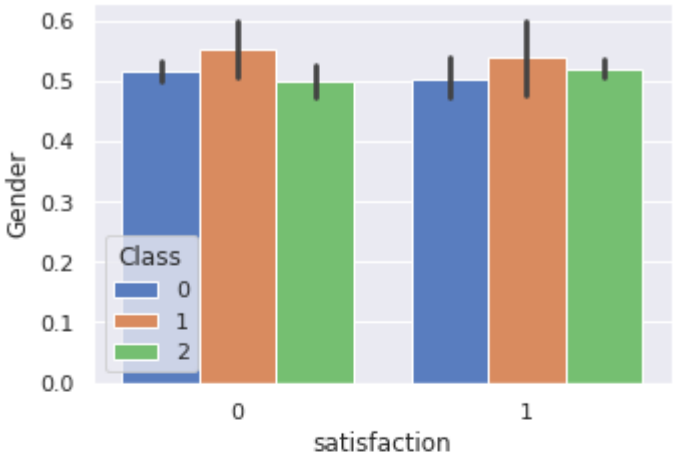

Checkin service
4
3
2
1
0
Customer Type
0
1

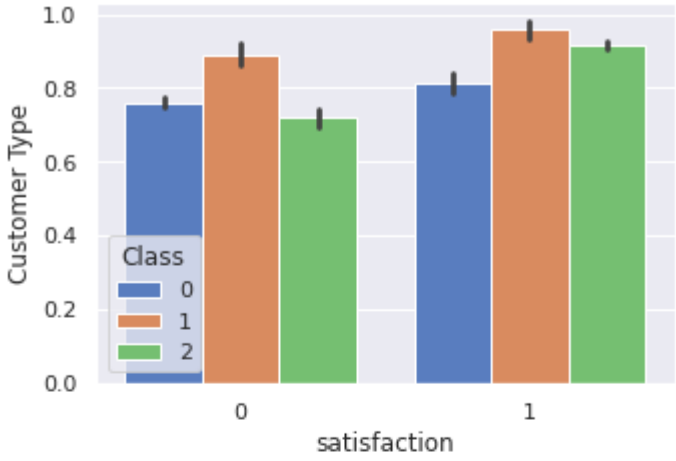
###Sodiq mijoz uchun: Yoshi 40 atrofida -Yuqori parvoz masofasidan,O'rindiqning qulayligi, parvozdagi o'yin-kulgi, tozalikdan mamnun.

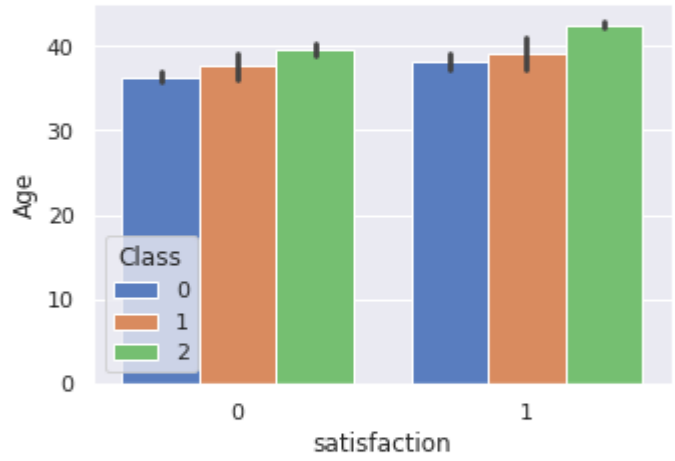
Ishonchsiz mijoz uchun:

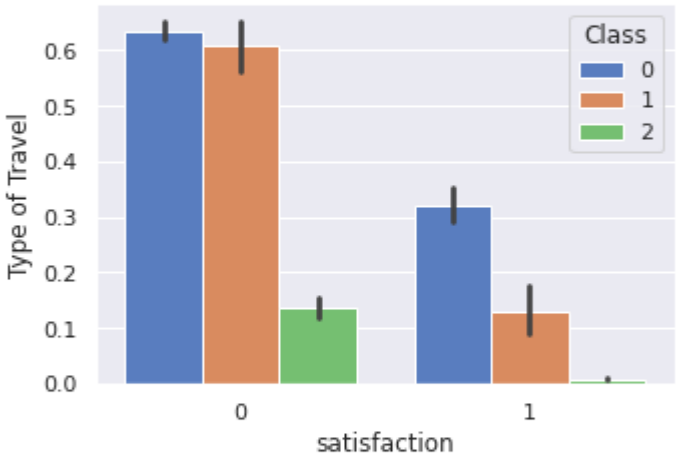
Yoshi 30 atrofida: Wi-Fi xizmatidan, onlayn bron qilish qulayligidan mamnun. Shunga qaramay, kechikish vaqti daqiqalari 12,5 yoki undan yuqori bo'lsa, ular odatda neytral yoki norozilikni his qilishadi.

