```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

### Loading dataset

```
df = pd.read_csv('/content/customer_churn.csv')
df.sample(5)
```

| | customerID | gender | SeniorCitizen | Partner | Dependents | tenure | PhoneService | MultipleLines | InternetService | OnlineSecurity | ... | DeviceProtection | TechSupport | StreamingTV | StreamingMovies | Contract | PaperlessBilling | PaymentMethod | MonthlyCharges | TotalCharges | Churn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3** | 7795-CFOCW | Male | 0 | No | No | 45 | No | No phone service | DSL | Yes | ... | Yes | Yes | No | No | One year | No | Bank transfer (automatic) | 42.30 | 1840.75 | No |
| **3127** | 1432-FPAXX | Female | 0 | No | No | 29 | No | No phone service | DSL | No | ... | No | No | No | No | Month-to-month | Yes | Electronic check | 30.60 | 856.35 | Yes |
| **5291** | 1334-PDUKM | Female | 0 | Yes | No | 68 | Yes | Yes | Fiber optic | No | ... | Yes | No | No | No | One year | No | Credit card (automatic) | 86.45 | 5762.95 | No |
| **3339** | 8690-ZVLCL | Female | 0 | Yes | Yes | 68 | Yes | Yes | DSL | Yes | ... | Yes | Yes | Yes | Yes | Two year | No | Credit card (automatic) | 88.00 | 6161.9 | No |
| **1381** | 3717-OEAUQ | Male | 0 | No | No | 2 | Yes | No | Fiber optic | No | ... | No | No | No | No | Month-to-month | No | Mailed check | 70.70 | 129.2 | No |

5 rows × 21 columns

### droping customerID column as it is of no use

```
#step 1:data exploration ie cust_id is useless
df.drop('customerID',axis='columns',inplace=True)
df.dtypes
```

| | 0 |
|---|---|
| **gender** | object |
| **SeniorCitizen** | int64 |
| **Partner** | object |
| **Dependents** | object |
| **tenure** | int64 |
| **PhoneService** | object |
| **MultipleLines** | object |
| **InternetService** | object |
| **OnlineSecurity** | object |
| **OnlineBackup** | object |
| **DeviceProtection** | object |
| **TechSupport** | object |
| **StreamingTV** | object |
| **StreamingMovies** | object |
| **Contract** | object |
| **PaperlessBilling** | object |
| **PaymentMethod** | object |
| **MonthlyCharges** | float64 |
| **TotalCharges** | object |
| **Churn** | object |

**dtype:** object

```
#TotalCharges        in str
df.TotalCharges.values
```

```
array(['29.85', '1889.5', '108.15', ..., '346.45', '306.6', '6844.5'],
      dtype=object)
```

```
df.MonthlyCharges.values#numbers
```

```
array([ 29.85,  56.95,  53.85, ...,  29.6 ,  74.4 , 105.65])
```

```
# pd.to_numeric(df.TotalCharges)
```

### converting TotalCharges to float as it is in object type

```
#to tackle spaces in TotalCharges
pd.to_numeric(df.TotalCharges,errors='coerce').isnull()   #put na if space in that col
```

| | TotalCharges |
|---|---|
| **0** | False |
| **1** | False |
| **2** | False |
| **3** | False |
| **4** | False |
| **...** | ... |
| **7038** | False |
| **7039** | False |
| **7040** | False |
| **7041** | False |
| **7042** | False |

7043 rows × 1 columns

**dtype:** bool

