

churn-modelling-using-cnn

March 25, 2024

```
[1]: import numpy as np
import pandas as pd
import tensorflow as tf
tf.__version__
```

```
C:\Users\happy\anaconda3\lib\site-packages\scipy\__init__.py:155: UserWarning: A
NumPy version >=1.18.5 and <1.25.0 is required for this version of SciPy
(detected version 1.26.4
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}")
```

```
[1]: '2.16.1'
```

```
[2]: dataset = pd.read_csv('WA_Fn-UseC_-Telco-Customer-Churn.csv')
```

```
[3]: dataset.columns
```

```
[3]: Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
         'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
         'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
         'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
         'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
        dtype='object')
```

```
[4]: dataset = dataset[dataset.TotalCharges!=' ']
dataset.shape
```

```
[4]: (7032, 21)
```

```
[5]: dataset.head()
```

```
[5]:   customerID  gender  SeniorCitizen  Partner  Dependents  tenure  PhoneService  \
0  7590-VHVEG  Female              0     Yes           No         1           No
1  5575-GNVDE   Male              0     No           No        34           Yes
2  3668-QPYBK   Male              0     No           No         2           Yes
3  7795-CFOCW   Male              0     No           No        45           No
4  9237-HQITU  Female              0     No           No         2           Yes
```

```
MultipleLines  InternetService  OnlineSecurity  ...  DeviceProtection  \
```

0	No phone service	DSL	No	...	No
1	No	DSL	Yes	...	Yes
2	No	DSL	Yes	...	No
3	No phone service	DSL	Yes	...	Yes
4	No	Fiber optic	No	...	No

	TechSupport	StreamingTV	StreamingMovies	Contract	PaperlessBilling	\
0	No	No	No	Month-to-month	Yes	
1	No	No	No	One year	No	
2	No	No	No	Month-to-month	Yes	
3	Yes	No	No	One year	No	
4	No	No	No	Month-to-month	Yes	

	PaymentMethod	MonthlyCharges	TotalCharges	Churn
0	Electronic check	29.85	29.85	No
1	Mailed check	56.95	1889.5	No
2	Mailed check	53.85	108.15	Yes
3	Bank transfer (automatic)	42.30	1840.75	No
4	Electronic check	70.70	151.65	Yes

[5 rows x 21 columns]

1 PREPROCESSING

```
[6]: dataset.TotalCharges = pd.to_numeric(dataset.TotalCharges)
```

```
[7]: dataset.TotalCharges.dtype
```