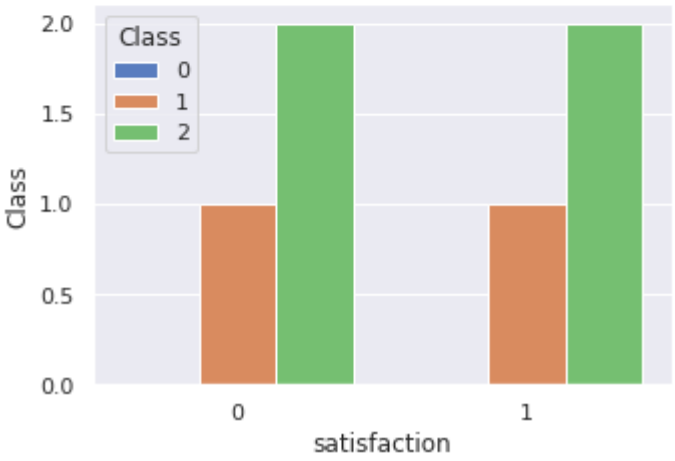
```
detail_barplot("Class")
```

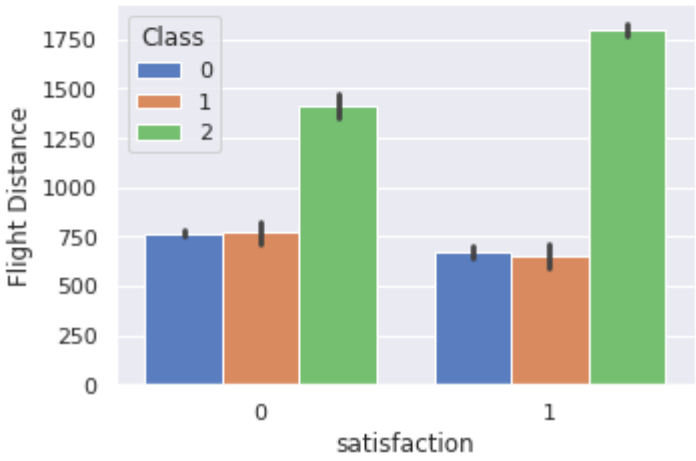

Gender
satisfaction
Class
0
1
2

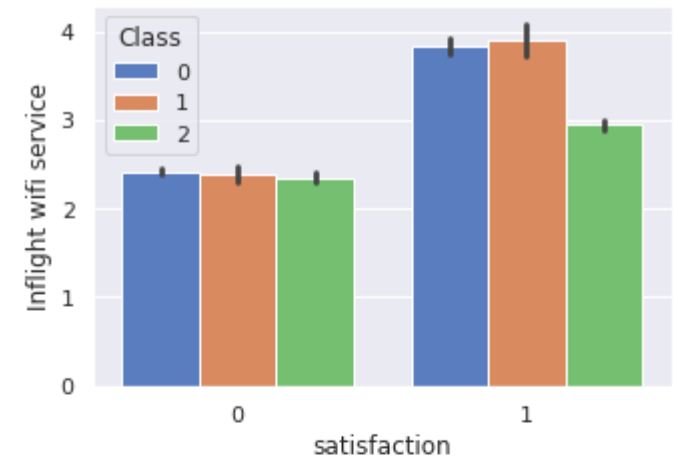

Customer Type
satisfaction
Class
0
1
2

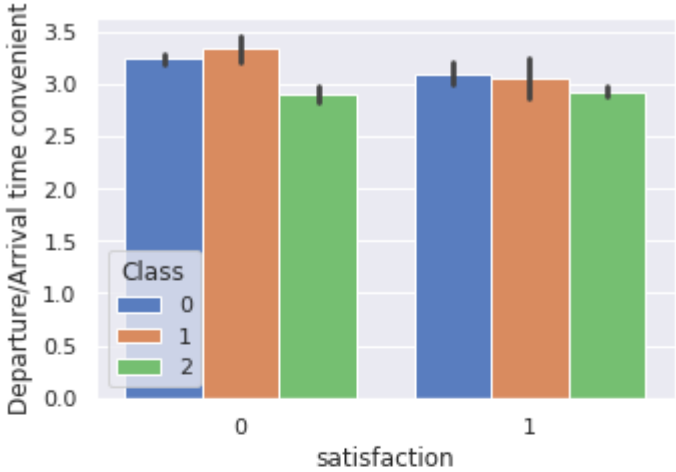

Age
satisfaction
Class
0
1
2

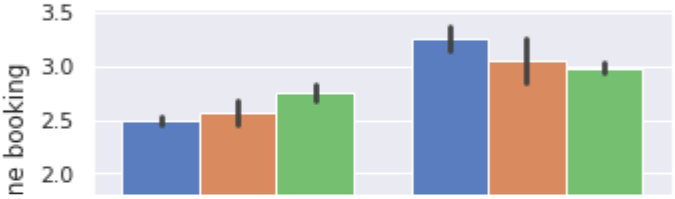

Type of Travel
satisfaction
Class
0
1
2

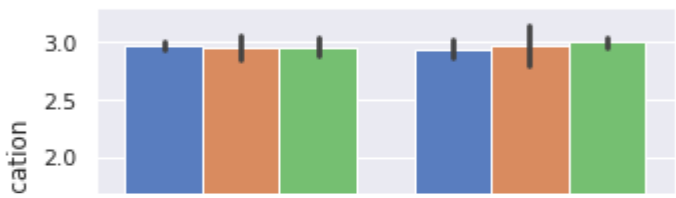

Class
satisfaction
Class
0
1
2

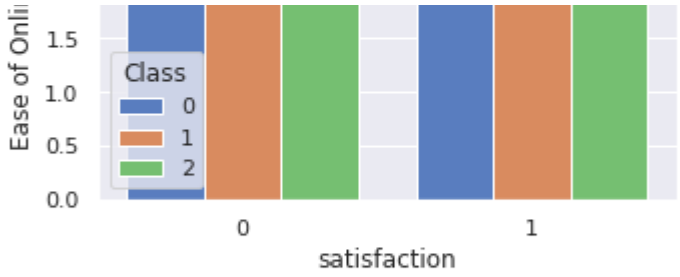

Flight Distance
satisfaction
Class
0
1
2

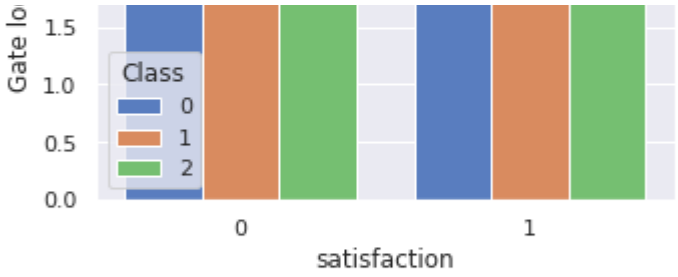

Inflight wifi service
satisfaction
Class
0
1
2

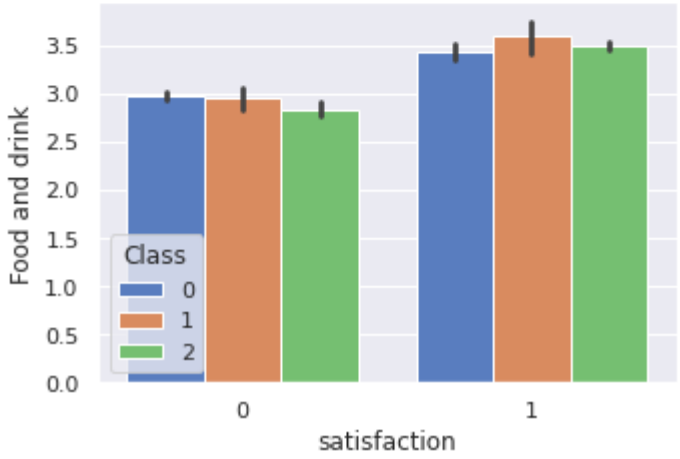

Departure/Arrival time convenient
satisfaction
Class
0
1
2

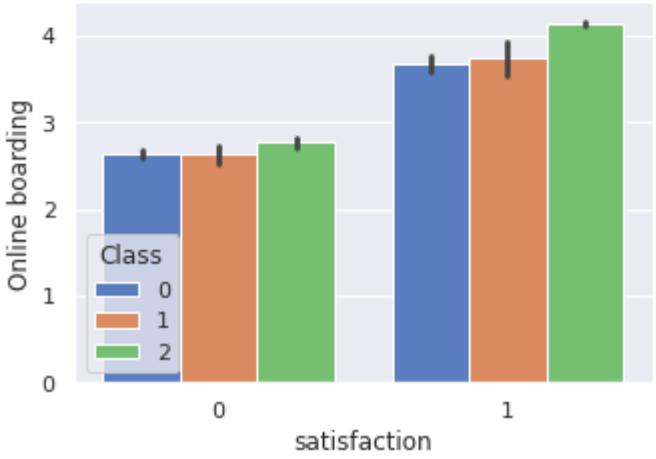

ne booking

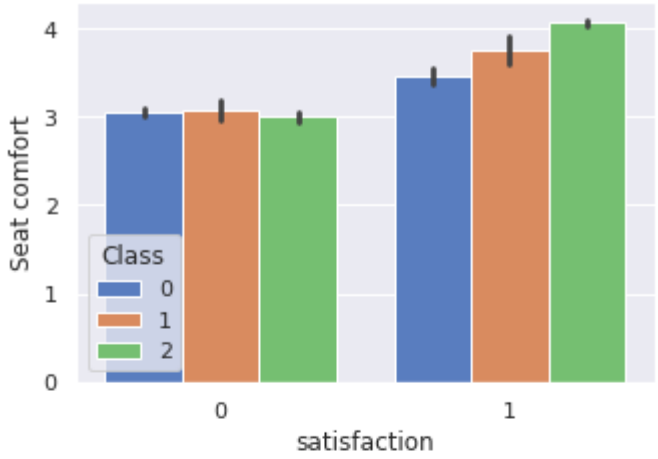

cation

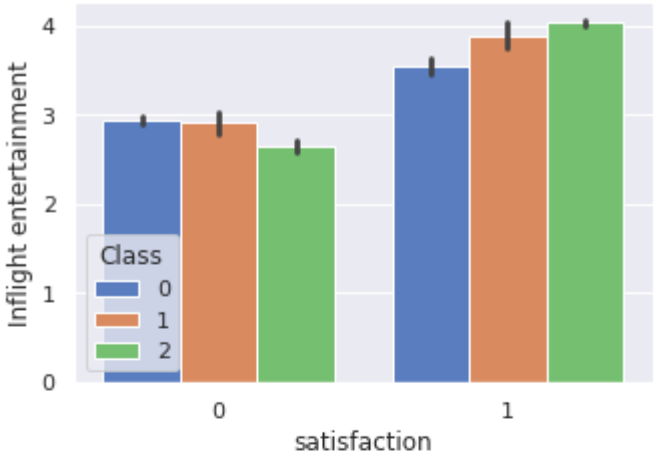

Ease of Onli
Class
0
1
2
0.0
0.5
1.0
1.5
0
1
satisfaction

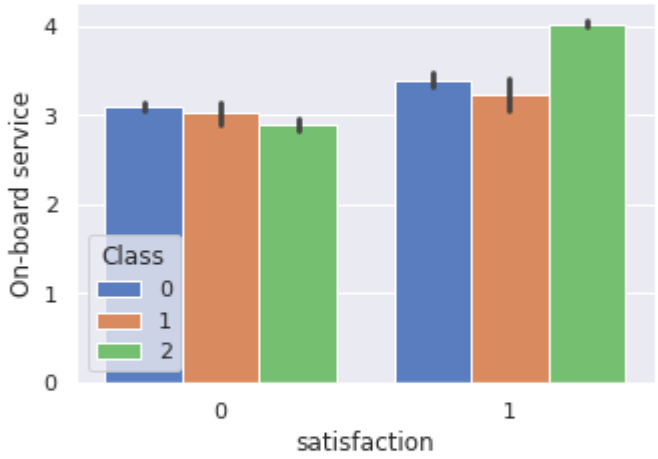

Gate lo
Class
0
1
2
0.0
0.5
1.0
1.5
0
1
satisfaction

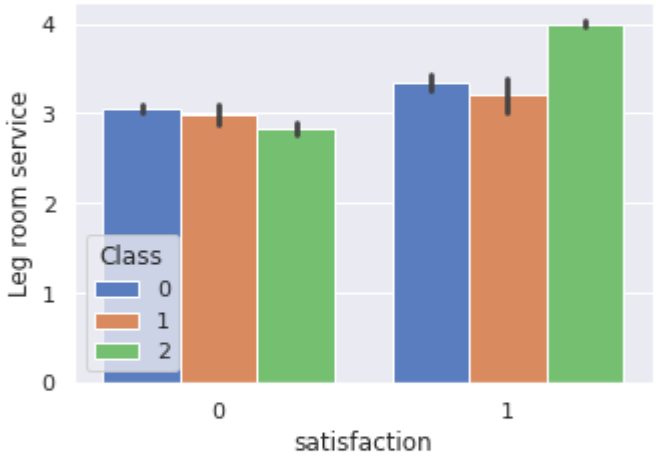

Food and drink
Class
0
1
2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
1
satisfaction

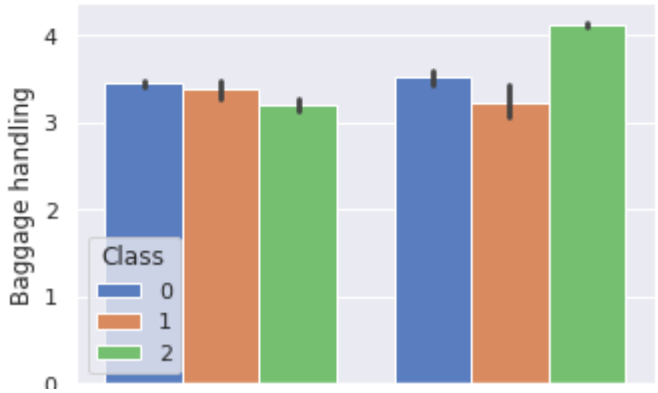

Online boarding
Class
0
1
2
0
1
2
3
4
0
1
satisfaction

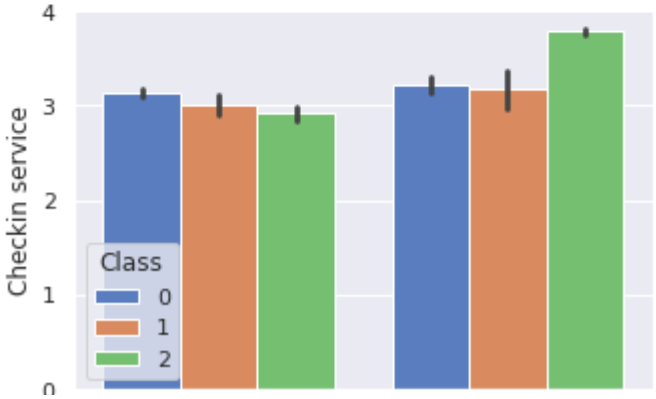

Seat comfort
Class
0
1
2
0
1
2
3
4
0
1
satisfaction


Inflight entertainment
Class
0
1
2
0
1
2
3
4
0
1
satisfaction


On-board service
Class
0
1
2
0
1
2
3
4
0
1
satisfaction


Leg room service
Class
0
1
2
0
1
2
3
4
0
1
satisfaction


Baggage handling
Class
0
1
2
0
1
2
3
4


Checkin service
Class
0
1
2
0
1
2
3
4

Machine Learningga tayorlash:

StratifiedShuffleSplit :

train va test setga ajratish:

```
from sklearn.model_selection import StratifiedShuffleSplit
stratified_split = StratifiedShuffleSplit(n_splits=1, test_size=0.2, random_state=42)
# stratified_split.split funksiyasi indekslar qaytaradi
for train_index, test_index in stratified_split.split(df_train,df_train['Gender']):
    # print(train_index)
    df_train_trainset = df_train.iloc[train_index]
    df_train_testset= df_train.iloc[test_index]
```