```
df[pd.to_numeric(df.TotalCharges,errors='coerce').isnull()]   #tota charges are nulls df
```

| | gender | SeniorCitizen | Partner | Dependents | tenure | PhoneService | MultipleLines | InternetService | OnlineSecurity | OnlineBackup | DeviceProtection | TechSupport | StreamingTV | StreamingMovies | Contract | PaperlessBilling | PaymentMethod | MonthlyCharges | TotalCharges | Churn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **488** | Female | 0 | Yes | Yes | 0 | No | No phone service | DSL | Yes | No | Yes | Yes | Yes | No | Two year | Yes | Bank transfer (automatic) | 52.55 | | No |
| **753** | Male | 0 | No | Yes | 0 | Yes | No | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | Two year | No | Mailed check | 20.25 | | No |
| **936** | Female | 0 | Yes | Yes | 0 | Yes | No | DSL | Yes | Yes | Yes | No | Yes | Yes | Two year | No | Mailed check | 80.85 | | No |
| **1082** | Male | 0 | Yes | Yes | 0 | Yes | Yes | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | Two year | No | Mailed check | 25.75 | | No |
| **1340** | Female | 0 | Yes | Yes | 0 | No | No phone service | DSL | Yes | Yes | Yes | Yes | Yes | No | Two year | No | Credit card (automatic) | 56.05 | | No |
| **3331** | Male | 0 | Yes | Yes | 0 | Yes | No | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | Two year | No | Mailed check | 19.85 | | No |
| **3826** | Male | 0 | Yes | Yes | 0 | Yes | Yes | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | Two year | No | Mailed check | 25.35 | | No |
| **4380** | Female | 0 | Yes | Yes | 0 | Yes | No | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | Two year | No | Mailed check | 20.00 | | No |
| **5218** | Male | 0 | Yes | Yes | 0 | Yes | No | No | No internet service | No internet service | No internet service | No internet service | No internet service | No internet service | One year | Yes | Mailed check | 19.70 | | No |
| **6670** | Female | 0 | Yes | Yes | 0 | Yes | Yes | DSL | No | Yes | Yes | Yes | Yes | No | Two year | No | Mailed check | 73.35 | | No |
| **6754** | Male | 0 | No | Yes | 0 | Yes | Yes | DSL | Yes | Yes | No | Yes | No | No | Two year | Yes | Bank transfer (automatic) | 61.90 | | No |

```
df[pd.to_numeric(df.TotalCharges,errors='coerce').isnull()].shape
```

```
(11, 20)
```

```
df.shape
```

```
(7043, 20)
```

```
df.iloc[488].TotalCharges #iloc is like indexing in array  (488 row)
```

```
' '
```

```
#drop 11 rows
df1 = df[df.TotalCharges!=' ']
df1.shape
```

```
(7032, 20)
```

```
df1.TotalCharges=pd.to_numeric(df1.TotalCharges)
```

```
<ipython-input-88-01816c9a1a9f>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df1.TotalCharges=pd.to_numeric(df1.TotalCharges)
```

```
df1.TotalCharges.dtypes
```

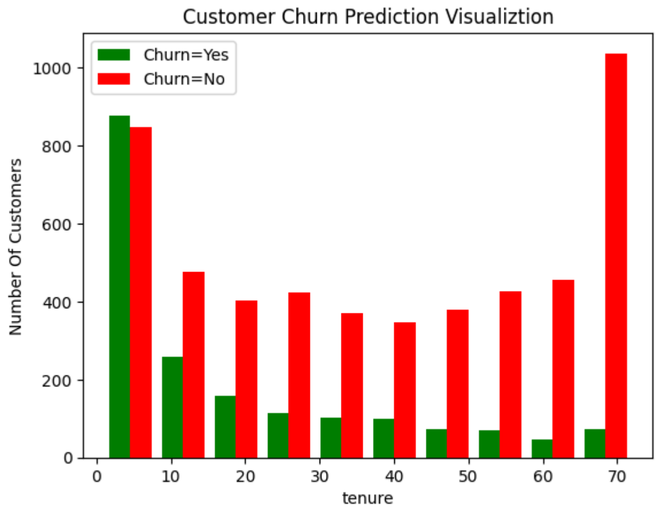
```
dtype('float64')
```

TENURE - HOW CUSTOMER LOYAL IS

```
tenure_churn_no = df1[df1.Churn == 'No'].tenure #not leaving
tenure_churn_Yes = df1[df1.Churn == 'Yes'].tenure # leaving IN MONTHS


plt.xlabel("tenure")
plt.ylabel("Number Of Customers")
plt.title("Customer Churn Prediction Visualiztion")
plt.hist([tenure_churn_Yes,tenure_churn_no],color=['green','red'],label=['Churn=Yes','Churn=No'])
plt.legend()
#AROUND 1000CUST ARE NOT LEAVAING WHERE TENURE =70
```

