Lending Club Loan Data Analysis

Import libraries

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense,Dropout
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.models import load_model
from sklearn.metrics import confusion_matrix, classification_report
from pickle import dump, load
%matplotlib inline
```

In [2]:

```
df = pd.read_csv('loan_data.csv')
```

In [3]:

```
df.info()
df.head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9578 entries, 0 to 9577
Data columns (total 14 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   credit.policy      9578 non-null   int64  
 1   purpose            9578 non-null   object 
 2   int.rate           9578 non-null   float64
 3   installment        9578 non-null   float64
 4   log.annual.inc     9578 non-null   float64
 5   dti                9578 non-null   float64
 6   fico               9578 non-null   int64  
 7   days.with.cr.line  9578 non-null   float64
 8   revol.bal          9578 non-null   int64  
 9   revol.util         9578 non-null   float64
 10  inq.last.6mths     9578 non-null   int64  
 11  delinq.2yrs        9578 non-null   int64  
 12  pub.rec            9578 non-null   int64  
 13  not.fully.paid     9578 non-null   int64  
dtypes: float64(6), int64(7), object(1)
memory usage: 1.0+ MB
```

Out[3]:

	credit.policy	purpose	int.rate	installment	log.annual.inc	dti	fico	days.with.cr.line
0	1	debt_consolidation	0.1189	829.10	11.350407	19.48	737	5639.958333
1	1	credit_card	0.1071	228.22	11.082143	14.29	707	2760.000000
2	1	debt_consolidation	0.1357	366.86	10.373491	11.63	682	4710.000000
3	1	debt_consolidation	0.1008	162.34	11.350407	8.10	712	2699.958333
4	1	credit_card	0.1426	102.92	11.299732	14.97	667	4066.000000

In [4]:

```
df.describe().transpose()
```

Out[4]:

	count	mean	std	min	25%	50%	
credit.policy	9578.0	0.804970	0.396245	0.000000	1.000000	1.000000	1.000
int.rate	9578.0	0.122640	0.026847	0.060000	0.103900	0.122100	0.140
installment	9578.0	319.089413	207.071301	15.670000	163.770000	268.950000	432.762
log.annual.inc	9578.0	10.932117	0.614813	7.547502	10.558414	10.928884	11.291
dti	9578.0	12.606679	6.883970	0.000000	7.212500	12.665000	17.950
fico	9578.0	710.846314	37.970537	612.000000	682.000000	707.000000	737.000
days.with.cr.line	9578.0	4560.767197	2496.930377	178.958333	2820.000000	4139.958333	5730.000
revol.bal	9578.0	16913.963876	33756.189557	0.000000	3187.000000	8596.000000	18249.500
revol.util	9578.0	46.799236	29.014417	0.000000	22.600000	46.300000	70.900
inq.last.6mths	9578.0	1.577469	2.200245	0.000000	0.000000	1.000000	2.000
delinq.2yrs	9578.0	0.163708	0.546215	0.000000	0.000000	0.000000	0.000
pub.rec	9578.0	0.062122	0.262126	0.000000	0.000000	0.000000	0.000
not.fully.paid	9578.0	0.160054	0.366676	0.000000	0.000000	0.000000	0.000

In [5]:

```
df['not.fully.paid'].isnull().mean()
```

Out[5]:

```
0.0
```

In [6]:

```
df1=pd.get_dummies(df, columns=['purpose'])
```

In [7]:

```
df1['log.annual.inc'] = np.exp(df1['log.annual.inc'])
```

In [8]:

```
df1.head()
```

Out[8]:

	credit.policy	int.rate	installment	log.annual.inc	dti	fico	days.with.cr.line	revol.bal	revol.ut
0	1	0.1189	829.10	85000.000385	19.48	737	5639.958333	28854	52.
1	1	0.1071	228.22	65000.000073	14.29	707	2760.000000	33623	76.
2	1	0.1357	366.86	31999.999943	11.63	682	4710.000000	3511	25.
3	1	0.1008	162.34	85000.000385	8.10	712	2699.958333	33667	73.
4	1	0.1426	102.92	80799.999636	14.97	667	4066.000000	4740	39.

In [9]:

```
df.groupby('not.fully.paid')['not.fully.paid'].count()/len(df)
```

Out[9]:

```
not.fully.paid
0    0.839946
```

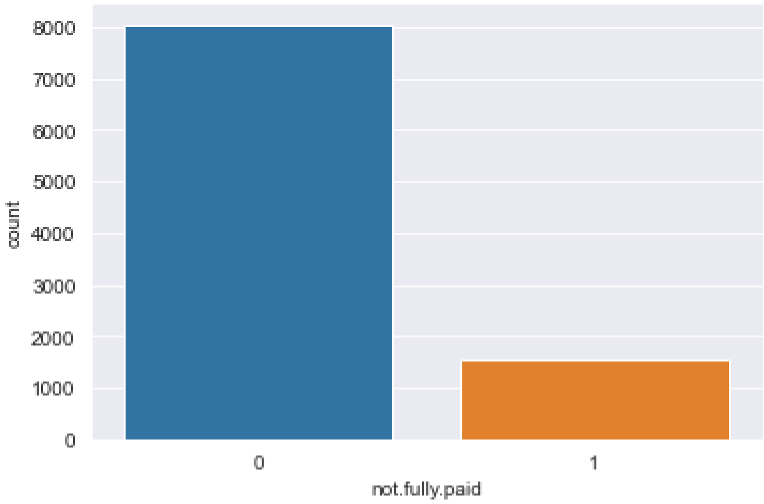
```
1    0.160054
Name: not.fully.paid, dtype: float64
```

In [10]:

```python
sns.set_style('darkgrid')
sns.countplot(x='not.fully.paid', data=df)
```

Out[10]:

```
<AxesSubplot:xlabel='not.fully.paid', ylabel='count'>
```



In [11]:

```python
count_class_0, count_class_1 = df['not.fully.paid'].value_counts()
```

In [12]:

```python
df_0 = df[df['not.fully.paid'] == 0]
df_1 = df[df['not.fully.paid'] == 1]
```

In [13]:

```python
df_1_over = df_1.sample(count_class_0, replace=True)
df_test_over = pd.concat([df_0, df_1_over], axis=0)
```

In [14]:

```python
print('Random over-sampling:')
print(df_test_over['not.fully.paid'].value_counts())
```

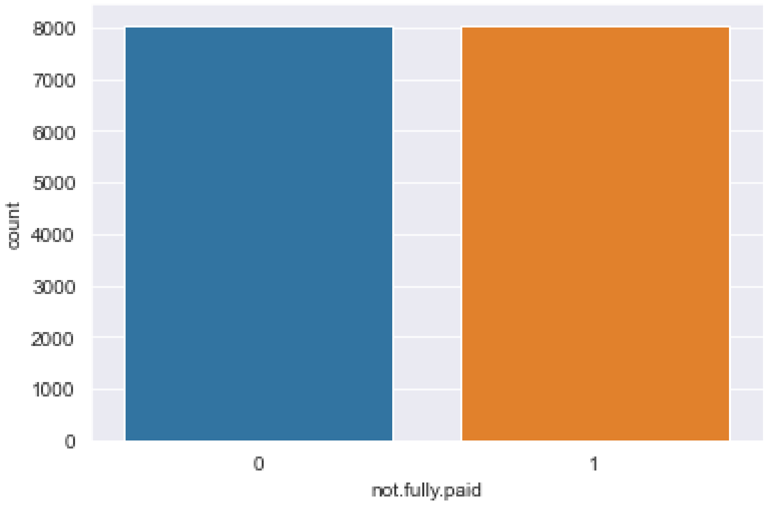
```
Random over-sampling:
0    8045
1    8045
Name: not.fully.paid, dtype: int64
```

In [15]:

```python
sns.set_style('darkgrid')
sns.countplot(x='not.fully.paid', data=df_test_over)
```

Out[15]:

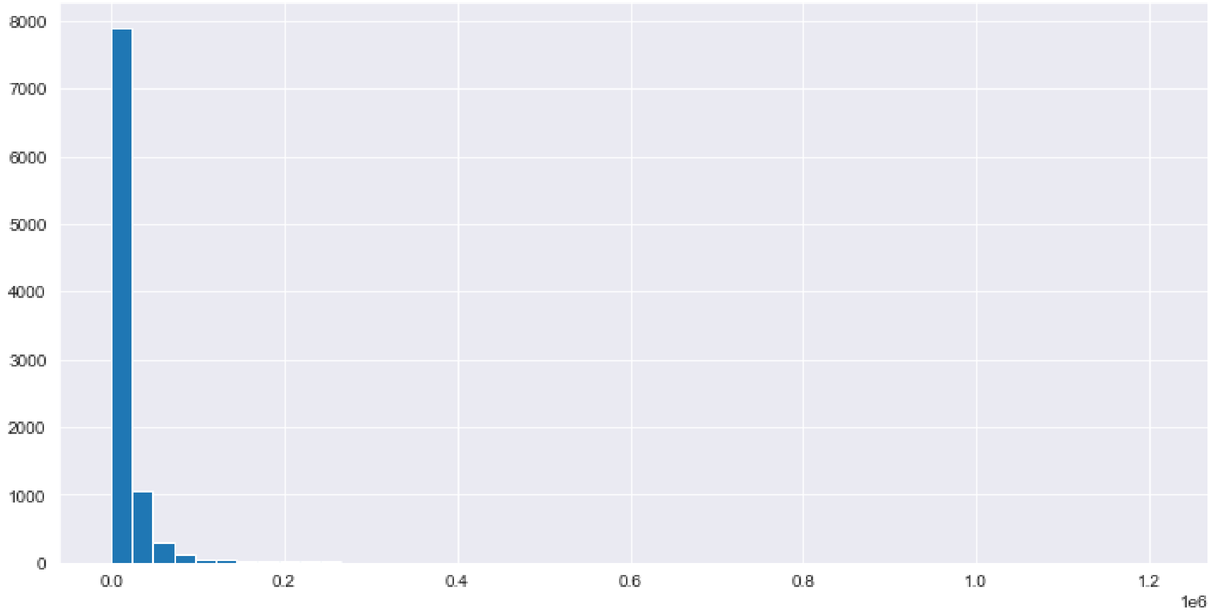
```
<AxesSubplot:xlabel='not.fully.paid', ylabel='count'>
```



In [16]:

```
df['revol.bal'].hist(figsize=[12,6], bins=50)
```

Out[16]: <AxesSubplot:>



In [17]:

```
df1=pd.get_dummies(df, columns=['purpose'])
```

In [18]:

```
plt.figure(figsize=(10,6))
df[df['credit.policy']==1]['fico'].hist(alpha=0.5,color='blue',bins=30,label='Credit
df[df['credit.policy']==0]['fico'].hist(alpha=0.5,color='red',bins=30,label='Credit.
plt.legend()
plt.xlabel('FICO')
```

Out[18]: Text(0.5, 0, 'FICO')

In [19]:

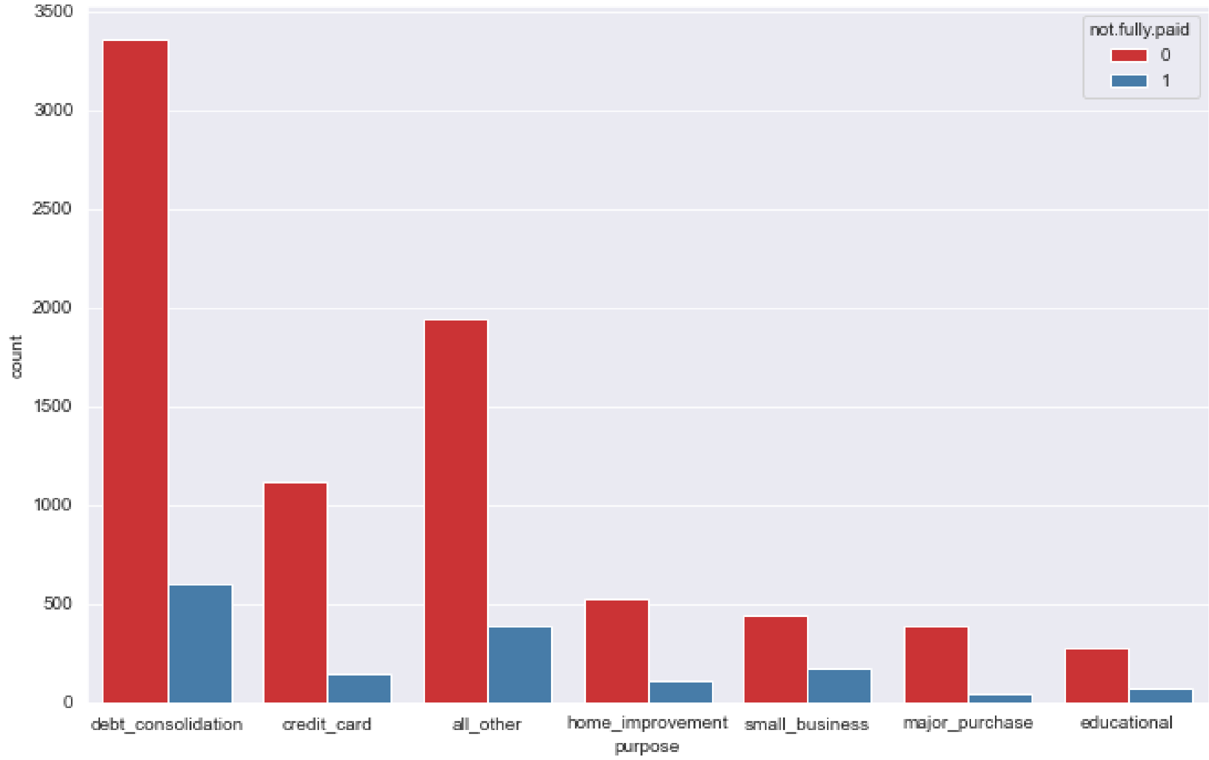
```
plt.figure(figsize=(10,6))
df[df['not.fully.paid']==1]['fico'].hist(alpha=0.5,color='blue',
                                          bins=30,label='not.fully.paid=1')
df[df['not.fully.paid']==0]['fico'].hist(alpha=0.5,color='red',
                                          bins=30,label='not.fully.paid=0')
plt.legend()
plt.xlabel('FICO')
```

Out[19]: Text(0.5, 0, 'FICO')

In [20]:

```
plt.figure(figsize=(11,7))
sns.countplot(x='purpose',hue='not.fully.paid',data=df,palette='Set1')
```

Out[20]: <AxesSubplot:xlabel='purpose', ylabel='count'>



In [21]:

```
sns.jointplot(x='fico',y='int.rate',data=df,color='purple')
```

Out[21]: <seaborn.axisgrid.JointGrid at 0x208261bd460>

In [22]:

```
plt.figure(figsize=(11,7))
sns.lmplot(y='int.rate',x='fico',data=df,hue='credit.policy',
           col='not.fully.paid',palette='Set1')
```

Out[22]: <seaborn.axisgrid.FacetGrid at 0x2082785c850>

<Figure size 792x504 with 0 Axes>

In [23]:

```
cat_feats = ['purpose']
```

In [24]:

```
final_data = pd.get_dummies(df_test_over,columns=cat_feats,drop_first=True)
```

In [25]:

```
final_data.info()
final_data.head()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 16090 entries, 0 to 5248
Data columns (total 19 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   credit.policy               16090 non-null  int64
 1   int.rate                    16090 non-null  float64
 2   installment                 16090 non-null  float64
 3   log.annual.inc              16090 non-null  float64
 4   dti                         16090 non-null  float64
 5   fico                        16090 non-null  int64
 6   days.with.cr.line           16090 non-null  float64
 7   revol.bal                   16090 non-null  int64
 8   revol.util                  16090 non-null  float64
 9   inq.last.6mths              16090 non-null  int64
 10  delinq.2yrs                 16090 non-null  int64
 11  pub.rec                     16090 non-null  int64
 12  not.fully.paid              16090 non-null  int64
 13  purpose_credit_card         16090 non-null  uint8
 14  purpose_debt_consolidation  16090 non-null  uint8
 15  purpose_educational         16090 non-null  uint8
 16  purpose_home_improvement    16090 non-null  uint8
 17  purpose_major_purchase      16090 non-null  uint8
 18  purpose_small_business      16090 non-null  uint8
dtypes: float64(6), int64(7), uint8(6)
memory usage: 2.3 MB
```

Out[25]:

	credit.policy	int.rate	installment	log.annual.inc	dti	fico	days.with.cr.line	revol.bal	revol.ut
0	1	0.1189	829.10	11.350407	19.48	737	5639.958333	28854	52.
1	1	0.1071	228.22	11.082143	14.29	707	2760.000000	33623	76.
2	1	0.1357	366.86	10.373491	11.63	682	4710.000000	3511	25.
3	1	0.1008	162.34	11.350407	8.10	712	2699.958333	33667	73.

	credit.policy	int.rate	installment	log.annual.inc	dti	fico	days.with.cr.line	revol.bal	revol.ut
4	1	0.1426	102.92	11.299732	14.97	667	4066.000000	4740	39.

In [26]:

```
final_data.corr()
```

Out[26]:

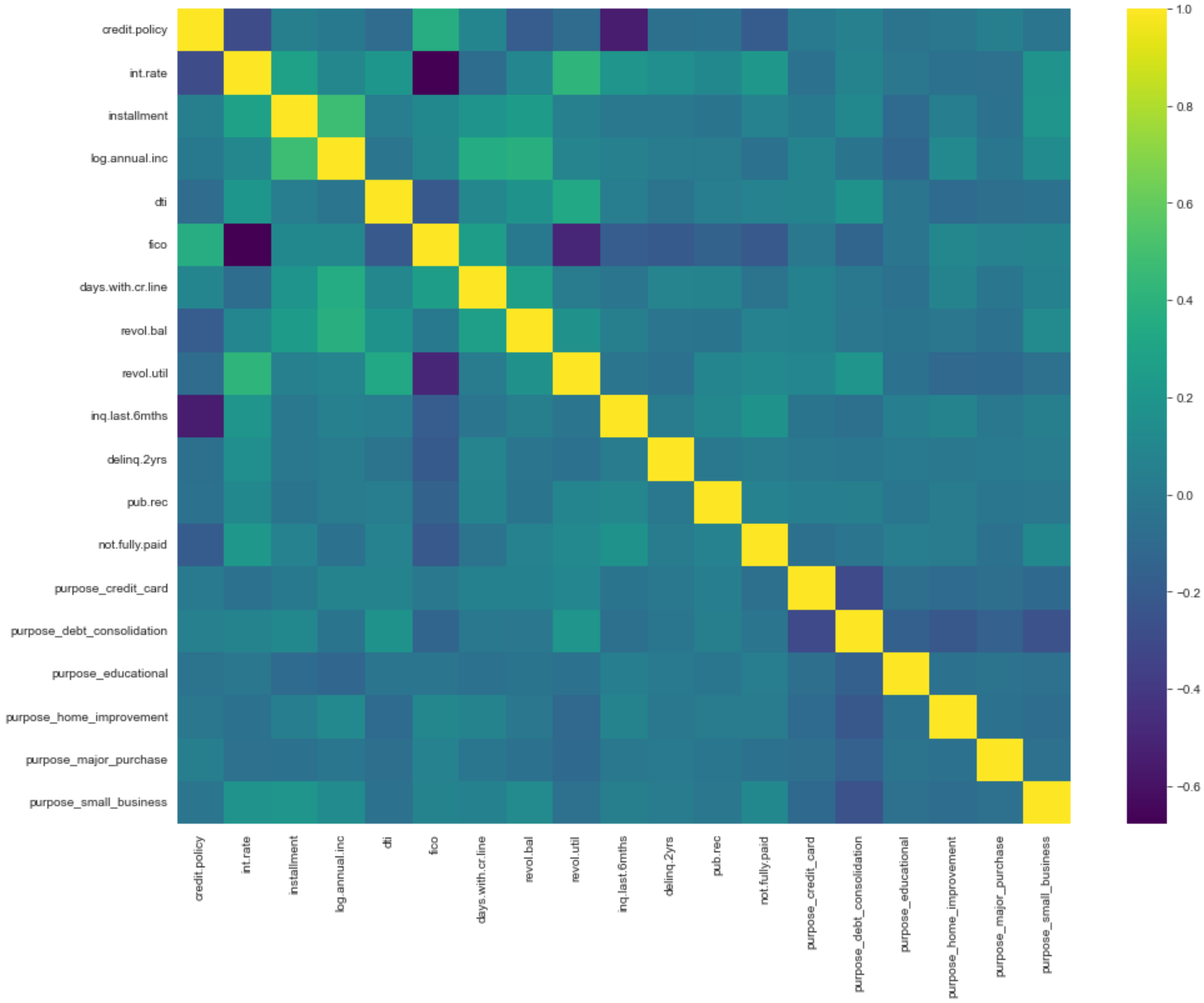
	credit.policy	int.rate	installment	log.annual.inc	dti	fic
credit.policy	1.000000	-0.292936	0.041604	-0.001350	-0.090071	0.36916
int.rate	-0.292936	1.000000	0.276567	0.096911	0.204188	-0.67861
installment	0.041604	0.276567	1.000000	0.474633	0.026456	0.10811
log.annual.inc	-0.001350	0.096911	0.474633	1.000000	-0.027900	0.10105
dti	-0.090071	0.204188	0.026456	-0.027900	1.000000	-0.21840
fico	0.369161	-0.678610	0.108112	0.101053	-0.218408	1.00000
days.with.cr.line	0.083334	-0.088130	0.187013	0.351656	0.101006	0.24754
revol.bal	-0.192345	0.089382	0.244833	0.383079	0.167429	0.00274
revol.util	-0.092568	0.413014	0.048807	0.075584	0.327976	-0.49831
inq.last.6mths	-0.548311	0.193937	-0.008135	0.045589	0.029469	-0.19039
delinq.2yrs	-0.067099	0.150418	-0.003552	0.019765	-0.037132	-0.20808
pub.rec	-0.053369	0.103463	-0.034209	0.012777	0.024347	-0.16018
not.fully.paid	-0.199075	0.215752	0.066307	-0.045227	0.057253	-0.21514
purpose_credit_card	0.004447	-0.046707	-0.003196	0.070919	0.073972	-0.00765
purpose_debt_consolidation	0.047619	0.069952	0.107542	-0.034128	0.178502	-0.13780
purpose_educational	-0.036258	-0.013537	-0.096777	-0.122052	-0.026607	-0.02306
purpose_home_improvement	-0.012949	-0.049965	0.033758	0.110007	-0.095456	0.09893
purpose_major_purchase	0.040188	-0.056724	-0.047970	-0.018209	-0.073832	0.05966
purpose_small_business	-0.023047	0.186254	0.195330	0.122265	-0.051991	0.07459

In [27]:

```
plt.figure(figsize=[16,12])
sns.heatmap(
        data=final_data.corr(),
        cmap='viridis',
        annot=False,
        fmt='.2g')
```

Out[27]:

```
<AxesSubplot:>
```



In [28]:

```
to_drop2 = ['revol.bal', 'days.with.cr.line', 'installment', 'revol.bal']
final_data.drop(to_drop2, axis=1, inplace=True)
```

In [29]:

```
final_data.isnull().mean()
```

Out[29]:

```
credit.policy                 0.0
int.rate                      0.0
log.annual.inc                0.0
dti                           0.0
fico                          0.0
revol.util                    0.0
inq.last.6mths                0.0
delinq.2yrs                   0.0
pub.rec                       0.0
not.fully.paid                0.0
purpose_credit_card           0.0
purpose_debt_consolidation    0.0
purpose_educational           0.0
purpose_home_improvement      0.0
purpose_major_purchase        0.0
purpose_small_business        0.0
dtype: float64
```

In [30]:

```
to_train = final_data[final_data['not.fully.paid'].isin([0,1])]
to_pred = final_data[final_data['not.fully.paid'] == 2]
```

In [31]:

```
X = to_train.drop('not.fully.paid', axis=1).values
y = to_train['not.fully.paid'].values
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_stat
```

In [32]:

```
scaler = MinMaxScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

In [33]:

```
X_train.shape
```

Out[33]:

```
(11263, 15)
```

In [34]:

```
model = Sequential()
model.add(Dense(94, activation='relu'))
model.add(Dense(30, activation='relu'))
model.add(Dense(15, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.compile(
        optimizer='adam',
        loss='binary_crossentropy',
        metrics=['accuracy'])
```