Ma'lumotlarni tozalash va qayta ishlash

Ma'lumotlarni qayta ishlash(ML ga tayyorlash) uchun KNN dan foydalanamiz

```
imputer = KNNImputer(n_neighbors=10, weights="uniform") # KNNImputer dan meros olamiz

# x_train
x_train = df_train_trainset.iloc[:,:-1]
x_train = imputer.fit_transform(x_train)
y_train = df_train_trainset.iloc[:,-1].to_numpy()

# x_test
x_test = df_train_testset.iloc[:,:-1]
x_test = imputer.fit_transform(x_test)
y_test = df_train_testset.iloc[:,-1].to_numpy()

# MinMaxScaler normalizatsiya qilish
x_scaler = MinMaxScaler() # normalizatsiya qilish
x_train = x_scaler.fit_transform(x_train)
x_test = x_scaler.fit_transform(x_test)
```

Modellarni o`qitamiz:

```
# Har bir classdan meros olib chiqamiz:

rf_clf = RandomForestClassifier()
lda_clf = LinearDiscriminantAnalysis()
svm_clf = SVC()
logisreg_clf = LogisticRegression()
GB_clf = GradientBoostingClassifier()
XGB_clf = XGBClassifier()
GNB_clf = GaussianNB()
```

```
DT_clf = DecisionTreeClassifier()

# har bir modelni clf_list(classifierList)ga joylaymiz:
clf_list = [rf_clf,lda_clf,svm_clf,logisreg_clf,GB_clf,XGB_clf,GNB_clf, DT_clf]
clf_name_list = ['Random_Forest','LDA','SupportVectorMachine','LogisticRegression','Gra

# Modellarni uqitamiz:
for clf in clf_list:
    clf.fit(x_train,y_train)
```

Natijalarni ko`rsatish:

```
train_acc_list = [] # train set uchun xatoliklar ro`yxati
test_acc_list = [] # test set uchun xatoliklar ro`yxati

for clf, name in zip(clf_list, clf_name_list): # ikki royxat uchun for sikli qollanishi

    y_pred_train = clf.predict(x_train)
    y_pred_test = clf.predict(x_test)

    print('**************************************************************************'
    print(name,': \n')

    print('Training natijalari:')
    print(classification_report(y_train, y_pred_train,
                                target_names=['Neytral yoki norozilik', 'satisfacti
    print('Testing natijalari:')
    print(classification_report(y_test, y_pred_test,
                                target_names=['Neytral yoki norozilik', 'satisfacti

    train_acc_list.append(accuracy_score(y_train, y_pred_train))
    test_acc_list.append(accuracy_score(y_test, y_pred_test))
```

```
**************************************************************************
Random_Forest :

Training natijalari:
                      precision    recall  f1-score   support

Neytral yoki norozilik       1.00      1.00      1.00      3978
          satisfaction       1.00      1.00      1.00      4022

              accuracy                           1.00      8000
             macro avg       1.00      1.00      1.00      8000
          weighted avg       1.00      1.00      1.00      8000

Testing natijalari:
                      precision    recall  f1-score   support
```

Neytral yoki norozilik	0.92	0.96	0.94	1022
satisfaction	0.96	0.91	0.94	978
accuracy			0.94	2000
macro avg	0.94	0.94	0.94	2000
weighted avg	0.94	0.94	0.94	2000

****

LDA :

Training natijalari:

	precision	recall	f1-score	support
Neytral yoki norozilik	0.86	0.88	0.87	3978
satisfaction	0.88	0.86	0.87	4022
accuracy			0.87	8000
macro avg	0.87	0.87	0.87	8000
weighted avg	0.87	0.87	0.87	8000

Testing natijalari:

	precision	recall	f1-score	support
Neytral yoki norozilik	0.85	0.90	0.87	1022
satisfaction	0.89	0.84	0.86	978
accuracy			0.87	2000
macro avg	0.87	0.87	0.87	2000
weighted avg	0.87	0.87	0.87	2000

****

SupportVectorMachine :

Training natijalari:

	precision	recall	f1-score	support
Neytral yoki norozilik	0.93	0.96	0.95	3978
satisfaction	0.96	0.93	0.94	4022
accuracy			0.94	8000
macro avg	0.95	0.94	0.94	8000
weighted avg	0.95	0.94	0.94	8000

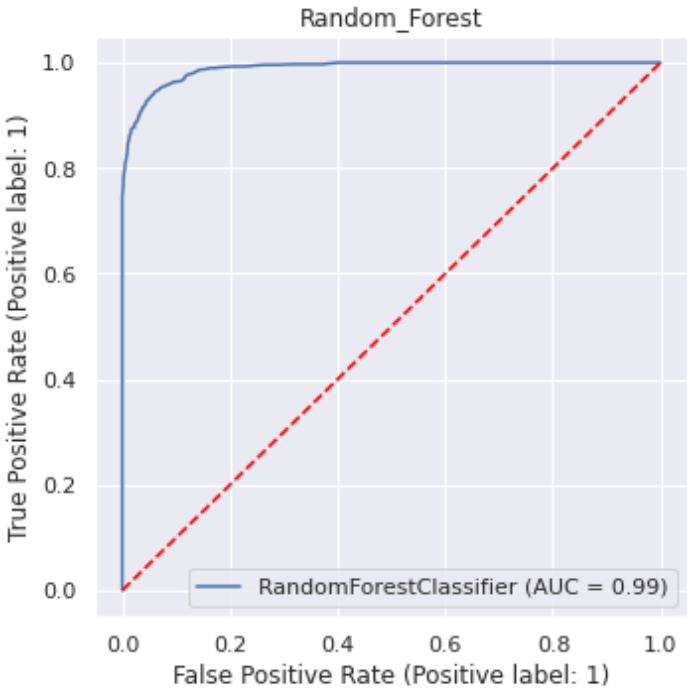
```
Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.91      0.96      0.94      1022
          satisfaction       0.96      0.90      0.93       978

              accuracy                           0.93      2000
             macro avg       0.93      0.93      0.93      2000
          weighted avg       0.93      0.93      0.93      2000

**********************************************************************
LogisticRegression :

Training natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.86      0.88      0.87      3978
          satisfaction       0.88      0.86      0.87      4022

              accuracy                           0.87      8000
             macro avg       0.87      0.87      0.87      8000
          weighted avg       0.87      0.87      0.87      8000

Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.85      0.90      0.87      1022
          satisfaction       0.89      0.83      0.86       978

              accuracy                           0.87      2000
             macro avg       0.87      0.87      0.87      2000
          weighted avg       0.87      0.87      0.87      2000

**********************************************************************
GradientBoosting :

Training natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.94      0.96      0.95      3978
          satisfaction       0.95      0.94      0.95      4022
```

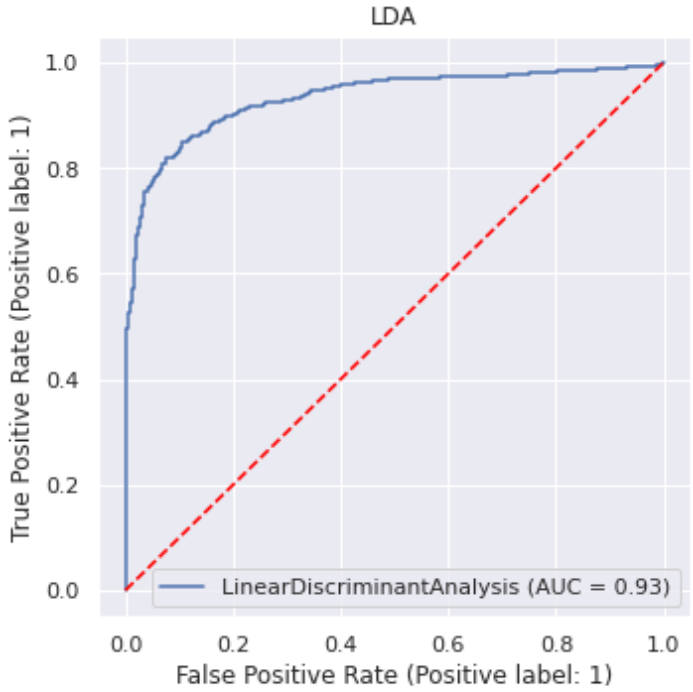
```
              accuracy                           0.95      8000
             macro avg       0.95      0.95      0.95      8000
          weighted avg       0.95      0.95      0.95      8000

Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.91      0.96      0.94      1022
          satisfaction       0.96      0.90      0.93       978

              accuracy                           0.94      2000
             macro avg       0.94      0.93      0.93      2000
          weighted avg       0.94      0.94      0.93      2000

**********************************************************************
XGBoost :

Training natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.93      0.96      0.94      3978
          satisfaction       0.95      0.93      0.94      4022

              accuracy                           0.94      8000
             macro avg       0.94      0.94      0.94      8000
          weighted avg       0.94      0.94      0.94      8000

Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.92      0.96      0.94      1022
          satisfaction       0.95      0.92      0.93       978

              accuracy                           0.94      2000
             macro avg       0.94      0.94      0.94      2000
          weighted avg       0.94      0.94      0.94      2000

**********************************************************************
GaussianNaiveBayes :

Training natijalari:
                        precision    recall  f1-score   support
```

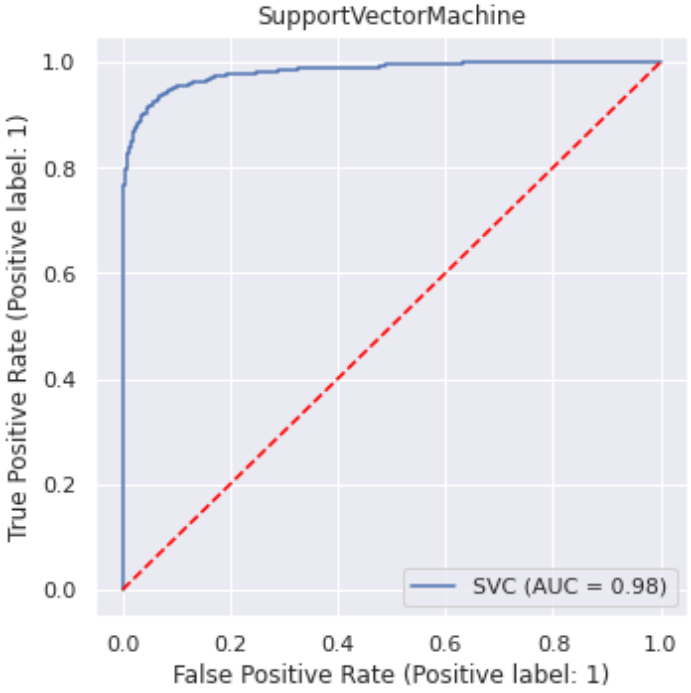
```
Neytral yoki norozilik       0.84      0.88      0.86      3978
          satisfaction       0.88      0.83      0.86      4022

              accuracy                           0.86      8000
             macro avg       0.86      0.86      0.86      8000
          weighted avg       0.86      0.86      0.86      8000

Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.81      0.93      0.87      1022
          satisfaction       0.91      0.77      0.84       978

              accuracy                           0.85      2000
             macro avg       0.86      0.85      0.85      2000
          weighted avg       0.86      0.85      0.85      2000

**************************************************************************
DecisionTreeClassifier :

Training natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       1.00      1.00      1.00      3978
          satisfaction       1.00      1.00      1.00      4022

              accuracy                           1.00      8000
             macro avg       1.00      1.00      1.00      8000
          weighted avg       1.00      1.00      1.00      8000

Testing natijalari:
                        precision    recall  f1-score   support

Neytral yoki norozilik       0.89      0.93      0.91      1022
          satisfaction       0.92      0.89      0.90       978

              accuracy                           0.91      2000
             macro avg       0.91      0.91      0.91      2000
          weighted avg       0.91      0.91      0.91      2000
```