```
<matplotlib.legend.Legend at 0x7888949cba30>
```




```
Start coding or generate with AI.
```

```
def print_unique_col_values(df):
  for column in df:
    if df[column].dtypes=='object':
      print(f'{column}: {df[column].unique()}')
```

```
print_unique_col_values(df1)
```

```
gender: ['Female' 'Male']
Partner: ['Yes' 'No']
Dependents: ['No' 'Yes']
PhoneService: ['No' 'Yes']
MultipleLines: ['No phone service' 'No' 'Yes']
InternetService: ['DSL' 'Fiber optic' 'No']
OnlineSecurity: ['No' 'Yes' 'No internet service']
OnlineBackup: ['Yes' 'No' 'No internet service']
DeviceProtection: ['No' 'Yes' 'No internet service']
TechSupport: ['No' 'Yes' 'No internet service']
StreamingTV: ['No' 'Yes' 'No internet service']
StreamingMovies: ['No' 'Yes' 'No internet service']
Contract: ['Month-to-month' 'One year' 'Two year']
PaperlessBilling: ['Yes' 'No']
PaymentMethod: ['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']
Churn: ['No' 'Yes']
```

```
df1.replace('No internet service','No',inplace=True)
df1.replace('No phone service','No',inplace=True)
print_unique_col_values(df1)
```

```
gender: ['Female' 'Male']
Partner: ['Yes' 'No']
Dependents: ['No' 'Yes']
PhoneService: ['No' 'Yes']
MultipleLines: ['No' 'Yes']
InternetService: ['DSL' 'Fiber optic' 'No']
OnlineSecurity: ['No' 'Yes']
OnlineBackup: ['Yes' 'No']
DeviceProtection: ['No' 'Yes']
TechSupport: ['No' 'Yes']
StreamingTV: ['No' 'Yes']
StreamingMovies: ['No' 'Yes']
Contract: ['Month-to-month' 'One year' 'Two year']
PaperlessBilling: ['Yes' 'No']
PaymentMethod: ['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']
Churn: ['No' 'Yes']
<ipython-input-93-911fb1bda1c4>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df1.replace('No internet service','No',inplace=True)
<ipython-input-93-911fb1bda1c4>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df1.replace('No phone service','No',inplace=True)
```

```
yes_no_columns = ['Partner','Dependents','PhoneService','MultipleLines','OnlineSecurity','OnlineBackup','DeviceProtection','TechSupport','StreamingTV','StreamingMovies','PaperlessBilling','Churn']

for col in yes_no_columns:
  df1[col].replace({'Yes': 1,'No': 0},inplace=True)
```

```
<ipython-input-94-0cbc454eee20>:4: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value) instead, to perform the operation inplace on the original object.


  df1[col].replace({'Yes': 1,'No': 0},inplace=True)
<ipython-input-94-0cbc454eee20>:4: FutureWarning: Downcasting behavior in `replace` is deprecated and will be removed in a future version. To retain the old behavior, explicitly call `result.infer_objects(copy=False)`. To opt-in to the future behavior, set `pd.set_option('f
  df1[col].replace({'Yes': 1,'No': 0},inplace=True)
<ipython-input-94-0cbc454eee20>:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df1[col].replace({'Yes': 1,'No': 0},inplace=True)
```