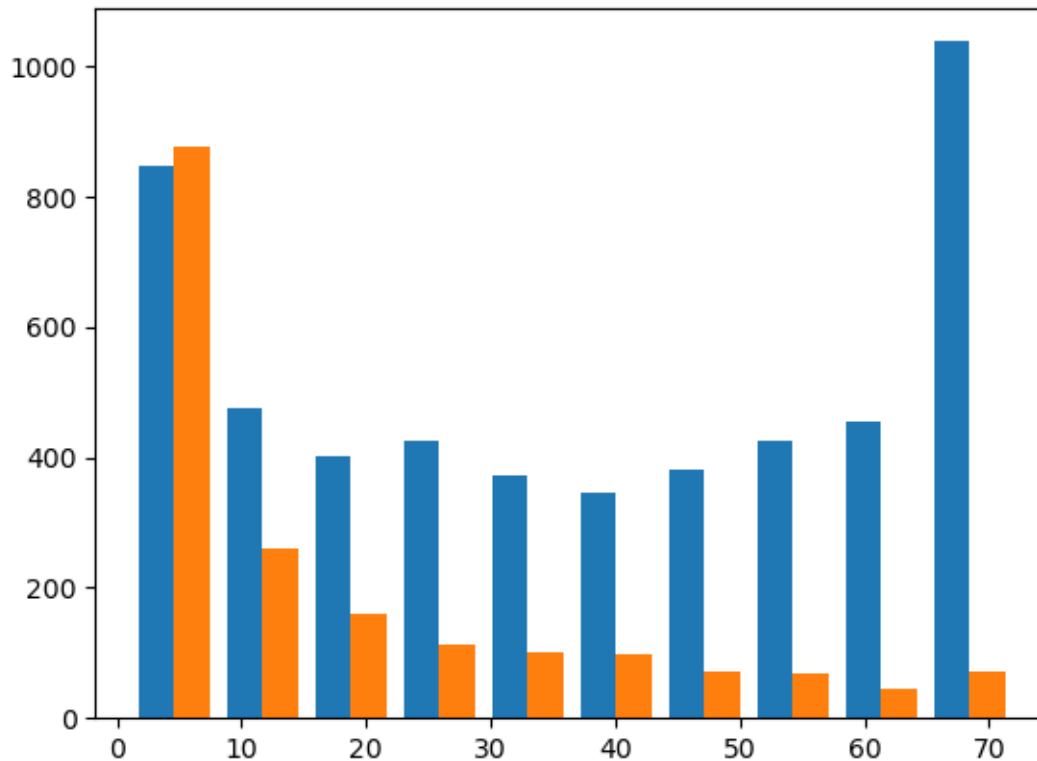
```
[7]: dtype('float64')
```

```
[8]: import matplotlib.pyplot as plt
```

```
[9]: tenure_churn_no = dataset[dataset.Churn=='No'].tenure
tenure_churn_yes = dataset[dataset.Churn=='Yes'].tenure

plt.hist([tenure_churn_no, tenure_churn_yes])
```

```
[9]: (array([[ 847.,  476.,  402.,  424.,  371.,  346.,  380.,  425.,  455.,
            1037.],
            [ 877.,  259.,  159.,  114.,  102.,   98.,   72.,   70.,   46.,
            72.]]),
array([ 1. ,  8.1, 15.2, 22.3, 29.4, 36.5, 43.6, 50.7, 57.8, 64.9, 72. ]),
<a list of 2 BarContainer objects>)
```



```
[10]: dataset.replace('No internet service', 'No', inplace=True)
dataset.replace('No phone service', 'No', inplace=True)
```

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

```
[12]: uniqueCV(dataset)
```

```
customerID : ['7590-VHVEG' '5575-GNVDE' '3668-QPYBK' ... '4801-JZAZL'
'8361-LTMKD'
'3186-AJIEK']
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']
```

```
[13]: yes_no_columns = ['Partner',
                        ↪ 'Dependents', 'PhoneService', 'MultipleLines', 'OnlineSecurity',
                        ↪ 'OnlineBackup', 'DeviceProtection', 'TechSupport', 'StreamingTV', 'StreamingMovies',
                        ↪ 'PaperlessBilling', 'Churn']
for col in yes_no_columns:
    dataset[col].replace({'Yes': 1, 'No' : 0}, inplace=True)
```

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

```
[15]: dataset['gender'].unique()
```

```
[15]: array([1, 0], dtype=int64)
```

```
[16]: df2 = pd.get_dummies(data=dataset,
                        ↪ columns=['InternetService', 'Contract', 'PaymentMethod'])
df2.columns
```

```
[16]: Index(['customerID', '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')
```

```
[17]: cols_to_scale = ['tenure', 'MonthlyCharges', 'TotalCharges']

from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()

df2[cols_to_scale] = scaler.fit_transform(df2[cols_to_scale])
```

```
[18]: df2 = df2.drop('customerID', axis=1)
```