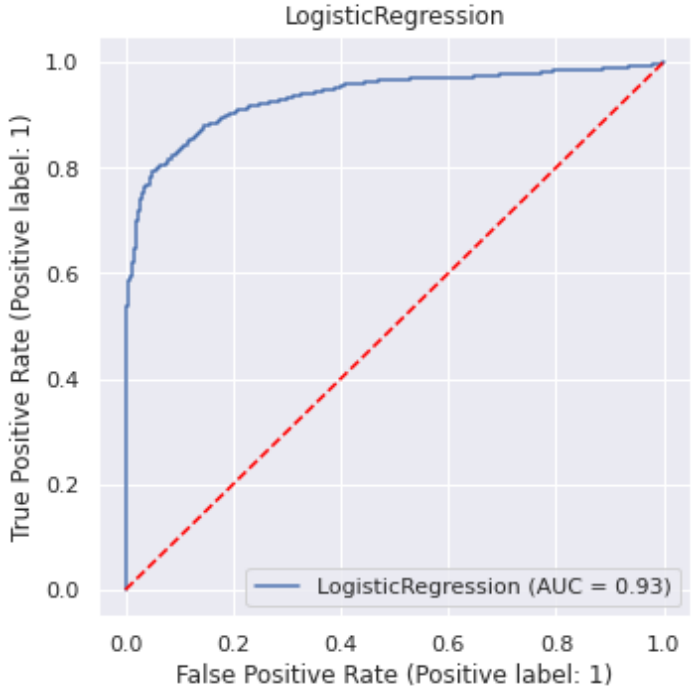
```
fig, axes = plt.subplots(nrows=4, ncols=2, figsize=(10,20))
line = np.linspace(0,1)
```

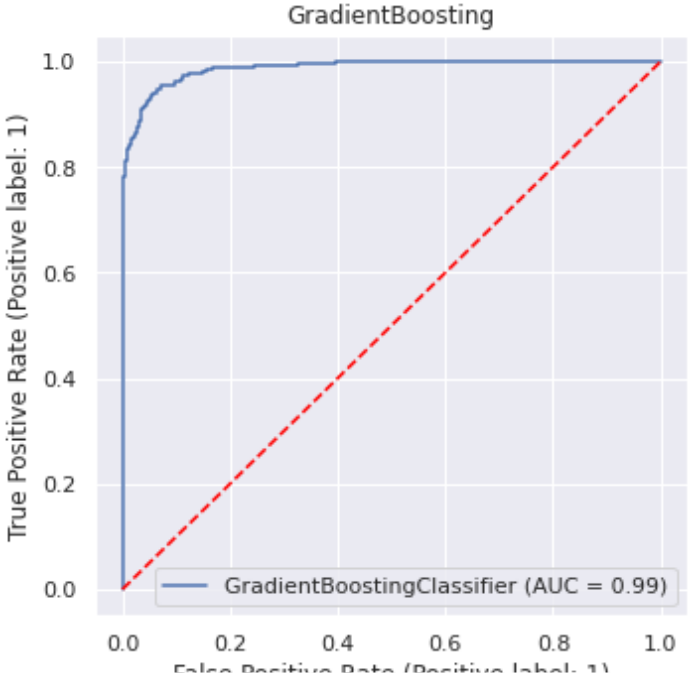
```
sns.set(font_scale=1.0)
for clf, ax,name in zip(clf_list, axes.flatten(),clf_name_list):
    plot_roc_curve(clf, x_test, y_test, ax=ax)
    ax.plot(line,line, color='red', linestyle='dashed')
    ax.title.set_text(name)
fig.tight_layout(pad=1.0)
plt.show()
```

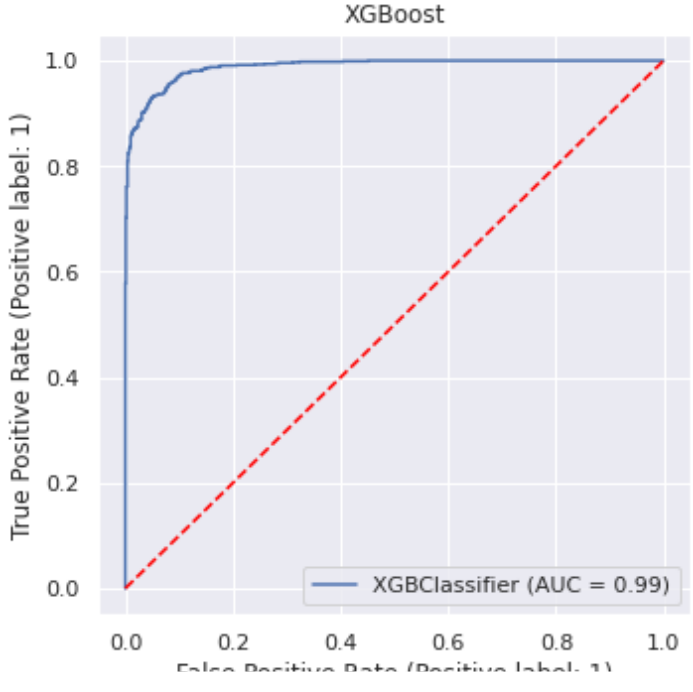

Random_Forest
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
RandomForestClassifier (AUC = 0.99)

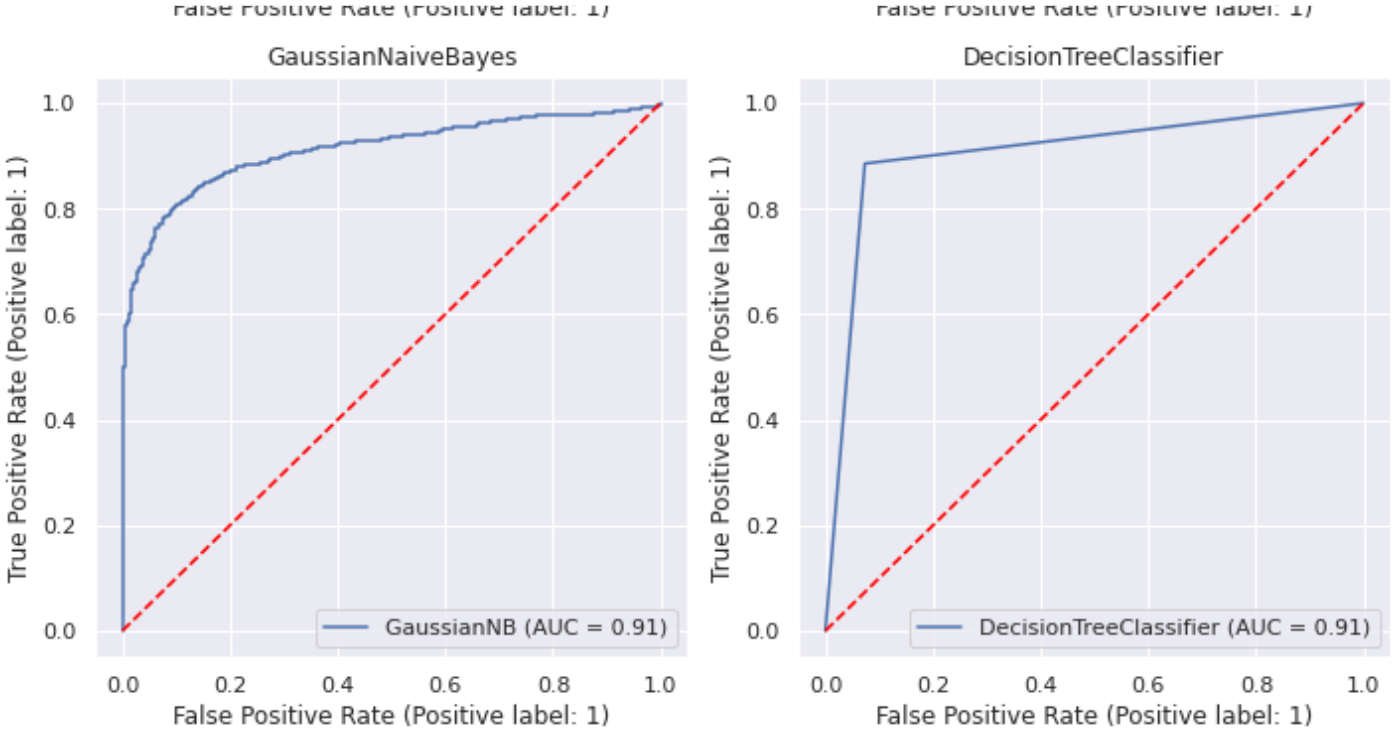

LDA
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
LinearDiscriminantAnalysis (AUC = 0.93)


SupportVectorMachine
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
SVC (AUC = 0.98)