In [35]:

```
early_stop = EarlyStopping(
        monitor='val_loss',
        mode='min',
        verbose=1,
        patience=25)
model.fit(
        X_train,
        y_train,
        epochs=200,
        batch_size=256,
        validation_data=(X_test, y_test),
         callbacks=[early_stop])
```

```
Epoch 1/200
44/44 [==============================] - 4s 48ms/step - loss: 0.6829 - accuracy: 0.5
655 - val_loss: 0.6681 - val_accuracy: 0.6045
Epoch 2/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6513 - accuracy: 0.62
02 - val_loss: 0.6507 - val_accuracy: 0.6049
Epoch 3/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6421 - accuracy: 0.62
41 - val_loss: 0.6480 - val_accuracy: 0.6134
Epoch 4/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6389 - accuracy: 0.62
62 - val_loss: 0.6457 - val_accuracy: 0.6161
Epoch 5/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6364 - accuracy: 0.6
282 - val_loss: 0.6433 - val_accuracy: 0.6147
Epoch 6/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6347 - accuracy: 0.63
16 - val_loss: 0.6427 - val_accuracy: 0.6261
Epoch 7/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6329 - accuracy: 0.63
13 - val_loss: 0.6413 - val_accuracy: 0.6196
Epoch 8/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6339 - accuracy: 0.63
25 - val_loss: 0.6420 - val_accuracy: 0.6184
Epoch 9/200
```

```
44/44 [==============================] - 0s 9ms/step - loss: 0.6308 - accuracy: 0.63
54 - val_loss: 0.6385 - val_accuracy: 0.6232
Epoch 10/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6296 - accuracy: 0.63
54 - val_loss: 0.6423 - val_accuracy: 0.6225
Epoch 11/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6286 - accuracy: 0.63
55 - val_loss: 0.6373 - val_accuracy: 0.6248
Epoch 12/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6266 - accuracy: 0.63
80 - val_loss: 0.6360 - val_accuracy: 0.6277
Epoch 13/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6252 - accuracy: 0.63
94 - val_loss: 0.6360 - val_accuracy: 0.6283
Epoch 14/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6259 - accuracy: 0.63
69 - val_loss: 0.6380 - val_accuracy: 0.6252
Epoch 15/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6244 - accuracy: 0.64
08 - val_loss: 0.6340 - val_accuracy: 0.6325
Epoch 16/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6264 - accuracy: 0.63
49 - val_loss: 0.6348 - val_accuracy: 0.6285
Epoch 17/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6219 - accuracy: 0.64
03 - val_loss: 0.6339 - val_accuracy: 0.6310
Epoch 18/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6209 - accuracy: 0.64
15 - val_loss: 0.6323 - val_accuracy: 0.6339
Epoch 19/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6203 - accuracy: 0.64
43 - val_loss: 0.6319 - val_accuracy: 0.6321
Epoch 20/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6192 - accuracy: 0.64
30 - val_loss: 0.6349 - val_accuracy: 0.6248
Epoch 21/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6177 - accuracy: 0.6
476 - val_loss: 0.6330 - val_accuracy: 0.6314
Epoch 22/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6170 - accuracy: 0.6
438 - val_loss: 0.6329 - val_accuracy: 0.6321
Epoch 23/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6162 - accuracy: 0.6
425 - val_loss: 0.6297 - val_accuracy: 0.6346
Epoch 24/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6153 - accuracy: 0.64
17 - val_loss: 0.6297 - val_accuracy: 0.6292
Epoch 25/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6127 - accuracy: 0.64
73 - val_loss: 0.6288 - val_accuracy: 0.6350
Epoch 26/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6127 - accuracy: 0.64
93 - val_loss: 0.6328 - val_accuracy: 0.6343
Epoch 27/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6120 - accuracy: 0.65
39 - val_loss: 0.6291 - val_accuracy: 0.6288
Epoch 28/200
44/44 [==============================] - 0s 11ms/step - loss: 0.6107 - accuracy: 0.6
503 - val_loss: 0.6293 - val_accuracy: 0.6292
Epoch 29/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6090 - accuracy: 0.6
503 - val_loss: 0.6295 - val_accuracy: 0.6290
Epoch 30/200
44/44 [==============================] - 0s 11ms/step - loss: 0.6070 - accuracy: 0.6
```

```
523 - val_loss: 0.6295 - val_accuracy: 0.6352
Epoch 31/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6067 - accuracy: 0.65
56 - val_loss: 0.6255 - val_accuracy: 0.6339
Epoch 32/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6066 - accuracy: 0.65
50 - val_loss: 0.6271 - val_accuracy: 0.6356
Epoch 33/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6036 - accuracy: 0.65
88 - val_loss: 0.6257 - val_accuracy: 0.6325
Epoch 34/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6048 - accuracy: 0.65
84 - val_loss: 0.6258 - val_accuracy: 0.6360
Epoch 35/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6040 - accuracy: 0.66
15 - val_loss: 0.6243 - val_accuracy: 0.6391
Epoch 36/200
44/44 [==============================] - 0s 11ms/step - loss: 0.5997 - accuracy: 0.6
648 - val_loss: 0.6236 - val_accuracy: 0.6406
Epoch 37/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6006 - accuracy: 0.66
15 - val_loss: 0.6226 - val_accuracy: 0.6451
Epoch 38/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5993 - accuracy: 0.66
48 - val_loss: 0.6251 - val_accuracy: 0.6420
Epoch 39/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5954 - accuracy: 0.67
26 - val_loss: 0.6218 - val_accuracy: 0.6395
Epoch 40/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5977 - accuracy: 0.66
60 - val_loss: 0.6210 - val_accuracy: 0.6462
Epoch 41/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5946 - accuracy: 0.67
24 - val_loss: 0.6187 - val_accuracy: 0.6486
Epoch 42/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5941 - accuracy: 0.67
13 - val_loss: 0.6198 - val_accuracy: 0.6437
Epoch 43/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5935 - accuracy: 0.6
706 - val_loss: 0.6213 - val_accuracy: 0.6387
Epoch 44/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5907 - accuracy: 0.67
42 - val_loss: 0.6224 - val_accuracy: 0.6455
Epoch 45/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5904 - accuracy: 0.67
21 - val_loss: 0.6193 - val_accuracy: 0.6433
Epoch 46/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5861 - accuracy: 0.68
19 - val_loss: 0.6210 - val_accuracy: 0.6352
Epoch 47/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5882 - accuracy: 0.67
66 - val_loss: 0.6230 - val_accuracy: 0.6443
Epoch 48/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5871 - accuracy: 0.67
72 - val_loss: 0.6225 - val_accuracy: 0.6428
Epoch 49/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5840 - accuracy: 0.68
05 - val_loss: 0.6177 - val_accuracy: 0.6447
Epoch 50/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5821 - accuracy: 0.68
36 - val_loss: 0.6145 - val_accuracy: 0.6493
Epoch 51/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5811 - accuracy: 0.68
24 - val_loss: 0.6169 - val_accuracy: 0.6542
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Epoch 52/200
44/44 [==============================] - 1s 12ms/step - loss: 0.5803 - accuracy: 0.6
823 - val_loss: 0.6153 - val_accuracy: 0.6526
Epoch 53/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5777 - accuracy: 0.68
42 - val_loss: 0.6132 - val_accuracy: 0.6534
Epoch 54/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5760 - accuracy: 0.68
81 - val_loss: 0.6142 - val_accuracy: 0.6511
Epoch 55/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5782 - accuracy: 0.68
75 - val_loss: 0.6120 - val_accuracy: 0.6565
Epoch 56/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5730 - accuracy: 0.68
99 - val_loss: 0.6126 - val_accuracy: 0.6528