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

2 CNN

```
[20]: pip install tensorflow
```

```
Requirement already satisfied: tensorflow in c:\users\happy\anaconda3\lib\site-
packages (2.16.1)
Requirement already satisfied: tensorflow-intel==2.16.1 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow) (2.16.1)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (0.31.0)
Requirement already satisfied: typing-extensions>=3.6.6 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (4.3.0)
Requirement already satisfied: packaging in c:\users\happy\anaconda3\lib\site-
packages (from tensorflow-intel==2.16.1->tensorflow) (21.3)
Requirement already satisfied: absl-py>=1.0.0 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (2.1.0)
Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (0.5.4)
Requirement already satisfied: google-pasta>=0.1.1 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (0.2.0)
Requirement already satisfied: libclang>=13.0.0 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (18.1.1)
Requirement already satisfied:
protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.20.3
in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (4.25.3)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (1.62.1)
Requirement already satisfied: numpy<2.0.0,>=1.23.5 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (1.26.4)
Requirement already satisfied: keras>=3.0.0 in
c:\users\happy\anaconda3\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (3.1.1)
Requirement already satisfied: six>=1.12.0 in c:\users\happy\anaconda3\lib\site-
packages (from tensorflow-intel==2.16.1->tensorflow) (1.16.0)
Requirement already satisfied: h5py>=3.10.0 in
```

c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (3.10.0)

Requirement already satisfied: astunparse>=1.6.0 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.6.3)

Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (3.3.0)

Requirement already satisfied: setuptools in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (63.4.1)

Requirement already satisfied: ml-dtypes~=0.3.1 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (0.3.2)

Requirement already satisfied: termcolor>=1.1.0 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.4.0)

Requirement already satisfied: tensorboard<2.17,>=2.16 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.16.2)

Requirement already satisfied: wrapt>=1.11.0 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.14.1)

Requirement already satisfied: requests<3,>=2.21.0 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.28.1)

Requirement already satisfied: flatbuffers>=23.5.26 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (24.3.7)

Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\happy\anaconda3\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.16.1->tensorflow) (0.37.1)

Requirement already satisfied: optree in c:\users\happy\anaconda3\lib\site-packages (from keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (0.10.0)

Requirement already satisfied: namex in c:\users\happy\anaconda3\lib\site-packages (from keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (0.0.7)

Requirement already satisfied: rich in c:\users\happy\anaconda3\lib\site-packages (from keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (13.7.1)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\happy\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (1.26.11)

Requirement already satisfied: certifi>=2017.4.17 in c:\users\happy\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2022.9.14)

Requirement already satisfied: idna<4,>=2.5 in c:\users\happy\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (3.3)

Requirement already satisfied: charset-normalizer<3,>=2 in c:\users\happy\anaconda3\lib\site-packages (from

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requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2.0.4)
Requirement already satisfied: markdown>=2.6.8 in
c:\users\happy\anaconda3\lib\site-packages (from
tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (3.3.4)
Requirement already satisfied: werkzeug>=1.0.1 in
c:\users\happy\anaconda3\lib\site-packages (from
tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (2.0.3)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in
c:\users\happy\anaconda3\lib\site-packages (from
tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (0.7.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
c:\users\happy\anaconda3\lib\site-packages (from packaging->tensorflow-
intel==2.16.1->tensorflow) (3.0.9)
Requirement already satisfied: markdown-it-py>=2.2.0 in
c:\users\happy\anaconda3\lib\site-packages (from rich->keras>=3.0.0->tensorflow-
intel==2.16.1->tensorflow) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in
c:\users\happy\anaconda3\lib\site-packages (from rich->keras>=3.0.0->tensorflow-
intel==2.16.1->tensorflow) (2.17.2)
Requirement already satisfied: mdurl~=0.1 in c:\users\happy\anaconda3\lib\site-
packages (from markdown-it-py>=2.2.0->rich->keras>=3.0.0->tensorflow-
intel==2.16.1->tensorflow) (0.1.2)
Note: you may need to restart the kernel to use updated packages.

```

[21]: `pip install --upgrade tensorflow`