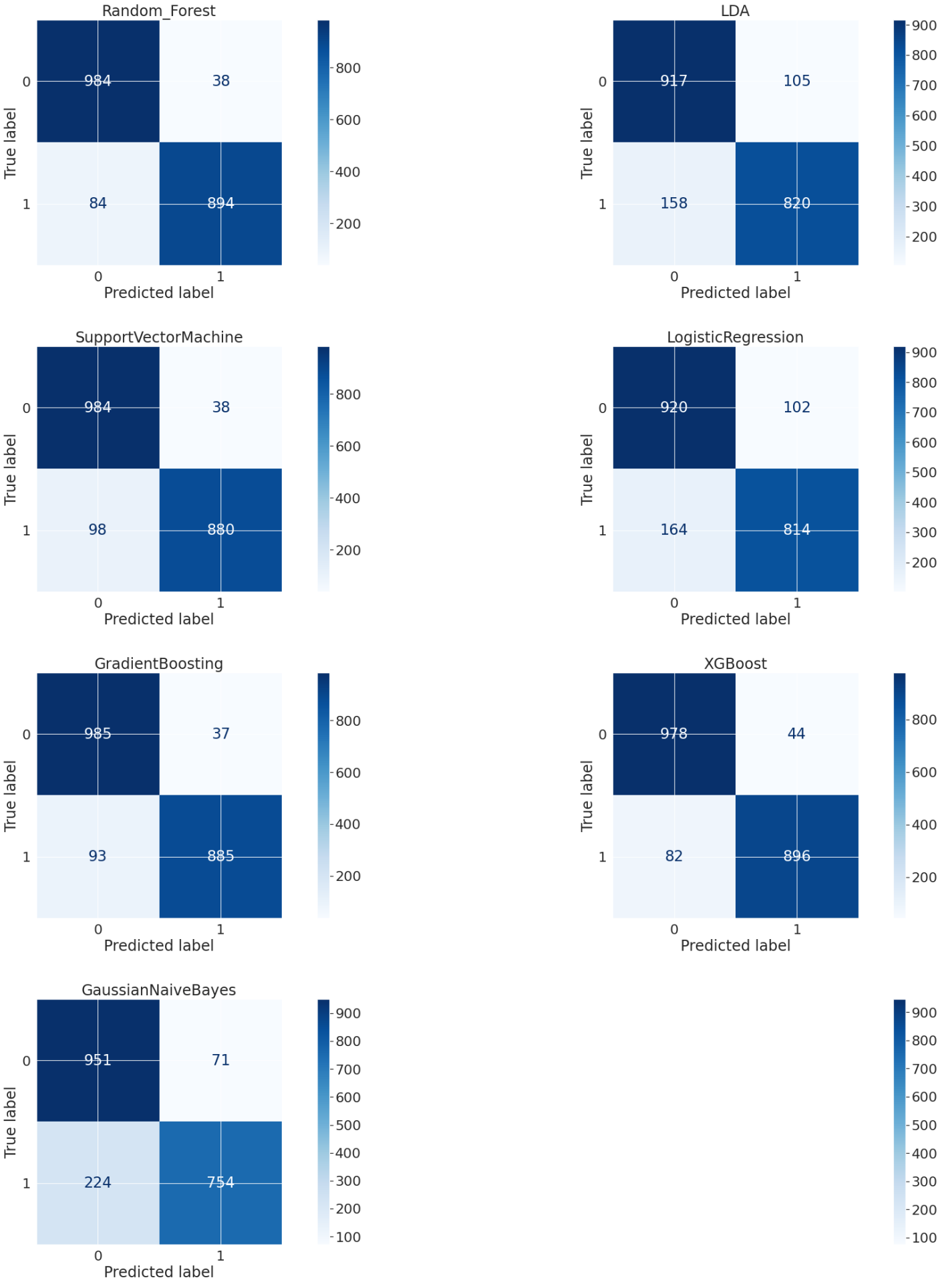

LogisticRegression
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
LogisticRegression (AUC = 0.93)


GradientBoosting
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
GradientBoostingClassifier (AUC = 0.99)


XGBoost
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
XGBClassifier (AUC = 0.99)

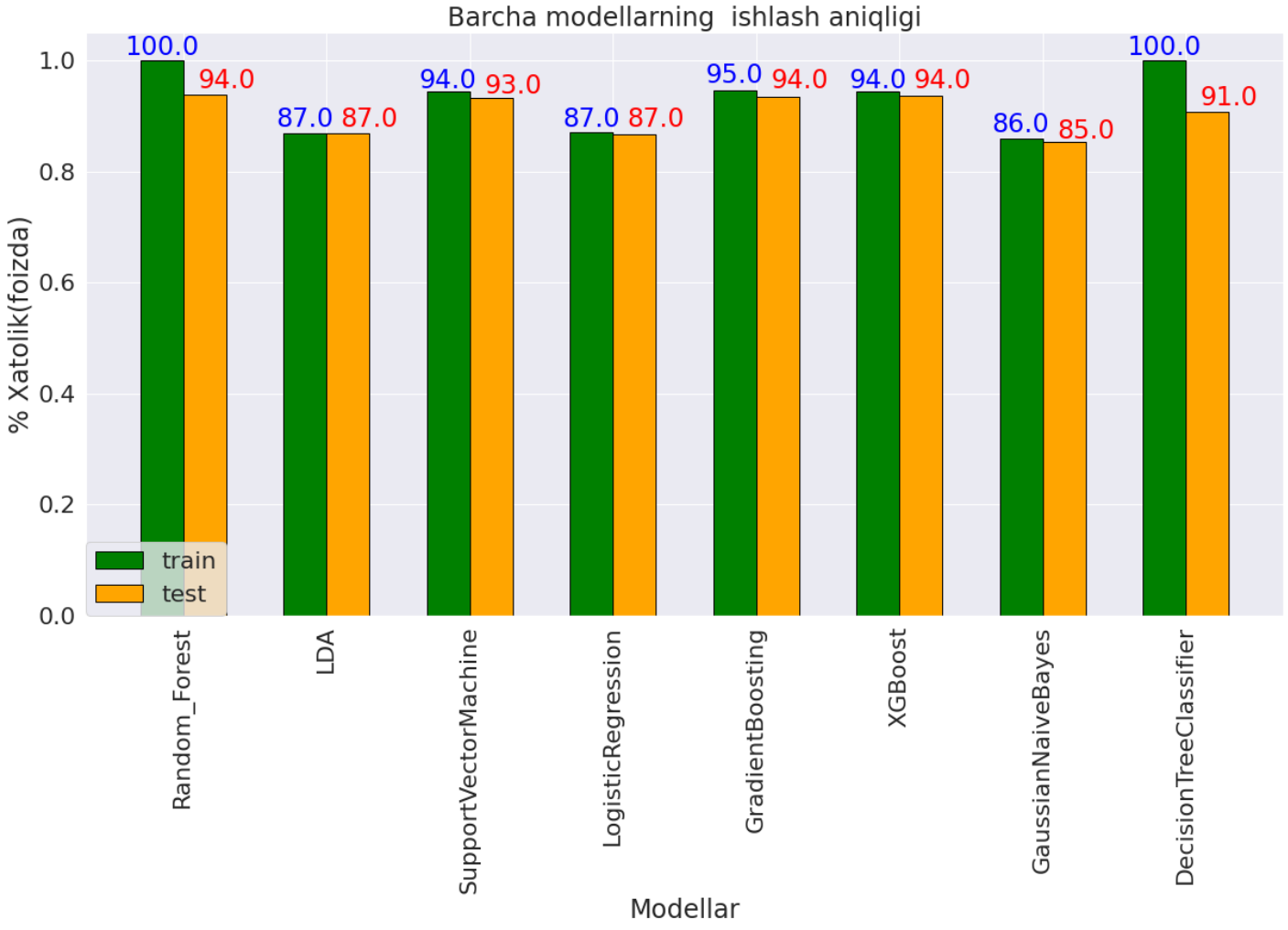



```
from sklearn.metrics import plot_confusion_matrix

fig, axes = plt.subplots(nrows=4, ncols=2, figsize=(30,30))

sns.set(font_scale=2)

for clf, ax,name in zip(clf_list, axes.flatten(),clf_name_list):
    # y_predict = clf.predict(x_test)
    plot_confusion_matrix(clf, x_test, y_test, ax=ax, cmap='Blues',
                          display_labels=['0', '1'])
    # ax = sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
    ax.title.set_text(name)
    plt.grid(False)
fig.tight_layout(pad=2)
fig.delaxes(axes[3][1])
plt.show()
```




```
plt.figure(figsize=(20,10))

n = np.arange(8)
```

```
width = 0.3

plt.bar(n, train_acc_list, color = 'green',
        width = width, edgecolor = 'black',
        label='train')
for i in range(len(train_acc_list)):
        plt.text(i,train_acc_list[i].round(2)+0.01,train_acc_list[i].round(2)*100,
                 ha = 'center',color = 'blue')

plt.bar(n + width, test_acc_list, color = 'orange',
        width = width, edgecolor = 'black',
        label='test')

for i in range(len(test_acc_list)):
        plt.text(i+0.25,test_acc_list[i].round(2)+0.01,test_acc_list[i].round(2)*100,cc

plt.xlabel("Modellar")
plt.ylabel("% Xatolik(foizda)")
plt.title("Barcha modellarning  ishlash aniqligi")

plt.xticks(n + width/2,clf_name_list,rotation=90)
plt.legend(loc =(0,0))

plt.show()
```



Ajoyib🙂🙂, eng yuqori sinov aniqligi 94% ga yetishi mumkin.