Epoch 57/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5730 - accuracy: 0.69
16 - val_loss: 0.6156 - val_accuracy: 0.6501
Epoch 58/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5718 - accuracy: 0.68
79 - val_loss: 0.6128 - val_accuracy: 0.6586
Epoch 59/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5716 - accuracy: 0.68
86 - val_loss: 0.6083 - val_accuracy: 0.6586
Epoch 60/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5700 - accuracy: 0.69
42 - val_loss: 0.6118 - val_accuracy: 0.6493
Epoch 61/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5667 - accuracy: 0.69
61 - val_loss: 0.6109 - val_accuracy: 0.6557
Epoch 62/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5644 - accuracy: 0.70
02 - val_loss: 0.6076 - val_accuracy: 0.6629
Epoch 63/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5632 - accuracy: 0.70
13 - val_loss: 0.6075 - val_accuracy: 0.6559
Epoch 64/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5660 - accuracy: 0.69
32 - val_loss: 0.6105 - val_accuracy: 0.6609
Epoch 65/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5651 - accuracy: 0.69
19 - val_loss: 0.6068 - val_accuracy: 0.6515
Epoch 66/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5637 - accuracy: 0.69
70 - val_loss: 0.6010 - val_accuracy: 0.6700
Epoch 67/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5574 - accuracy: 0.70
59 - val_loss: 0.6029 - val_accuracy: 0.6617
Epoch 68/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5566 - accuracy: 0.70
20 - val_loss: 0.6027 - val_accuracy: 0.6600
Epoch 69/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5545 - accuracy: 0.70
43 - val_loss: 0.6011 - val_accuracy: 0.6712
Epoch 70/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5554 - accuracy: 0.70
12 - val_loss: 0.6047 - val_accuracy: 0.6576
Epoch 71/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5539 - accuracy: 0.70
64 - val_loss: 0.6035 - val_accuracy: 0.6594
Epoch 72/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5523 - accuracy: 0.70
43 - val_loss: 0.6024 - val_accuracy: 0.6582
Epoch 73/200
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44/44 [==============================] - 0s 8ms/step - loss: 0.5493 - accuracy: 0.71
22 - val_loss: 0.6014 - val_accuracy: 0.6569
Epoch 74/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5511 - accuracy: 0.70
48 - val_loss: 0.5988 - val_accuracy: 0.6642
Epoch 75/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5477 - accuracy: 0.71
06 - val_loss: 0.5988 - val_accuracy: 0.6671
Epoch 76/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5474 - accuracy: 0.71
07 - val_loss: 0.5959 - val_accuracy: 0.6631
Epoch 77/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5459 - accuracy: 0.71
26 - val_loss: 0.6009 - val_accuracy: 0.6663
Epoch 78/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5458 - accuracy: 0.70
91 - val_loss: 0.5968 - val_accuracy: 0.6723
Epoch 79/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5418 - accuracy: 0.71
42 - val_loss: 0.5991 - val_accuracy: 0.6629
Epoch 80/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5429 - accuracy: 0.71
08 - val_loss: 0.5970 - val_accuracy: 0.6752
Epoch 81/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5392 - accuracy: 0.71
47 - val_loss: 0.5927 - val_accuracy: 0.6694
Epoch 82/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5403 - accuracy: 0.71
66 - val_loss: 0.6038 - val_accuracy: 0.6663
Epoch 83/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5409 - accuracy: 0.71
07 - val_loss: 0.5967 - val_accuracy: 0.6685
Epoch 84/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5378 - accuracy: 0.71
99 - val_loss: 0.5909 - val_accuracy: 0.6741
Epoch 85/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5347 - accuracy: 0.71
78 - val_loss: 0.5901 - val_accuracy: 0.6750
Epoch 86/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5347 - accuracy: 0.72
20 - val_loss: 0.5921 - val_accuracy: 0.6704
Epoch 87/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5314 - accuracy: 0.72
49 - val_loss: 0.5945 - val_accuracy: 0.6766
Epoch 88/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5327 - accuracy: 0.72
09 - val_loss: 0.5958 - val_accuracy: 0.6675
Epoch 89/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5358 - accuracy: 0.71
80 - val_loss: 0.5954 - val_accuracy: 0.6685
Epoch 90/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5292 - accuracy: 0.72
57 - val_loss: 0.5916 - val_accuracy: 0.6756
Epoch 91/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5273 - accuracy: 0.72
49 - val_loss: 0.5871 - val_accuracy: 0.6760
Epoch 92/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5276 - accuracy: 0.72
82 - val_loss: 0.5880 - val_accuracy: 0.6820
Epoch 93/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5268 - accuracy: 0.72
79 - val_loss: 0.5877 - val_accuracy: 0.6791
Epoch 94/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5255 - accuracy: 0.72
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57 - val_loss: 0.5894 - val_accuracy: 0.6737
Epoch 95/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5234 - accuracy: 0.72
96 - val_loss: 0.5973 - val_accuracy: 0.6710
Epoch 96/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5224 - accuracy: 0.73
05 - val_loss: 0.5880 - val_accuracy: 0.6814
Epoch 97/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5198 - accuracy: 0.73
36 - val_loss: 0.5856 - val_accuracy: 0.6766
Epoch 98/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5206 - accuracy: 0.73
38 - val_loss: 0.5897 - val_accuracy: 0.6826
Epoch 99/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5179 - accuracy: 0.73
49 - val_loss: 0.5897 - val_accuracy: 0.6768
Epoch 100/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5187 - accuracy: 0.73
21 - val_loss: 0.6001 - val_accuracy: 0.6750
Epoch 101/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5192 - accuracy: 0.73
05 - val_loss: 0.5881 - val_accuracy: 0.6874
Epoch 102/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5152 - accuracy: 0.73
46 - val_loss: 0.5866 - val_accuracy: 0.6880
Epoch 103/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5135 - accuracy: 0.73
69 - val_loss: 0.5881 - val_accuracy: 0.6797
Epoch 104/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5130 - accuracy: 0.73
63 - val_loss: 0.5827 - val_accuracy: 0.6843
Epoch 105/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5125 - accuracy: 0.73
60 - val_loss: 0.5820 - val_accuracy: 0.6822
Epoch 106/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5109 - accuracy: 0.73
99 - val_loss: 0.5928 - val_accuracy: 0.6797
Epoch 107/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5094 - accuracy: 0.73
88 - val_loss: 0.5816 - val_accuracy: 0.6814
Epoch 108/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5084 - accuracy: 0.7
406 - val_loss: 0.5858 - val_accuracy: 0.6930
Epoch 109/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5091 - accuracy: 0.74
01 - val_loss: 0.5831 - val_accuracy: 0.6795
Epoch 110/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5068 - accuracy: 0.73
68 - val_loss: 0.5823 - val_accuracy: 0.6888
Epoch 111/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5060 - accuracy: 0.74
27 - val_loss: 0.5852 - val_accuracy: 0.6899
Epoch 112/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5064 - accuracy: 0.74
24 - val_loss: 0.5810 - val_accuracy: 0.6851
Epoch 113/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5045 - accuracy: 0.74
33 - val_loss: 0.5779 - val_accuracy: 0.6915
Epoch 114/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5036 - accuracy: 0.74
31 - val_loss: 0.5814 - val_accuracy: 0.6762
Epoch 115/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5030 - accuracy: 0.74
14 - val_loss: 0.5800 - val_accuracy: 0.6924
```