```
df1
```

| | gender | SeniorCitizen | Partner | Dependents | tenure | PhoneService | MultipleLines | InternetService | OnlineSecurity | OnlineBackup | DeviceProtection | TechSupport | StreamingTV | StreamingMovies | Contract | PaperlessBilling | PaymentMethod | MonthlyCharges | TotalCharges | Churn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | Female | 0 | 1 | 0 | 1 | 0 | 0 | DSL | 0 | 1 | 0 | 0 | 0 | 0 | Month-to-month | 1 | Electronic check | 29.85 | 29.85 | 0 |
| **1** | Male | 0 | 0 | 0 | 34 | 1 | 0 | DSL | 1 | 0 | 1 | 0 | 0 | 0 | One year | 0 | Mailed check | 56.95 | 1889.50 | 0 |
| **2** | Male | 0 | 0 | 0 | 2 | 1 | 0 | DSL | 1 | 1 | 0 | 0 | 0 | 0 | Month-to-month | 1 | Mailed check | 53.85 | 108.15 | 1 |
| **3** | Male | 0 | 0 | 0 | 45 | 0 | 0 | DSL | 1 | 0 | 1 | 1 | 0 | 0 | One year | 0 | Bank transfer (automatic) | 42.30 | 1840.75 | 0 |
| **4** | Female | 0 | 0 | 0 | 2 | 1 | 0 | Fiber optic | 0 | 0 | 0 | 0 | 0 | 0 | Month-to-month | 1 | Electronic check | 70.70 | 151.65 | 1 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **7038** | Male | 0 | 1 | 1 | 24 | 1 | 1 | DSL | 1 | 0 | 1 | 1 | 1 | 1 | One year | 1 | Mailed check | 84.80 | 1990.50 | 0 |
| **7039** | Female | 0 | 1 | 1 | 72 | 1 | 1 | Fiber optic | 0 | 1 | 1 | 0 | 1 | 1 | One year | 1 | Credit card (automatic) | 103.20 | 7362.90 | 0 |
| **7040** | Female | 0 | 1 | 1 | 11 | 0 | 0 | DSL | 1 | 0 | 0 | 0 | 0 | 0 | Month-to-month | 1 | Electronic check | 29.60 | 346.45 | 0 |
| **7041** | Male | 1 | 1 | 0 | 4 | 1 | 1 | Fiber optic | 0 | 0 | 0 | 0 | 0 | 0 | Month-to-month | 1 | Mailed check | 74.40 | 306.60 | 1 |
| **7042** | Male | 0 | 0 | 0 | 66 | 1 | 0 | Fiber optic | 1 | 0 | 1 | 1 | 1 | 1 | Two year | 1 | Bank transfer (automatic) | 105.65 | 6844.50 | 0 |

7032 rows × 20 columns

Next steps: Generate code with df1 | View recommended plots | New interactive sheet

```
print_unique_col_values(df1)
```

```
gender: ['Female' 'Male']
InternetService: ['DSL' 'Fiber optic' 'No']
Contract: ['Month-to-month' 'One year' 'Two year']
PaymentMethod: ['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']
```

```
df1['gender'].replace({'Female':1,'Male':0},inplace=True)
```

```
<ipython-input-97-ba153b6b6960>:1: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value) instead, to perform the operation inplace on the original object.


  df1['gender'].replace({'Female':1,'Male':0},inplace=True)
<ipython-input-97-ba153b6b6960>:1: FutureWarning: Downcasting behavior in `replace` is deprecated and will be removed in a future version. To retain the old behavior, explicitly call `result.infer_objects(copy=False)`. To opt-in to the future behavior, set `pd.set_option('f
  df1['gender'].replace({'Female':1,'Male':0},inplace=True)
<ipython-input-97-ba153b6b6960>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df1['gender'].replace({'Female':1,'Male':0},inplace=True)
```

```
df1.gender.unique()
```

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

```
print_unique_col_values(df1)
```

```
InternetService: ['DSL' 'Fiber optic' 'No']
Contract: ['Month-to-month' 'One year' 'Two year']
PaymentMethod: ['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']
```

```
df2 = pd.get_dummies(data=df1,columns=['InternetService','Contract','PaymentMethod']) # ONE HOT ENCODING ->it creates 3cols for single InternetServic
df2.columns

# df2
```

```
Index(['gender', 'SeniorCitizen', 'Partner', 'Dependents', 'tenure',
       'PhoneService', 'MultipleLines', 'OnlineSecurity', 'OnlineBackup',
       'DeviceProtection', 'TechSupport', 'StreamingTV', 'StreamingMovies',
       'PaperlessBilling', 'MonthlyCharges', 'TotalCharges', 'Churn',
       'InternetService_DSL', 'InternetService_Fiber optic',
       'InternetService_No', 'Contract_Month-to-month', 'Contract_One year',
       'Contract_Two year', 'PaymentMethod_Bank transfer (automatic)',
       'PaymentMethod_Credit card (automatic)',
       'PaymentMethod_Electronic check', 'PaymentMethod_Mailed check'],
      dtype='object')
```