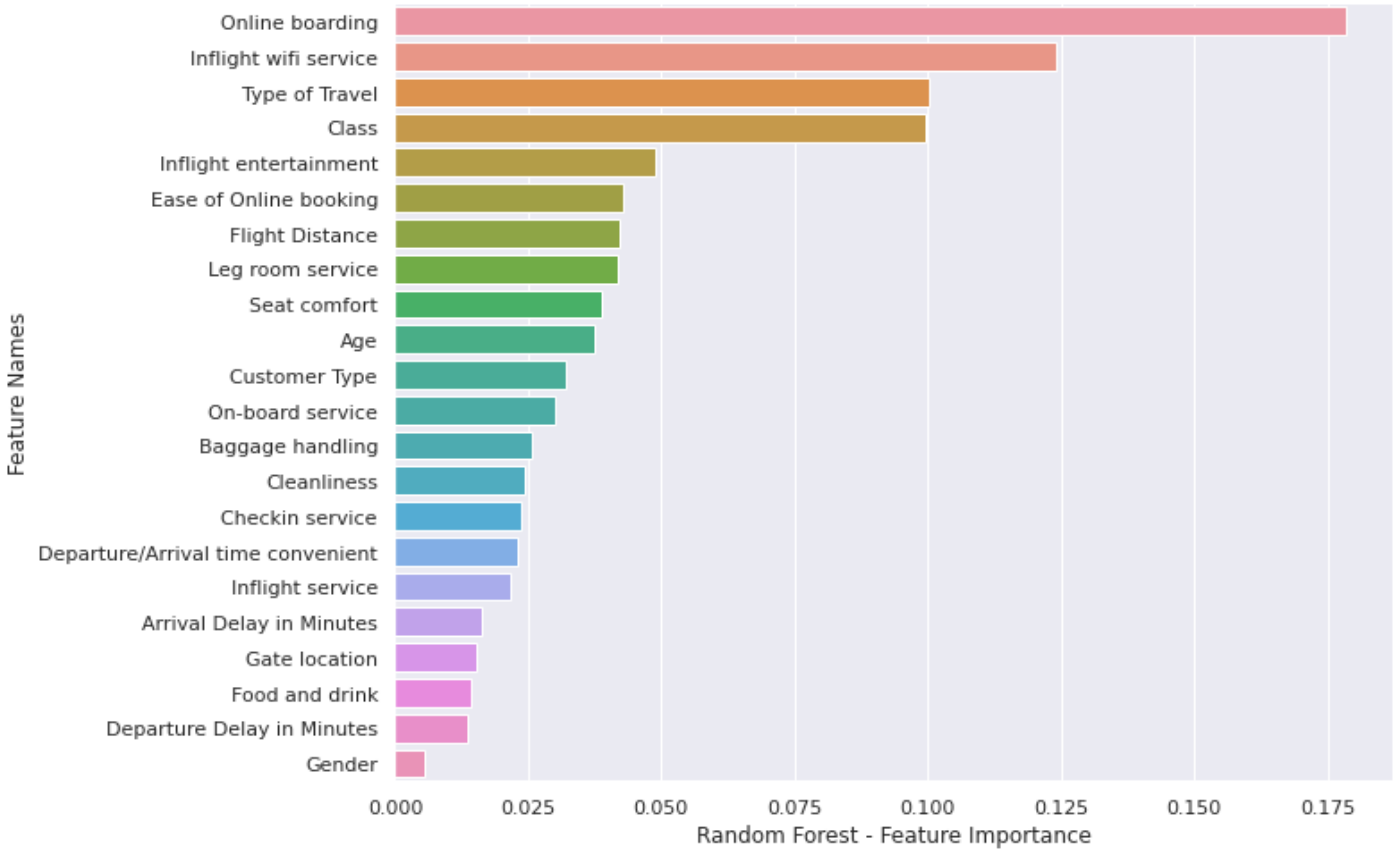
Bu qiymat bilan `satisfaction` ustuni bilan qaysi qiymatlar koproq bog`liqligini tekshiramiz:

```
clf_list[0].feature_importances_
```

```
array([0.00560439, 0.03223183, 0.03753419, 0.10016073, 0.09958537,
       0.04208074, 0.12414769, 0.02289285, 0.04296   , 0.01538709,
       0.01427728, 0.17844723, 0.03891464, 0.04899507, 0.0301527 ,
       0.04167009, 0.02563223, 0.02363905, 0.02159582, 0.02432836,
       0.01350889, 0.01625378])
```

Random Forest

```
feature_importance = clf_list[0].feature_importances_ # random forest
col_name = df_train.iloc[:,:-1].columns
rf_fi ={'feature_names':col_name,'feature_importance':feature_importance} # lug`at

df_plt = pd.DataFrame(rf_fi) # data frame yaratdik
df_plt.sort_values(by=['feature_importance'], ascending=False,inplace=True)

sns.set(font_scale=1)
plt.figure(figsize=(10,8))
sns.barplot(x=df_plt['feature_importance'], y=df_plt['feature_names'])
#plt.style.use("ggplot")
plt.xlabel('Random Forest - Feature Importance')
plt.ylabel('Feature Names')
plt.show()
```

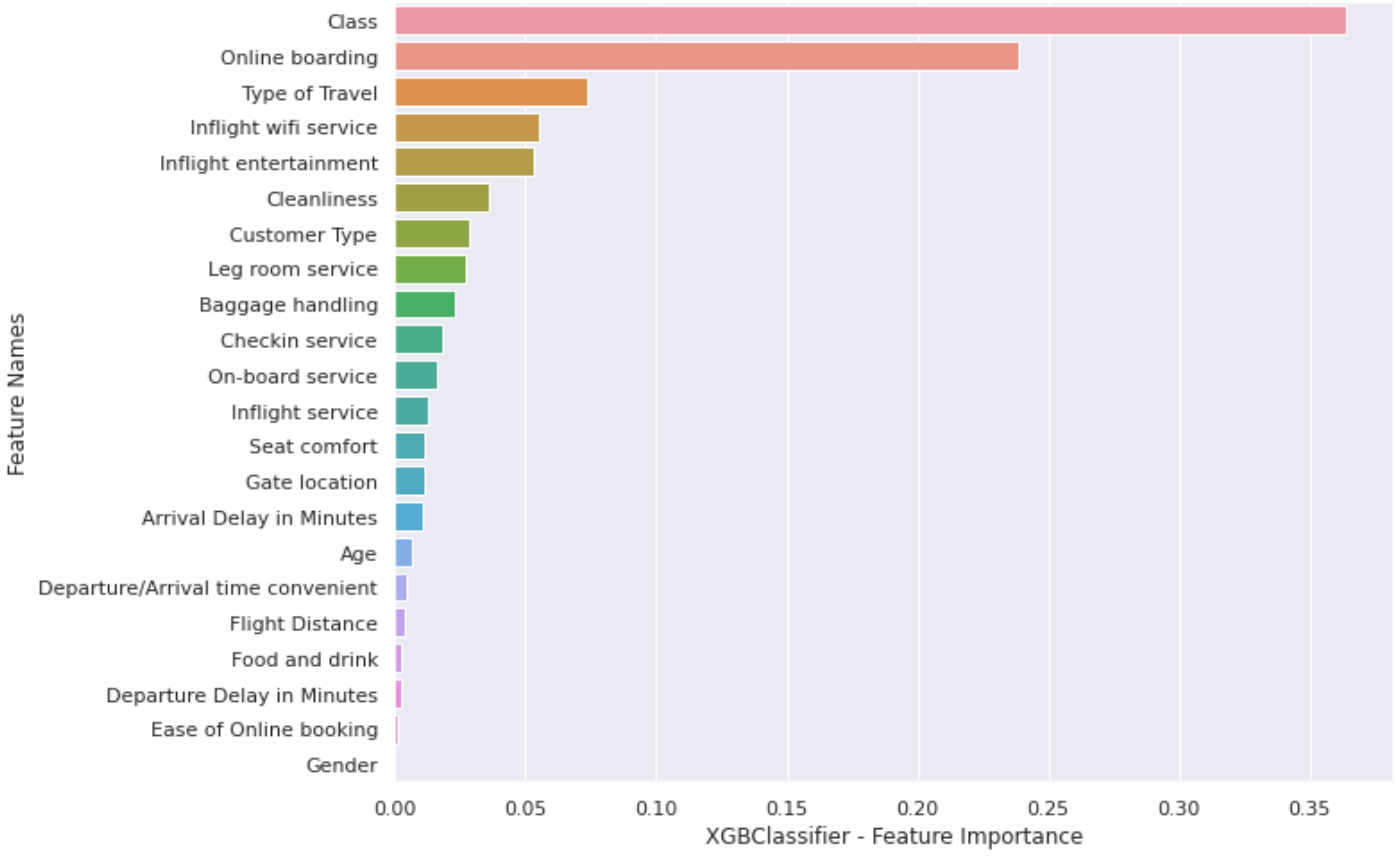



```
clf_list
```

```
[RandomForestClassifier(),
 LinearDiscriminantAnalysis(),
 SVC(),
 LogisticRegression(),
 GradientBoostingClassifier(),
 XGBClassifier(),
 GaussianNB(),
 DecisionTreeClassifier()]
```

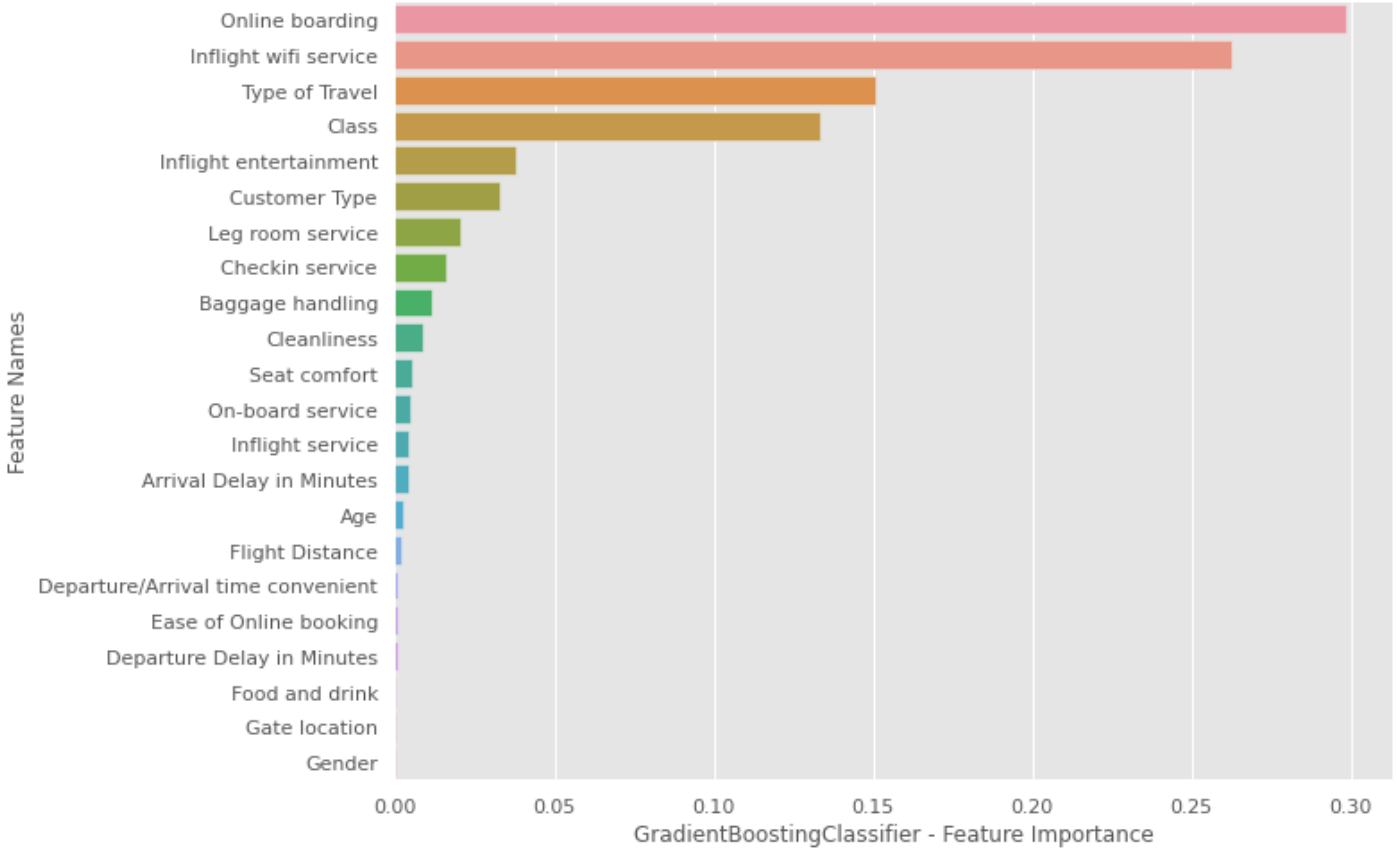
XGBClassifier

```
feature_importance = clf_list[-3].feature_importances_
col_name = df_train.iloc[:,:-1].columns
xgbs_fi ={'feature_names':col_name,'feature_importance':feature_importance}

df_plt = pd.DataFrame(xgbs_fi)
df_plt.sort_values(by=['feature_importance'], ascending=False,inplace=True)

plt.figure(figsize=(10,8))
sns.barplot(x=df_plt['feature_importance'], y=df_plt['feature_names'])
plt.style.use("ggplot")
plt.xlabel('XGBClassifier - Feature Importance')
plt.ylabel('Feature Names')
plt.show()
```