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Epoch 116/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4987 - accuracy: 0.7
485 - val_loss: 0.5785 - val_accuracy: 0.6866
Epoch 117/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5005 - accuracy: 0.74
09 - val_loss: 0.5797 - val_accuracy: 0.6870
Epoch 118/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4985 - accuracy: 0.74
81 - val_loss: 0.5845 - val_accuracy: 0.6853
Epoch 119/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4987 - accuracy: 0.7
442 - val_loss: 0.5814 - val_accuracy: 0.6882
Epoch 120/200
44/44 [==============================] - 0s 11ms/step - loss: 0.4973 - accuracy: 0.7
470 - val_loss: 0.5848 - val_accuracy: 0.6866
Epoch 121/200
44/44 [==============================] - 0s 11ms/step - loss: 0.4989 - accuracy: 0.7
463 - val_loss: 0.5759 - val_accuracy: 0.6948
Epoch 122/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4968 - accuracy: 0.74
72 - val_loss: 0.5741 - val_accuracy: 0.6957
Epoch 123/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4956 - accuracy: 0.7
495 - val_loss: 0.6200 - val_accuracy: 0.6718
Epoch 124/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5025 - accuracy: 0.74
13 - val_loss: 0.5830 - val_accuracy: 0.6977
Epoch 125/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4949 - accuracy: 0.75
22 - val_loss: 0.5823 - val_accuracy: 0.6961
Epoch 126/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4892 - accuracy: 0.7
568 - val_loss: 0.5844 - val_accuracy: 0.6955
Epoch 127/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4975 - accuracy: 0.75
10 - val_loss: 0.5891 - val_accuracy: 0.6874
Epoch 128/200
44/44 [==============================] - 0s 11ms/step - loss: 0.4933 - accuracy: 0.7
491 - val_loss: 0.5798 - val_accuracy: 0.6926
Epoch 129/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4860 - accuracy: 0.7
563 - val_loss: 0.5735 - val_accuracy: 0.6986
Epoch 130/200
44/44 [==============================] - 1s 11ms/step - loss: 0.4901 - accuracy: 0.7
536 - val_loss: 0.5751 - val_accuracy: 0.6967
Epoch 131/200
44/44 [==============================] - 0s 11ms/step - loss: 0.4881 - accuracy: 0.7
549 - val_loss: 0.5780 - val_accuracy: 0.6928
Epoch 132/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4853 - accuracy: 0.75
56 - val_loss: 0.5725 - val_accuracy: 0.7033
Epoch 133/200
44/44 [==============================] - 0s 11ms/step - loss: 0.4889 - accuracy: 0.7
557 - val_loss: 0.5698 - val_accuracy: 0.6973
Epoch 134/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4827 - accuracy: 0.75
60 - val_loss: 0.5738 - val_accuracy: 0.6959
Epoch 135/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4862 - accuracy: 0.7
533 - val_loss: 0.5696 - val_accuracy: 0.7000
Epoch 136/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4839 - accuracy: 0.75
73 - val_loss: 0.5875 - val_accuracy: 0.6926
Epoch 137/200
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44/44 [==============================] - 0s 9ms/step - loss: 0.4830 - accuracy: 0.75
93 - val_loss: 0.5700 - val_accuracy: 0.6994
Epoch 138/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4775 - accuracy: 0.76
13 - val_loss: 0.5767 - val_accuracy: 0.6953
Epoch 139/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4830 - accuracy: 0.76
05 - val_loss: 0.5708 - val_accuracy: 0.7000
Epoch 140/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4807 - accuracy: 0.76
00 - val_loss: 0.5716 - val_accuracy: 0.6977
Epoch 141/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4787 - accuracy: 0.75
78 - val_loss: 0.5687 - val_accuracy: 0.7027
Epoch 142/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4876 - accuracy: 0.75
16 - val_loss: 0.5906 - val_accuracy: 0.6963
Epoch 143/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4882 - accuracy: 0.75
32 - val_loss: 0.5684 - val_accuracy: 0.6988
Epoch 144/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4829 - accuracy: 0.75
57 - val_loss: 0.5691 - val_accuracy: 0.7000
Epoch 145/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4759 - accuracy: 0.76
44 - val_loss: 0.5683 - val_accuracy: 0.7008
Epoch 146/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4774 - accuracy: 0.75
64 - val_loss: 0.5687 - val_accuracy: 0.7037
Epoch 147/200
44/44 [==============================] - 0s 10ms/step - loss: 0.4741 - accuracy: 0.7
630 - val_loss: 0.5868 - val_accuracy: 0.6973
Epoch 148/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4741 - accuracy: 0.76
33 - val_loss: 0.5713 - val_accuracy: 0.6973
Epoch 149/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4739 - accuracy: 0.76
25 - val_loss: 0.5684 - val_accuracy: 0.7054
Epoch 150/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4720 - accuracy: 0.76
47 - val_loss: 0.5716 - val_accuracy: 0.6977
Epoch 151/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4714 - accuracy: 0.76
50 - val_loss: 0.5732 - val_accuracy: 0.7037
Epoch 152/200
44/44 [==============================] - 0s 7ms/step - loss: 0.4708 - accuracy: 0.76
84 - val_loss: 0.5765 - val_accuracy: 0.7035
Epoch 153/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4682 - accuracy: 0.76
88 - val_loss: 0.5637 - val_accuracy: 0.7058
Epoch 154/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4675 - accuracy: 0.77
21 - val_loss: 0.6008 - val_accuracy: 0.6897
Epoch 155/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4731 - accuracy: 0.76
03 - val_loss: 0.5621 - val_accuracy: 0.7089
Epoch 156/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4678 - accuracy: 0.77
21 - val_loss: 0.5722 - val_accuracy: 0.7054
Epoch 157/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4694 - accuracy: 0.76
68 - val_loss: 0.5822 - val_accuracy: 0.7011
Epoch 158/200
44/44 [==============================] - 0s 7ms/step - loss: 0.4681 - accuracy: 0.76
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63 - val_loss: 0.5666 - val_accuracy: 0.7077
Epoch 159/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4638 - accuracy: 0.76
80 - val_loss: 0.5656 - val_accuracy: 0.7054
Epoch 160/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4645 - accuracy: 0.77
00 - val_loss: 0.5794 - val_accuracy: 0.6992
Epoch 161/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4701 - accuracy: 0.76
44 - val_loss: 0.5675 - val_accuracy: 0.7044
Epoch 162/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4624 - accuracy: 0.77
41 - val_loss: 0.5740 - val_accuracy: 0.7050
Epoch 163/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4630 - accuracy: 0.77
30 - val_loss: 0.5746 - val_accuracy: 0.7011
Epoch 164/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4635 - accuracy: 0.76
90 - val_loss: 0.5824 - val_accuracy: 0.7019
Epoch 165/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4642 - accuracy: 0.77
11 - val_loss: 0.5623 - val_accuracy: 0.7037
Epoch 166/200
44/44 [==============================] - 0s 7ms/step - loss: 0.4639 - accuracy: 0.77
02 - val_loss: 0.5617 - val_accuracy: 0.7102
Epoch 167/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4607 - accuracy: 0.76
96 - val_loss: 0.5913 - val_accuracy: 0.6969
Epoch 168/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4630 - accuracy: 0.77
30 - val_loss: 0.5597 - val_accuracy: 0.7118
Epoch 169/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4585 - accuracy: 0.77
42 - val_loss: 0.5689 - val_accuracy: 0.7093
Epoch 170/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4618 - accuracy: 0.77
24 - val_loss: 0.5691 - val_accuracy: 0.7046
Epoch 171/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4576 - accuracy: 0.77
46 - val_loss: 0.5649 - val_accuracy: 0.7158
Epoch 172/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4548 - accuracy: 0.77
70 - val_loss: 0.5827 - val_accuracy: 0.7079
Epoch 173/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4609 - accuracy: 0.77
10 - val_loss: 0.5633 - val_accuracy: 0.7081
Epoch 174/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4562 - accuracy: 0.77
45 - val_loss: 0.5604 - val_accuracy: 0.7154
Epoch 175/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4544 - accuracy: 0.78
03 - val_loss: 0.5644 - val_accuracy: 0.7089
Epoch 176/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4535 - accuracy: 0.77
80 - val_loss: 0.5587 - val_accuracy: 0.7116
Epoch 177/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4507 - accuracy: 0.78
08 - val_loss: 0.5665 - val_accuracy: 0.7077
Epoch 178/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4526 - accuracy: 0.78
05 - val_loss: 0.5599 - val_accuracy: 0.7077
Epoch 179/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4542 - accuracy: 0.77
74 - val_loss: 0.5859 - val_accuracy: 0.7073
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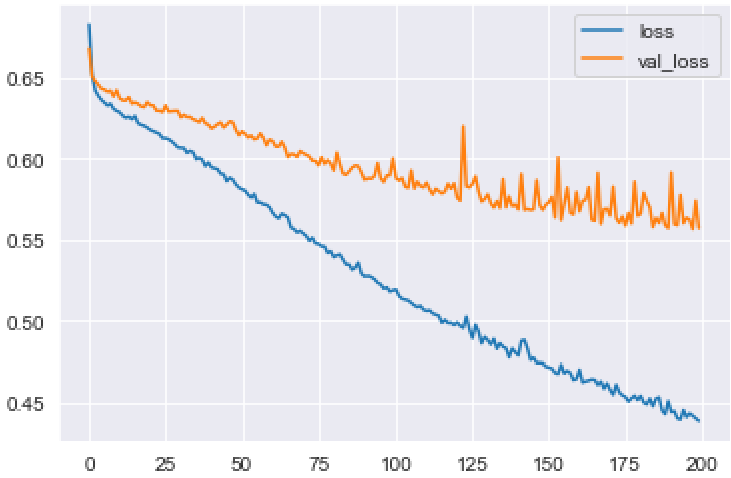
Epoch 180/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4515 - accuracy: 0.77
78 - val_loss: 0.5647 - val_accuracy: 0.7110
Epoch 181/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4541 - accuracy: 0.77
58 - val_loss: 0.5660 - val_accuracy: 0.7145
Epoch 182/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4500 - accuracy: 0.78
24 - val_loss: 0.5790 - val_accuracy: 0.7125
Epoch 183/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4490 - accuracy: 0.78
03 - val_loss: 0.5739 - val_accuracy: 0.7104
Epoch 184/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4524 - accuracy: 0.77
93 - val_loss: 0.5699 - val_accuracy: 0.7108
Epoch 185/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4478 - accuracy: 0.78
24 - val_loss: 0.5578 - val_accuracy: 0.7261
Epoch 186/200
44/44 [==============================] - 0s 7ms/step - loss: 0.4524 - accuracy: 0.77
92 - val_loss: 0.5634 - val_accuracy: 0.7156
Epoch 187/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4532 - accuracy: 0.77
76 - val_loss: 0.5603 - val_accuracy: 0.7220
Epoch 188/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4451 - accuracy: 0.78
48 - val_loss: 0.5665 - val_accuracy: 0.7137
Epoch 189/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4429 - accuracy: 0.78
63 - val_loss: 0.5589 - val_accuracy: 0.7201
Epoch 190/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4509 - accuracy: 0.77
79 - val_loss: 0.5571 - val_accuracy: 0.7230
Epoch 191/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4442 - accuracy: 0.78
18 - val_loss: 0.5915 - val_accuracy: 0.7050
Epoch 192/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4447 - accuracy: 0.78
00 - val_loss: 0.5596 - val_accuracy: 0.7236
Epoch 193/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4402 - accuracy: 0.79
01 - val_loss: 0.5589 - val_accuracy: 0.7154
Epoch 194/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4396 - accuracy: 0.78
95 - val_loss: 0.5777 - val_accuracy: 0.7102
Epoch 195/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4454 - accuracy: 0.78
50 - val_loss: 0.5602 - val_accuracy: 0.7265
Epoch 196/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4410 - accuracy: 0.78
60 - val_loss: 0.5635 - val_accuracy: 0.7176
Epoch 197/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4433 - accuracy: 0.78
67 - val_loss: 0.5624 - val_accuracy: 0.7149
Epoch 198/200
44/44 [==============================] - 0s 8ms/step - loss: 0.4419 - accuracy: 0.78
44 - val_loss: 0.5566 - val_accuracy: 0.7212
Epoch 199/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4403 - accuracy: 0.78
50 - val_loss: 0.5741 - val_accuracy: 0.7122
Epoch 200/200
44/44 [==============================] - 0s 9ms/step - loss: 0.4387 - accuracy: 0.78
82 - val_loss: 0.5571 - val_accuracy: 0.7170
<keras.callbacks.History at 0x20828fecc70>
```

Out[35]:

In [36]:

```
pd.DataFrame(model.history.history)[['loss','val_loss']].plot()
```

Out[36]: <AxesSubplot:>



In [40]:

```
predictions = (model.predict(X_test) > 0.5).astype("int32")
print(confusion_matrix(y_test,predictions),'\n',classification_report(y_test,predict
```

```
[[1781  656]
 [ 710 1680]]
              precision    recall  f1-score   support

           0       0.71      0.73      0.72      2437
           1       0.72      0.70      0.71      2390

    accuracy                           0.72      4827
   macro avg       0.72      0.72      0.72      4827
weighted avg       0.72      0.72      0.72      4827
```

In [48]:

```
model_new = Sequential()
model_new.add(Dense(94, activation='relu'))
model_new.add(Dropout(0.2))
model_new.add(Dense(30, activation='relu'))
model_new.add(Dropout(0.2))
model_new.add(Dense(15, activation='relu'))
model_new.add(Dropout(0.2))
model_new.add(
        Dense(1, activation='sigmoid'))
model_new.compile(
        optimizer='adam',
        loss='binary_crossentropy',
        metrics=['binary_accuracy'])
model_new.fit(
        X_train,
        y_train,
        epochs=200,
        batch_size=256,
        validation_data=(X_test, y_test),
         callbacks=[early_stop])
```

```
Epoch 1/200
44/44 [==============================] - 1s 10ms/step - loss: 0.6827 - binary_accura
cy: 0.5697 - val_loss: 0.6669 - val_binary_accuracy: 0.5993
```

```
Epoch 2/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6620 - binary_accurac
y: 0.6080 - val_loss: 0.6564 - val_binary_accuracy: 0.6033
Epoch 3/200
44/44 [==============================] - 0s 4ms/step - loss: 0.6549 - binary_accurac
y: 0.6141 - val_loss: 0.6548 - val_binary_accuracy: 0.6039
Epoch 4/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6513 - binary_accurac
y: 0.6204 - val_loss: 0.6513 - val_binary_accuracy: 0.6076
Epoch 5/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6522 - binary_accurac
y: 0.6179 - val_loss: 0.6506 - val_binary_accuracy: 0.6095
Epoch 6/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6488 - binary_accurac
y: 0.6191 - val_loss: 0.6474 - val_binary_accuracy: 0.6089
Epoch 7/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6475 - binary_accurac
y: 0.6194 - val_loss: 0.6479 - val_binary_accuracy: 0.6099
Epoch 8/200
44/44 [==============================] - 0s 4ms/step - loss: 0.6445 - binary_accurac
y: 0.6214 - val_loss: 0.6472 - val_binary_accuracy: 0.6124
Epoch 9/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6461 - binary_accurac
y: 0.6227 - val_loss: 0.6436 - val_binary_accuracy: 0.6140
Epoch 10/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6418 - binary_accurac
y: 0.6335 - val_loss: 0.6425 - val_binary_accuracy: 0.6188
Epoch 11/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6405 - binary_accurac
y: 0.6271 - val_loss: 0.6428 - val_binary_accuracy: 0.6213
Epoch 12/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6394 - binary_accurac
y: 0.6258 - val_loss: 0.6412 - val_binary_accuracy: 0.6227
Epoch 13/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6405 - binary_accurac
y: 0.6306 - val_loss: 0.6415 - val_binary_accuracy: 0.6190
Epoch 14/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6386 - binary_accurac
y: 0.6298 - val_loss: 0.6393 - val_binary_accuracy: 0.6184
Epoch 15/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6360 - binary_accurac
y: 0.6368 - val_loss: 0.6394 - val_binary_accuracy: 0.6194
Epoch 16/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6377 - binary_accurac
y: 0.6330 - val_loss: 0.6385 - val_binary_accuracy: 0.6201
Epoch 17/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6379 - binary_accurac
y: 0.6342 - val_loss: 0.6385 - val_binary_accuracy: 0.6246
Epoch 18/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6350 - binary_accurac
y: 0.6291 - val_loss: 0.6380 - val_binary_accuracy: 0.6242
Epoch 19/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6351 - binary_accurac
y: 0.6314 - val_loss: 0.6373 - val_binary_accuracy: 0.6246
Epoch 20/200
44/44 [==============================] - 0s 5ms/step - loss: 0.6349 - binary_accurac
y: 0.6357 - val_loss: 0.6367 - val_binary_accuracy: 0.6252
Epoch 21/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6338 - binary_accurac
y: 0.6333 - val_loss: 0.6366 - val_binary_accuracy: 0.6275
Epoch 22/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6325 - binary_accurac
y: 0.6308 - val_loss: 0.6363 - val_binary_accuracy: 0.6292
Epoch 23/200
```

```
44/44 [==============================] - 1s 12ms/step - loss: 0.6314 - binary_accura
cy: 0.6387 - val_loss: 0.6387 - val_binary_accuracy: 0.6190
Epoch 24/200
44/44 [==============================] - 1s 12ms/step - loss: 0.6301 - binary_accura
cy: 0.6345 - val_loss: 0.6374 - val_binary_accuracy: 0.6256
Epoch 25/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6315 - binary_accura
cy: 0.6374 - val_loss: 0.6353 - val_binary_accuracy: 0.6285
Epoch 26/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6295 - binary_accurac
y: 0.6380 - val_loss: 0.6349 - val_binary_accuracy: 0.6285
Epoch 27/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6303 - binary_accurac
y: 0.6389 - val_loss: 0.6349 - val_binary_accuracy: 0.6271
Epoch 28/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6288 - binary_accurac
y: 0.6406 - val_loss: 0.6355 - val_binary_accuracy: 0.6343
Epoch 29/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6286 - binary_accurac
y: 0.6419 - val_loss: 0.6340 - val_binary_accuracy: 0.6327
Epoch 30/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6291 - binary_accurac
y: 0.6406 - val_loss: 0.6340 - val_binary_accuracy: 0.6256
Epoch 31/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6275 - binary_accurac
y: 0.6414 - val_loss: 0.6325 - val_binary_accuracy: 0.6385
Epoch 32/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6259 - binary_accurac
y: 0.6444 - val_loss: 0.6320 - val_binary_accuracy: 0.6356
Epoch 33/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6260 - binary_accurac
y: 0.6401 - val_loss: 0.6315 - val_binary_accuracy: 0.6314
Epoch 34/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6239 - binary_accurac
y: 0.6431 - val_loss: 0.6332 - val_binary_accuracy: 0.6327
Epoch 35/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6234 - binary_accura
cy: 0.6394 - val_loss: 0.6315 - val_binary_accuracy: 0.6327
Epoch 36/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6241 - binary_accurac
y: 0.6429 - val_loss: 0.6316 - val_binary_accuracy: 0.6358
Epoch 37/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6227 - binary_accurac
y: 0.6448 - val_loss: 0.6305 - val_binary_accuracy: 0.6360
Epoch 38/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6246 - binary_accurac
y: 0.6477 - val_loss: 0.6312 - val_binary_accuracy: 0.6337
Epoch 39/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6222 - binary_accurac
y: 0.6390 - val_loss: 0.6308 - val_binary_accuracy: 0.6341
Epoch 40/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6217 - binary_accurac
y: 0.6454 - val_loss: 0.6324 - val_binary_accuracy: 0.6348
Epoch 41/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6224 - binary_accurac
y: 0.6465 - val_loss: 0.6298 - val_binary_accuracy: 0.6375
Epoch 42/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6201 - binary_accurac
y: 0.6484 - val_loss: 0.6312 - val_binary_accuracy: 0.6323
Epoch 43/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6216 - binary_accurac
y: 0.6457 - val_loss: 0.6307 - val_binary_accuracy: 0.6356
Epoch 44/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6195 - binary_accurac
```