```
df2.sample(3)
```

| | gender | SeniorCitizen | Partner | Dependents | tenure | PhoneService | MultipleLines | OnlineSecurity | OnlineBackup | DeviceProtection | ... | InternetService_DSL | InternetService_Fiber optic | InternetService_No | Contract_Month-to-month | Contract_One year | Contract_Two year | PaymentMethod_Bank transfer (automatic) | Payment car |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4434** | 1 | 0 | 1 | 0 | 16 | 1 | 1 | 1 | 1 | 1 | ... | False | True | False | True | False | False | False | |
| **5417** | 0 | 0 | 1 | 1 | 14 | 1 | 0 | 1 | 1 | 0 | ... | True | False | False | False | False | True | True | |
| **5525** | 1 | 0 | 1 | 1 | 54 | 1 | 1 | 0 | 0 | 0 | ... | False | False | True | False | True | False | True | |

3 rows × 27 columns

```
df2.dtypes
```

| | 0 |
|---|---|
| **gender** | int64 |
| **SeniorCitizen** | int64 |
| **Partner** | int64 |
| **Dependents** | int64 |
| **tenure** | int64 |
| **PhoneService** | int64 |
| **MultipleLines** | int64 |
| **OnlineSecurity** | int64 |
| **OnlineBackup** | int64 |
| **DeviceProtection** | int64 |
| **TechSupport** | int64 |
| **StreamingTV** | int64 |
| **StreamingMovies** | int64 |
| **PaperlessBilling** | int64 |
| **MonthlyCharges** | float64 |
| **TotalCharges** | float64 |
| **Churn** | int64 |
| **InternetService_DSL** | bool |
| **InternetService_Fiber optic** | bool |
| **InternetService_No** | bool |
| **Contract_Month-to-month** | bool |
| **Contract_One year** | bool |
| **Contract_Two year** | bool |
| **PaymentMethod_Bank transfer (automatic)** | bool |
| **PaymentMethod_Credit card (automatic)** | bool |
| **PaymentMethod_Electronic check** | bool |
| **PaymentMethod_Mailed check** | bool |

**dtype:** object

SCALING /255

```
cols_to_scale = ['tenure','MonthlyCharges','TotalCharges']#these cols not interms of 1s and 0s
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
df2[cols_to_scale] = scaler.fit_transform(df2[cols_to_scale])
```

```
for col in df2:
  print(f'{col}: {df2[col].unique()}')
```

```
gender: [1 0]
SeniorCitizen: [0 1]
Partner: [1 0]
Dependents: [0 1]
tenure: [0.         0.46478873 0.01408451 0.61971831 0.09859155 0.29577465
 0.12676056 0.38028169 0.85915493 0.16901408 0.21126761 0.8028169
 0.67605634 0.33802817 0.95774648 0.71830986 0.98591549 0.28169014
 0.15492958 0.4084507  0.64788732 1.         0.22535211 0.36619718
 0.05633803 0.63380282 0.14084507 0.97183099 0.87323944 0.5915493
 0.1971831  0.83098592 0.23943662 0.91549296 0.11267606 0.02816901
 0.42253521 0.69014085 0.88732394 0.77464789 0.08450704 0.57746479
 0.47887324 0.66197183 0.3943662  0.90140845 0.52112676 0.94366197
 0.43661972 0.76056338 0.50704225 0.49295775 0.56338028 0.07042254
 0.04225352 0.45070423 0.92957746 0.30985915 0.78873239 0.84507042
 0.18309859 0.26760563 0.73239437 0.54929577 0.81690141 0.32394366
 0.6056338  0.25352113 0.74647887 0.70422535 0.35211268 0.53521127]
PhoneService: [0 1]
MultipleLines: [0 1]
OnlineSecurity: [0 1]
OnlineBackup: [1 0]
DeviceProtection: [0 1]
TechSupport: [0 1]
StreamingTV: [0 1]
StreamingMovies: [0 1]
PaperlessBilling: [1 0]
MonthlyCharges: [0.11542289 0.38507463 0.35422886 ... 0.44626866 0.25820896 0.60149254]
TotalCharges: [0.0012751  0.21586661 0.01031041 ... 0.03780868 0.03321025 0.78764136]
Churn: [0 1]
InternetService_DSL: [ True False]
InternetService_Fiber optic: [False  True]
InternetService_No: [False  True]
Contract_Month-to-month: [ True False]
Contract_One year: [False  True]
Contract_Two year: [False  True]
PaymentMethod_Bank transfer (automatic): [False  True]
PaymentMethod_Credit card (automatic): [False  True]
PaymentMethod_Electronic check: [ True False]
PaymentMethod_Mailed check: [False  True]
```