GradientBoostingClassifier

```
feature_importance = clf_list[-4].feature_importances_
col_name = df_train.iloc[:,:-1].columns
gb_fi ={'feature_names':col_name,'feature_importance':feature_importance}

df_plt = pd.DataFrame(gb_fi)
df_plt.sort_values(by=['feature_importance'], ascending=False,inplace=True)

plt.figure(figsize=(10,8))
sns.barplot(x=df_plt['feature_importance'], y=df_plt['feature_names'])
plt.style.use("ggplot")
plt.xlabel('GradientBoostingClassifier - Feature Importance')
plt.ylabel('Feature Names')
plt.show()
```



DNN prediction:

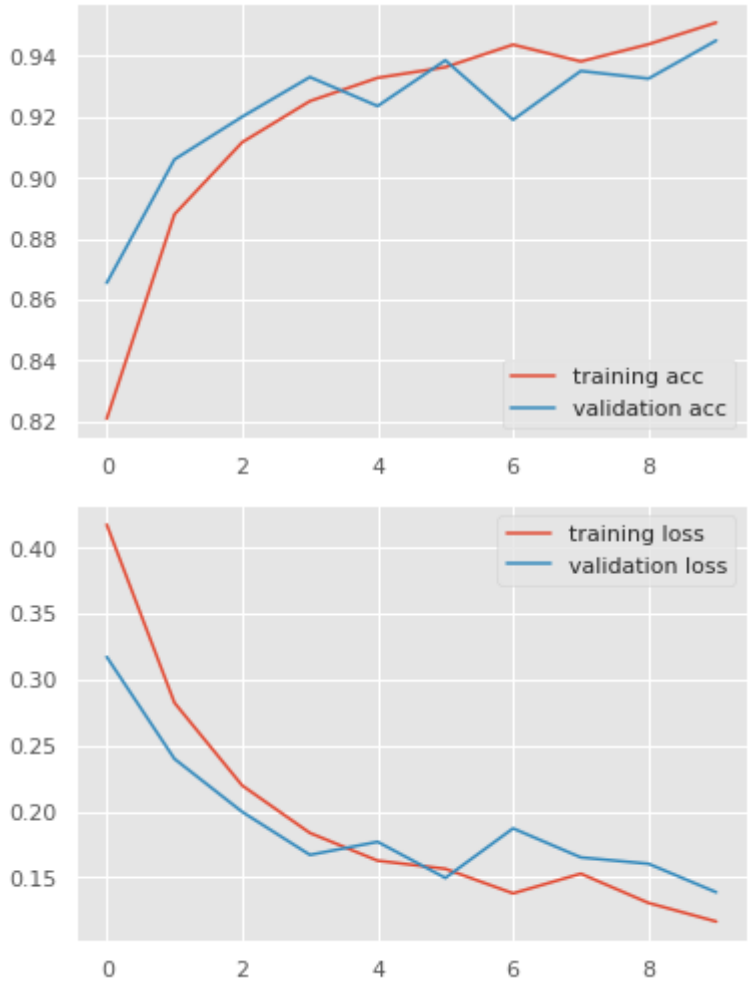
```
dnn_model = Sequential()
dnn_model.add(Dense(512, input_dim=x_train.shape[1], activation='relu'))
dnn_model.add(Dense(512, activation='relu'))
dnn_model.add(Dense(512, activation='relu'))
dnn_model.add(Dense(512, activation='relu'))
dnn_model.add(Dense(1, activation='sigmoid'))

dnn_model.compile(loss='binary_crossentropy', optimizer='adam',metrics=['accuracy'])
history = dnn_model.fit(x_train, y_train, epochs=10, batch_size=256,validation_data=(x_
```

```
Epoch 1/10
32/32 [==============================] - 2s 37ms/step - loss: 0.4176 - accuracy: 0.8210
```

```
- val_loss: 0.3173 - val_accuracy: 0.8655
Epoch 2/10
32/32 [==============================] - 1s 31ms/step - loss: 0.2825 - accuracy: 0.8880
- val_loss: 0.2400 - val_accuracy: 0.9060
Epoch 3/10
32/32 [==============================] - 1s 30ms/step - loss: 0.2198 - accuracy: 0.9116
- val_loss: 0.1998 - val_accuracy: 0.9200
Epoch 4/10
32/32 [==============================] - 1s 31ms/step - loss: 0.1838 - accuracy: 0.9251
- val_loss: 0.1672 - val_accuracy: 0.9330
Epoch 5/10
32/32 [==============================] - 1s 31ms/step - loss: 0.1628 - accuracy: 0.9327
- val_loss: 0.1771 - val_accuracy: 0.9235
Epoch 6/10
32/32 [==============================] - 1s 31ms/step - loss: 0.1566 - accuracy: 0.9362
- val_loss: 0.1497 - val_accuracy: 0.9385
Epoch 7/10
32/32 [==============================] - 1s 31ms/step - loss: 0.1380 - accuracy: 0.9436
- val_loss: 0.1873 - val_accuracy: 0.9190
Epoch 8/10
32/32 [==============================] - 1s 32ms/step - loss: 0.1529 - accuracy: 0.9381
- val_loss: 0.1652 - val_accuracy: 0.9350
Epoch 9/10
32/32 [==============================] - 1s 31ms/step - loss: 0.1307 - accuracy: 0.9438
- val_loss: 0.1604 - val_accuracy: 0.9325
Epoch 10/10
32/32 [==============================] - 1s 30ms/step - loss: 0.1166 - accuracy: 0.9509
- val_loss: 0.1388 - val_accuracy: 0.9450
```

```
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(len(acc))

plt.plot(epochs, acc, label='training acc')
plt.plot(epochs, val_acc, label='validation acc')
plt.legend()
plt.figure()

plt.plot(epochs, loss, label='training loss')
plt.plot(epochs, val_loss, label='validation loss')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7ff84fa3a790>
```



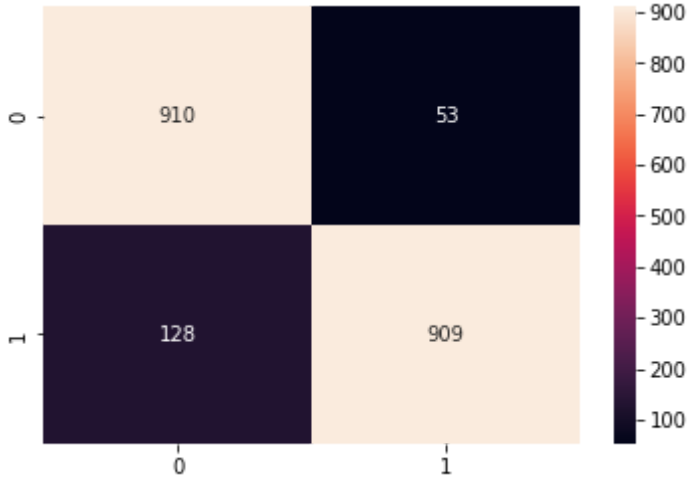
Biz foydalanadigan modellar:

#KNeighborsClassifier

```
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier(n_neighbors=5) # k-ni qiymati
knn.fit(X_train_prepared, y_train)

# tekshirish (X-test va y_test yordamida)
y_predict = knn.predict(X_test_prepared)


# BAHOLASH:
from sklearn.metrics import confusion_matrix, precision_score, recall_score, f1_score,
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)
```

```
# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/neighbors/_classification.py:198:
DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples,), for example using ravel().
  return self._fit(X, y)
```




```
Classification_report:
              precision    recall  f1-score   support

           0       0.88      0.94      0.91       963
           1       0.94      0.88      0.91      1037

    accuracy                           0.91      2000
   macro avg       0.91      0.91      0.91      2000
weighted avg       0.91      0.91      0.91      2000


jaccard index: 0.8339449541284404

precision: 0.9449064449064449
recall: 0.8765670202507232
f1_score: 0.9094547273636819

Model aniqligi: 91.0 %
```

Optimal **k** ni topamiz:

`for` tsikli orqali:

```
# f1 = []
# for k in range(1,25):
#     knn = KNeighborsClassifier(n_neighbors=k) # k-ni qiymati
#     knn.fit(X_train_prepared, y_train)
#     y_predict = knn.predict(X_test_prepared)
```

```
#     f1.append(f1_score(y_test, y_predict))

# plt.figure(figsize=(10,6))
# plt.plot(range(1,25),f1)
# plt.xticks(range(1,25))
# plt.grid()
# plt.show()
```

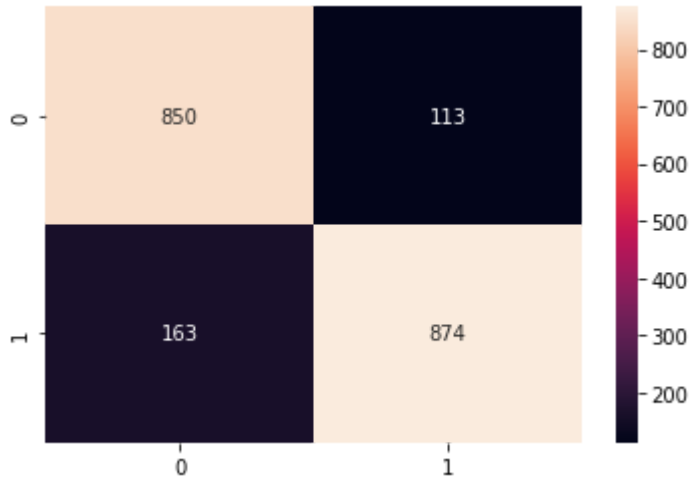
GridSearchCV orqali

```
# from sklearn.model_selection import GridSearchCV

# param_grid = {'n_neighbors': np.arange(1, 25)}

# knn_gscv = GridSearchCV(knn, param_grid, cv=5)

# knn_gscv.fit(X_train, y_train)

# print(knn_gscv.best_params_)
```