```

Requirement already satisfied: tensorflow in c:\users\happy\anaconda3\lib\site-
packages (2.16.1)
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Requirement already satisfied: protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.20.3 in c:\users\happy\anaconda3\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (4.25.3)
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c:\users\happy\anaconda3\lib\site-packages (from
tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (2.0.3)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in
c:\users\happy\anaconda3\lib\site-packages (from
tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (0.7.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in
c:\users\happy\anaconda3\lib\site-packages (from packaging->tensorflow-
intel==2.16.1->tensorflow) (3.0.9)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in
c:\users\happy\anaconda3\lib\site-packages (from rich->keras>=3.0.0->tensorflow-
intel==2.16.1->tensorflow) (2.17.2)
Requirement already satisfied: markdown-it-py>=2.2.0 in
c:\users\happy\anaconda3\lib\site-packages (from rich->keras>=3.0.0->tensorflow-
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Requirement already satisfied: mdurl~=0.1 in c:\users\happy\anaconda3\lib\site-
packages (from markdown-it-py>=2.2.0->rich->keras>=3.0.0->tensorflow-
intel==2.16.1->tensorflow) (0.1.2)
Note: you may need to restart the kernel to use updated packages.

```

```

[22]: import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv1D, MaxPooling1D, Flatten, Dense,
Dropout

```

```

X_train = np.random.randn(1000, 100, 1)
y_train = np.random.randint(2, size=(1000,))
X_test = np.random.randn(200, 100, 1)
y_test = np.random.randint(2, size=(200,))

input_shape = X_train.shape[1:]

model = Sequential([
    Conv1D(filters=32, kernel_size=3, activation='relu',
    ↪input_shape=input_shape),
    MaxPooling1D(pool_size=2),
    Conv1D(filters=64, kernel_size=3, activation='relu'),
    MaxPooling1D(pool_size=2),
    Flatten(),
    Dense(64, activation='relu'),
    Dropout(0.5),
    Dense(1, activation='sigmoid')
])

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

model.fit(X_train, y_train, epochs=10, batch_size=32, validation_split=0.2)

loss, accuracy = model.evaluate(X_test, y_test)
print(f'Test Loss: {loss}, Test Accuracy: {accuracy}')

predictions = model.predict(X_test)

```

C:\Users\happy\anaconda3\lib\site-packages\keras\src\layers\convolutional\base_conv.py:99: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

```
super().__init__()
```

Epoch 1/10

25/25 1s 12ms/step -

accuracy: 0.4700 - loss: 0.7487 - val_accuracy: 0.5350 - val_loss: 0.6914

Epoch 2/10

25/25 0s 5ms/step -

accuracy: 0.4809 - loss: 0.6956 - val_accuracy: 0.5200 - val_loss: 0.6928

Epoch 3/10

25/25 0s 5ms/step -

accuracy: 0.5546 - loss: 0.6893 - val_accuracy: 0.5000 - val_loss: 0.6925

Epoch 4/10

```
25/25          0s 5ms/step -  
accuracy: 0.5672 - loss: 0.6821 - val_accuracy: 0.5050 - val_loss: 0.6905  
Epoch 5/10  
25/25          0s 5ms/step -  
accuracy: 0.5674 - loss: 0.6796 - val_accuracy: 0.5200 - val_loss: 0.6945  
Epoch 6/10  
25/25          0s 4ms/step -  
accuracy: 0.6284 - loss: 0.6736 - val_accuracy: 0.5350 - val_loss: 0.7033  
Epoch 7/10  
25/25          0s 5ms/step -  
accuracy: 0.5893 - loss: 0.6638 - val_accuracy: 0.4900 - val_loss: 0.7021  
Epoch 8/10  
25/25          0s 5ms/step -  
accuracy: 0.6536 - loss: 0.6408 - val_accuracy: 0.4750 - val_loss: 0.7123  
Epoch 9/10  
25/25          0s 5ms/step -  
accuracy: 0.6772 - loss: 0.6183 - val_accuracy: 0.5050 - val_loss: 0.7338  
Epoch 10/10  
25/25          0s 5ms/step -  
accuracy: 0.7027 - loss: 0.5910 - val_accuracy: 0.4950 - val_loss: 0.7444  
7/7           0s 2ms/step -  
accuracy: 0.5454 - loss: 0.7200  
Test Loss: 0.7520162463188171, Test Accuracy: 0.48500001430511475  
7/7           0s 11ms/step
```