```
x = df2.drop('Churn',axis='columns')
y = df2['Churn']
```

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.2,random_state=5)
x_train.shape
```

```
(5625, 26)
```

```
y_train.shape
```

```
(5625,)
```

```
y_test.shape
```

```
(1407,)
```

```
y_test[0:5]
```

| | Churn |
|---|---|
| **2660** | 0 |
| **744** | 0 |
| **5579** | 1 |
| **64** | 1 |
| **3287** | 1 |

**dtype:** int64

```
x_test.head()
```

| | gender | SeniorCitizen | Partner | Dependents | tenure | PhoneService | MultipleLines | OnlineSecurity | OnlineBackup | DeviceProtection | ... | InternetService_DSL | InternetService_Fiber optic | InternetService_No | Contract_Month-to-month | Contract_One year | Contract_Two year | PaymentMethod_Bank transfer (automatic) | Payme c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2660** | 0 | 0 | 0 | 1 | 0.169014 | 1 | 0 | 1 | 0 | 0 | ... | True | False | False | True | False | False | False | |
| **744** | 1 | 0 | 0 | 0 | 0.056338 | 1 | 0 | 0 | 0 | 0 | ... | True | False | False | True | False | False | False | |
| **5579** | 1 | 0 | 1 | 1 | 0.971831 | 1 | 1 | 1 | 1 | 1 | ... | False | True | False | False | False | True | True | |
| **64** | 1 | 0 | 0 | 0 | 0.112676 | 1 | 1 | 0 | 0 | 0 | ... | False | True | False | True | False | False | False | |
| **3287** | 0 | 0 | 1 | 1 | 0.253521 | 1 | 1 | 0 | 0 | 0 | ... | False | True | False | False | True | False | False | |

5 rows × 26 columns

```
x_test.shape
```

```
(1407, 26)
```

```
from sklearn.tree import DecisionTreeClassifier
clf = DecisionTreeClassifier(random_state=100)
clf.fit(x_train,y_train)
```

```
DecisionTreeClassifier(random_state=100)
```

```
clf.score(x_test,y_test)
```

```
0.7114427860696517
```

```
from sklearn.ensemble import RandomForestClassifier
clf_forest = RandomForestClassifier()
clf_forest.fit(x_train,y_train)
```

```
RandomForestClassifier()
```

```
clf_forest.score(x_test,y_test)
```

```
0.7746979388770433
```

```
from sklearn.ensemble import AdaBoostClassifier

ada_boost_clf = AdaBoostClassifier(n_estimators=30)
ada_boost_clf.fit(x_train, y_train)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/ensemble/_weight_boosting.py:527: FutureWarning: The SAMME.R algorithm (the default) is deprecated and will be removed in 1.6. Use the SAMME algorithm to circumvent this warning.
  warnings.warn(
AdaBoostClassifier(n_estimators=30)
```

```
ada_boost_clf.score(x_test,y_test)
```

```
0.7910447761194029
```

```
import tensorflow as tf
from tensorflow import keras

model = keras.Sequential([    #each neuron in i/p layer accept 1 feature
    keras.layers.Dense(20, input_shape=(26,), activation='relu'), #20 hidden
    keras.layers.Dense(1, activation='sigmoid'),
])
#ML is an art of experiments there is no like golden rule here

model.compile(optimizer='adam',
              loss='binary_crossentropy',
              metrics=['accuracy'])

model.fit(x_train, y_train, epochs=50)
```

```
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8061 - loss: 0.4078
Epoch 27/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8124 - loss: 0.4037
Epoch 28/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8226 - loss: 0.3849
Epoch 29/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8144 - loss: 0.4037
Epoch 30/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8160 - loss: 0.3889
Epoch 31/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8148 - loss: 0.3969
Epoch 32/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8113 - loss: 0.4004
Epoch 33/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8245 - loss: 0.3904
Epoch 34/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8129 - loss: 0.4016
Epoch 35/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8119 - loss: 0.3996
Epoch 36/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8152 - loss: 0.4054
Epoch 37/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8156 - loss: 0.3901
Epoch 38/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 1ms/step - accuracy: 0.8199 - loss: 0.3954
Epoch 39/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8201 - loss: 0.3917
Epoch 40/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8179 - loss: 0.3968
Epoch 41/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8154 - loss: 0.3960
Epoch 42/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8136 - loss: 0.4000
Epoch 43/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8209 - loss: 0.3936
Epoch 44/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8112 - loss: 0.3981
Epoch 45/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.8174 - loss: 0.3923
Epoch 46/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8317 - loss: 0.3749
Epoch 47/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8230 - loss: 0.3755
Epoch 48/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8228 - loss: 0.3907
Epoch 49/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8234 - loss: 0.3903
Epoch 50/50
176/176 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8044 - loss: 0.4011
<keras.src.callbacks.history.History at 0x788894837580>
```

```
model.evaluate(x_test, y_test)
```

```
44/44 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - accuracy: 0.8002 - loss: 0.4389
[0.4457562267780304, 0.7931769490242004]
```

```
ypred = model.predict(x_test)
ypred[:5] #<0.5 means 0
```

```
44/44 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step
array([[0.22248532],
       [0.48275548],
       [0.01177306],
       [0.7871818 ],
       [0.6676382 ]], dtype=float32)
```

```
y_pred =[]
for element in ypred:
  if element > 0.5:
    y_pred.append(1)
  else:
    y_pred.append(0)
```

```
y_pred[0:7]
```

```
[0, 0, 0, 1, 1, 1, 0]
```

```
y_test[0:7]
```