#Logistic Regresssion:

```
from sklearn.linear_model import LogisticRegression
LR_model = LogisticRegression()

LR_model.fit(X_train_prepared, y_train)

# tekshirish
y_predict = LR_model.predict(X_test_prepared)

# Baholash
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)


# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/validation.py:993:
DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```



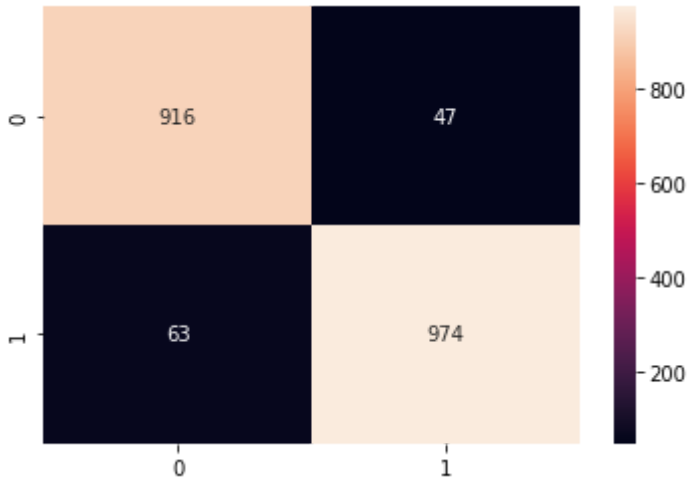

```
Classification_report:
              precision    recall  f1-score   support

           0       0.84      0.88      0.86       963
           1       0.89      0.84      0.86      1037

    accuracy                           0.86      2000
   macro avg       0.86      0.86      0.86      2000
weighted avg       0.86      0.86      0.86      2000


jaccard index: 0.76

precision: 0.8855116514690983
recall: 0.8428158148505304
f1_score: 0.8636363636363636

Model aniqligi: 86.2 %
```

Random Forest:

```
from sklearn.ensemble import RandomForestClassifier
RF_model = RandomForestClassifier()
RF_model.fit(X_train_prepared, y_train)

# tekshirish
y_predict = RF_model.predict(X_test_prepared)

# Baholash
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
```

```
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)


# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```

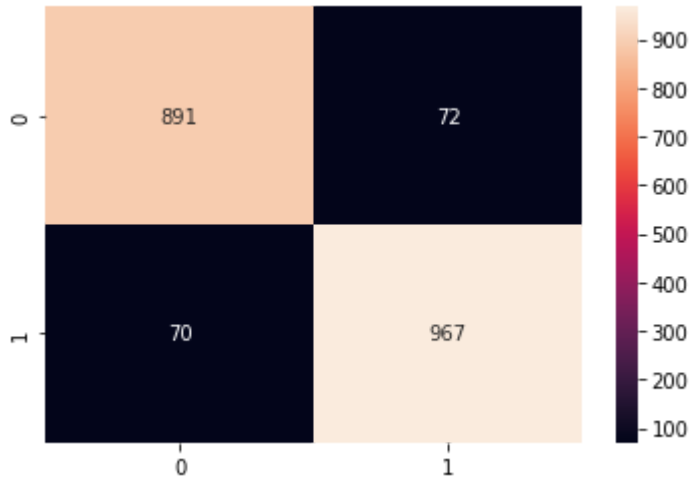
```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: DataConversionWarning:
A column-vector y was passed when a 1d array was expected. Please change the shape of y
to (n_samples,), for example using ravel().
  This is separate from the ipykernel package so we can avoid doing imports until
```




```
Classification_report:
              precision    recall  f1-score   support

           0       0.94      0.95      0.94       963
           1       0.95      0.94      0.95      1037

    accuracy                           0.94      2000
   macro avg       0.94      0.95      0.94      2000
weighted avg       0.95      0.94      0.95      2000


jaccard index: 0.8985239852398524

precision: 0.9539666993143977
recall: 0.9392478302796529
f1_score: 0.9465500485908649

Model aniqligi: 94.5 %
```

DecisionTree:

```
from sklearn.tree import DecisionTreeClassifier
Tree_model = DecisionTreeClassifier()

Tree_model.fit(X_train_prepared, y_train)

# tekshirish
y_predict = Tree_model.predict(X_test_prepared)

# Baholash
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)


# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```



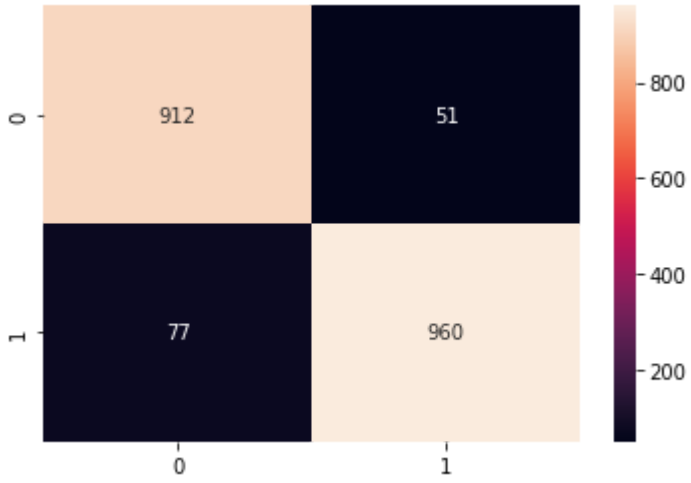

```
Classification_report:
              precision    recall  f1-score   support

           0       0.93      0.93      0.93       963
           1       0.93      0.93      0.93      1037

    accuracy                           0.93      2000
   macro avg       0.93      0.93      0.93      2000
weighted avg       0.93      0.93      0.93      2000


jaccard index: 0.8719567177637512
```

```
precision: 0.9307025986525506
recall: 0.9324975891996142
f1_score: 0.9315992292870905

Model aniqligi: 92.9 %
```

SVC:

```
from sklearn.svm import SVC
SVC_model = SVC()

SVC_model.fit(X_train_prepared, y_train)

# tekshirish
y_predict = SVC_model.predict(X_test_prepared)

# Baholash
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)


# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/validation.py:993:
DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

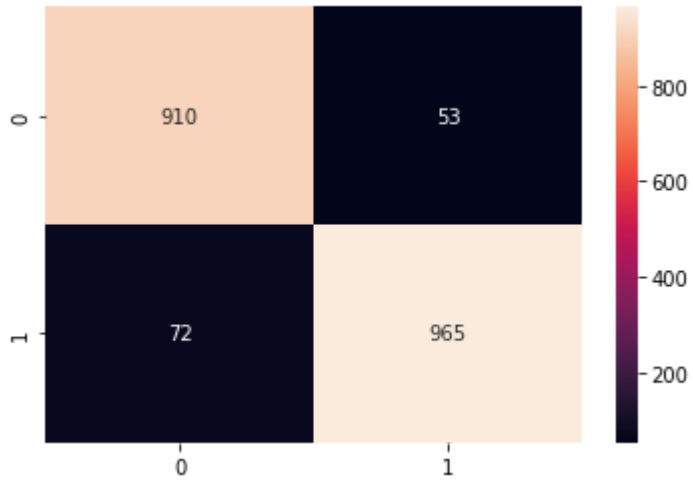


```
Classification_report:
              precision    recall  f1-score   support

           0       0.92      0.95      0.93       963
           1       0.95      0.93      0.94      1037

    accuracy                           0.94      2000
   macro avg       0.94      0.94      0.94      2000
weighted avg       0.94      0.94      0.94      2000


jaccard index: 0.8823529411764706

precision: 0.9495548961424333
recall: 0.9257473481195757
f1_score: 0.9375000000000001

Model aniqligi: 93.6 %
```

```
from xgboost import XGBClassifier
XGBC_model = XGBClassifier()

XGBC_model.fit(X_train_prepared, y_train)

# tekshirish
y_predict = XGBC_model.predict(X_test_prepared)

# Baholash
sns.heatmap(confusion_matrix(y_test, y_predict), annot=True, fmt ='g')
plt.show()

# aniqlik:
precision = precision_score(y_test, y_predict)
recall = recall_score(y_test, y_predict)
f1 = f1_score(y_test, y_predict)
accuracy = accuracy_score(y_test, y_predict)
jaccard_index = jaccard_score(y_test, y_predict)
class_report = classification_report(y_test, y_predict)


# chop etish:
print(f"Classification_report:\n{class_report}\n\njaccard index: {jaccard_index}\n\npre
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/preprocessing/_label.py:98:
DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/preprocessing/_label.py:133:
DataConversionWarning: A column-vector y was passed when a 1d array was expected.
Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```




```
Classification_report:
              precision    recall  f1-score   support

           0       0.93      0.94      0.94       963
           1       0.95      0.93      0.94      1037

    accuracy                           0.94      2000
   macro avg       0.94      0.94      0.94      2000
weighted avg       0.94      0.94      0.94      2000


jaccard index: 0.8853211009174312

precision: 0.9479371316306483
recall: 0.9305689488910318
f1_score: 0.9391727493917275

Model aniqligi: 93.8 %
```

Bu dataset uchun eng yaxshi ko'rsatgich `RandomForest` modelda ekan.

Bizga qo'yilgan vazifaga o'tamiz. df_test uchun `satisfaction` ni bashorat qilamiz:

```
df_test.head(3)
```

id	gender	CustType	age	traveltype	Class	FlightDis	wifiservis	DepArrTime	EObook	gateloc	...	SeatCom	Inflent
1	0	1	25	0	0	2704	2	2	2	3	...	5	

id	gender	CustType	age	traveltype	Class	FlightDis	wifiservis	DepArrTime	EObook	gateloc	...	SeatCom	Inflent
2	0	1	49	1	2	1623	1	1	1	1	...	4	
3	1	1	51	1	2	338	4	4	4	4	...	5	

3 rows × 22 columns

```
df_test_prepared = pipeline.fit_transform(df_test)
```

```
y_predict_test = RF_model.predict(df_test_prepared)
y_predict_test
```

```
array([0, 1, 1, ..., 0, 1, 0])
```

```
y_predict_test
```

```
array([0, 1, 1, ..., 0, 1, 0])
```

```
ss_df.satisfaction = y_predict_test
ss_df
```

id	satisfaction
1	0
2	1
3	1
4	1
5	0
...	...
3996	1
3997	0
3998	0
3999	1
4000	0

4000 rows × 1 columns

```
ss_df.to_csv('submission_data_09.csv')
```