| | Churn |
|---|---|
| **2660** | 0 |
| **744** | 0 |
| **5579** | 1 |
| **64** | 1 |
| **3287** | 1 |
| **816** | 1 |
| **2670** | 0 |

**dtype:** int64

```
from sklearn.metrics import confusion_matrix , classification_report

print(classification_report(y_test,y_pred))
```

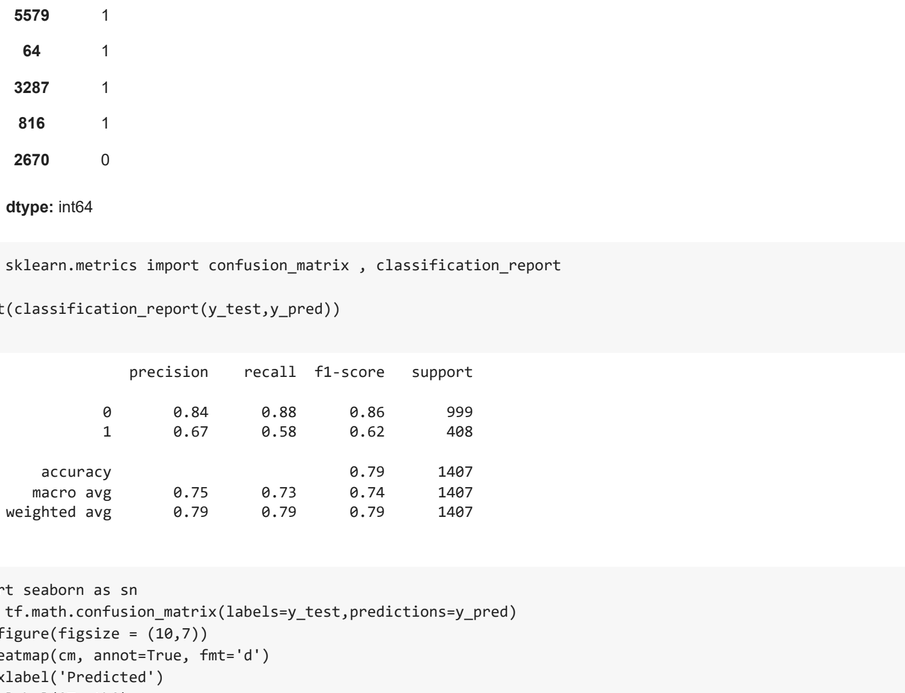
```
              precision    recall  f1-score   support

           0       0.84      0.88      0.86       999
           1       0.67      0.58      0.62       408

    accuracy                           0.79      1407
   macro avg       0.75      0.73      0.74      1407
weighted avg       0.79      0.79      0.79      1407
```

```
import seaborn as sn
cm = tf.math.confusion_matrix(labels=y_test,predictions=y_pred)
plt.figure(figsize = (10,7))
sn.heatmap(cm, annot=True, fmt='d')
plt.xlabel('Predicted')
plt.ylabel('Truth')
#
```

```
Text(95.72222222222221, 0.5, 'Truth')
```




ACCURACY

```
round((893+209)/(893+199+209+106),2)
```

```
0.78
```

## Precision for 0 class i.e Precision for customer who did not churn

```
893/(893+106)
```

```
0.8938938938938938
```

## Precision for 1 class i.e Precision for customer who actually churned

```
209/(209+209)
```

```
0.5
```

## Recall for 0 class ie total correct pred for 0 class / total 0th samples

```
875/(875+124)
```

```
0.8758758758758759
```

## Recall for 1 class ie total correct pred for 1 class / total 1th samples

```
240/(240+168)
```

```
0.5882352941176471
```

**SMOTE** - To Handle imbalance dataset

```
# Class count
count_class_0, count_class_1 = df1.Churn.value_counts()

# Dividing by class
df_class_0 = df2[df2['Churn'] == 0]
df_class_1 = df2[df2['Churn'] == 1]
```

```
df_class_0.shape
```

```
(5163, 27)
```

```
df_class_1.shape
```

```
(1869, 27)
```

```
X = df2.drop('Churn',axis='columns')
y = df2['Churn']
```

```
#imbalanced learn
from imblearn.over_sampling import SMOTE

smote = SMOTE(sampling_strategy='minority')
X_sm, y_sm = smote.fit_resample(X, y)

y_sm.value_counts()
```

```
      count
Churn
0     5163
1     5163
dtype: int64
```

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X_sm, y_sm, test_size=0.2, random_state=15, stratify=y_sm)
```

```
y_train.value_counts()
```

```
      count
Churn
1     4130
0     4130
dtype: int64
```

```
Start coding or generate with AI.
```

```
import tensorflow as tf
from tensorflow import keras
from sklearn.metrics import confusion_matrix , classification_report



def ANN(X_train, y_train, X_test, y_test, loss, weights):
    model = keras.Sequential([
        keras.layers.Dense(26, input_dim=26, activation='relu'),
        keras.layers.Dense(15, activation='relu'),
        keras.layers.Dense(1, activation='sigmoid')
    ])

    model.compile(optimizer='adam', loss=loss, metrics=['accuracy'])

    if weights == -1:
        model.fit(X_train, y_train, epochs=100)
    else:
        model.fit(X_train, y_train, epochs=100, class_weight = weights)

    print(model.evaluate(X_test, y_test))

    y_preds = model.predict(X_test)
    y_preds = np.round(y_preds)

    print("Classification Report: \n", classification_report(y_test, y_preds))

    return y_preds
```

```
y_preds = ANN(X_train, y_train, X_test, y_test, 'binary_crossentropy', -1)
#259 -> 32 batch miniBatch
```

```
259/259 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8589 - loss: 0.3255
Epoch 100/100
259/259 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.8536 - loss: 0.3334
65/65 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - accuracy: 0.7914 - loss: 0.4505
[0.4399339258670807, 0.7981606721878052]
65/65 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step
Classification Report:
              precision    recall  f1-score   support

           0       0.82      0.76      0.79      1033
           1       0.78      0.84      0.81      1033

    accuracy                           0.80      2066
   macro avg       0.80      0.80      0.80      2066
weighted avg       0.80      0.80      0.80      2066
```

```
rf_classifier = RandomForestClassifier(n_estimators=100, random_state=42)
rf_classifier.fit(X_train, y_train)
```

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

```
rf_classifier.score(X_test,y_test)
```

```
0.8451113262342691
```

```
y_pred = rf_classifier.predict(X_test)
```

```
print("Classification Report: \n", classification_report(y_test, y_pred))
```

```
Classification Report:
              precision    recall  f1-score   support

           0       0.87      0.81      0.84      1033
           1       0.82      0.88      0.85      1033

    accuracy                           0.85      2066
   macro avg       0.85      0.85      0.84      2066
weighted avg       0.85      0.85      0.84      2066
```