```
y: 0.6476 - val_loss: 0.6303 - val_binary_accuracy: 0.6389
Epoch 45/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6168 - binary_accurac
y: 0.6484 - val_loss: 0.6291 - val_binary_accuracy: 0.6375
Epoch 46/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6195 - binary_accurac
y: 0.6474 - val_loss: 0.6281 - val_binary_accuracy: 0.6358
Epoch 47/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6185 - binary_accurac
y: 0.6489 - val_loss: 0.6285 - val_binary_accuracy: 0.6393
Epoch 48/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6197 - binary_accurac
y: 0.6484 - val_loss: 0.6298 - val_binary_accuracy: 0.6375
Epoch 49/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6155 - binary_accurac
y: 0.6512 - val_loss: 0.6274 - val_binary_accuracy: 0.6354
Epoch 50/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6175 - binary_accura
cy: 0.6515 - val_loss: 0.6272 - val_binary_accuracy: 0.6368
Epoch 51/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6142 - binary_accurac
y: 0.6536 - val_loss: 0.6304 - val_binary_accuracy: 0.6319
Epoch 52/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6146 - binary_accurac
y: 0.6471 - val_loss: 0.6264 - val_binary_accuracy: 0.6383
Epoch 53/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6136 - binary_accurac
y: 0.6518 - val_loss: 0.6260 - val_binary_accuracy: 0.6377
Epoch 54/200
44/44 [==============================] - 0s 9ms/step - loss: 0.6131 - binary_accurac
y: 0.6557 - val_loss: 0.6271 - val_binary_accuracy: 0.6377
Epoch 55/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6144 - binary_accurac
y: 0.6498 - val_loss: 0.6279 - val_binary_accuracy: 0.6391
Epoch 56/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6151 - binary_accurac
y: 0.6552 - val_loss: 0.6255 - val_binary_accuracy: 0.6387
Epoch 57/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6111 - binary_accurac
y: 0.6555 - val_loss: 0.6271 - val_binary_accuracy: 0.6418
Epoch 58/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6124 - binary_accurac
y: 0.6496 - val_loss: 0.6252 - val_binary_accuracy: 0.6375
Epoch 59/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6106 - binary_accurac
y: 0.6512 - val_loss: 0.6259 - val_binary_accuracy: 0.6352
Epoch 60/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6115 - binary_accurac
y: 0.6563 - val_loss: 0.6253 - val_binary_accuracy: 0.6346
Epoch 61/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6092 - binary_accurac
y: 0.6550 - val_loss: 0.6238 - val_binary_accuracy: 0.6370
Epoch 62/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6105 - binary_accurac
y: 0.6563 - val_loss: 0.6240 - val_binary_accuracy: 0.6352
Epoch 63/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6088 - binary_accurac
y: 0.6548 - val_loss: 0.6231 - val_binary_accuracy: 0.6366
Epoch 64/200
44/44 [==============================] - 0s 10ms/step - loss: 0.6073 - binary_accura
cy: 0.6586 - val_loss: 0.6254 - val_binary_accuracy: 0.6348
Epoch 65/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6089 - binary_accurac
y: 0.6596 - val_loss: 0.6233 - val_binary_accuracy: 0.6385
```

```
Epoch 66/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6056 - binary_accurac
y: 0.6592 - val_loss: 0.6234 - val_binary_accuracy: 0.6348
Epoch 67/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6084 - binary_accurac
y: 0.6629 - val_loss: 0.6240 - val_binary_accuracy: 0.6412
Epoch 68/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6085 - binary_accurac
y: 0.6565 - val_loss: 0.6232 - val_binary_accuracy: 0.6422
Epoch 69/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6057 - binary_accurac
y: 0.6609 - val_loss: 0.6205 - val_binary_accuracy: 0.6462
Epoch 70/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6046 - binary_accurac
y: 0.6615 - val_loss: 0.6197 - val_binary_accuracy: 0.6482
Epoch 71/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6061 - binary_accurac
y: 0.6616 - val_loss: 0.6207 - val_binary_accuracy: 0.6464
Epoch 72/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6041 - binary_accurac
y: 0.6608 - val_loss: 0.6217 - val_binary_accuracy: 0.6439
Epoch 73/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6054 - binary_accurac
y: 0.6614 - val_loss: 0.6185 - val_binary_accuracy: 0.6470
Epoch 74/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6016 - binary_accurac
y: 0.6656 - val_loss: 0.6195 - val_binary_accuracy: 0.6459
Epoch 75/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6072 - binary_accurac
y: 0.6592 - val_loss: 0.6196 - val_binary_accuracy: 0.6505
Epoch 76/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6030 - binary_accurac
y: 0.6636 - val_loss: 0.6189 - val_binary_accuracy: 0.6493
Epoch 77/200
44/44 [==============================] - 0s 6ms/step - loss: 0.6006 - binary_accurac
y: 0.6667 - val_loss: 0.6199 - val_binary_accuracy: 0.6424
Epoch 78/200
44/44 [==============================] - 0s 7ms/step - loss: 0.6031 - binary_accurac
y: 0.6615 - val_loss: 0.6184 - val_binary_accuracy: 0.6495
Epoch 79/200
44/44 [==============================] - 0s 8ms/step - loss: 0.6009 - binary_accurac
y: 0.6662 - val_loss: 0.6172 - val_binary_accuracy: 0.6557
Epoch 80/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5968 - binary_accurac
y: 0.6705 - val_loss: 0.6194 - val_binary_accuracy: 0.6470
Epoch 81/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5984 - binary_accurac
y: 0.6656 - val_loss: 0.6179 - val_binary_accuracy: 0.6489
Epoch 82/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5965 - binary_accurac
y: 0.6644 - val_loss: 0.6156 - val_binary_accuracy: 0.6534
Epoch 83/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5972 - binary_accurac
y: 0.6673 - val_loss: 0.6143 - val_binary_accuracy: 0.6503
Epoch 84/200
44/44 [==============================] - 1s 14ms/step - loss: 0.5985 - binary_accura
cy: 0.6641 - val_loss: 0.6140 - val_binary_accuracy: 0.6567
Epoch 85/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5987 - binary_accurac
y: 0.6675 - val_loss: 0.6179 - val_binary_accuracy: 0.6486
Epoch 86/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5958 - binary_accura
cy: 0.6650 - val_loss: 0.6134 - val_binary_accuracy: 0.6511
Epoch 87/200
```

```
44/44 [==============================] - 0s 10ms/step - loss: 0.5968 - binary_accura
cy: 0.6714 - val_loss: 0.6135 - val_binary_accuracy: 0.6542
Epoch 88/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5940 - binary_accurac
y: 0.6668 - val_loss: 0.6144 - val_binary_accuracy: 0.6480
Epoch 89/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5943 - binary_accurac
y: 0.6680 - val_loss: 0.6127 - val_binary_accuracy: 0.6551
Epoch 90/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5918 - binary_accurac
y: 0.6732 - val_loss: 0.6135 - val_binary_accuracy: 0.6571
Epoch 91/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5950 - binary_accurac
y: 0.6725 - val_loss: 0.6113 - val_binary_accuracy: 0.6515
Epoch 92/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5942 - binary_accurac
y: 0.6694 - val_loss: 0.6113 - val_binary_accuracy: 0.6563
Epoch 93/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5947 - binary_accurac
y: 0.6712 - val_loss: 0.6086 - val_binary_accuracy: 0.6582
Epoch 94/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5933 - binary_accurac
y: 0.6723 - val_loss: 0.6130 - val_binary_accuracy: 0.6493
Epoch 95/200
44/44 [==============================] - 0s 6ms/step - loss: 0.5903 - binary_accurac
y: 0.6727 - val_loss: 0.6096 - val_binary_accuracy: 0.6563
Epoch 96/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5900 - binary_accurac
y: 0.6781 - val_loss: 0.6089 - val_binary_accuracy: 0.6571
Epoch 97/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5911 - binary_accurac
y: 0.6750 - val_loss: 0.6082 - val_binary_accuracy: 0.6522
Epoch 98/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5882 - binary_accurac
y: 0.6760 - val_loss: 0.6075 - val_binary_accuracy: 0.6615
Epoch 99/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5877 - binary_accurac
y: 0.6776 - val_loss: 0.6074 - val_binary_accuracy: 0.6549
Epoch 100/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5874 - binary_accurac
y: 0.6792 - val_loss: 0.6110 - val_binary_accuracy: 0.6594
Epoch 101/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5875 - binary_accurac
y: 0.6776 - val_loss: 0.6074 - val_binary_accuracy: 0.6549
Epoch 102/200
44/44 [==============================] - 0s 11ms/step - loss: 0.5901 - binary_accura
cy: 0.6709 - val_loss: 0.6097 - val_binary_accuracy: 0.6619
Epoch 103/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5874 - binary_accura
cy: 0.6747 - val_loss: 0.6069 - val_binary_accuracy: 0.6569
Epoch 104/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5861 - binary_accurac
y: 0.6766 - val_loss: 0.6057 - val_binary_accuracy: 0.6617
Epoch 105/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5859 - binary_accurac
y: 0.6759 - val_loss: 0.6063 - val_binary_accuracy: 0.6644
Epoch 106/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5862 - binary_accurac
y: 0.6803 - val_loss: 0.6061 - val_binary_accuracy: 0.6588
Epoch 107/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5841 - binary_accurac
y: 0.6802 - val_loss: 0.6049 - val_binary_accuracy: 0.6615
Epoch 108/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5832 - binary_accurac
```

```
y: 0.6806 - val_loss: 0.6053 - val_binary_accuracy: 0.6629
Epoch 109/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5872 - binary_accurac
y: 0.6766 - val_loss: 0.6065 - val_binary_accuracy: 0.6617
Epoch 110/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5835 - binary_accurac
y: 0.6820 - val_loss: 0.6026 - val_binary_accuracy: 0.6648
Epoch 111/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5788 - binary_accurac
y: 0.6875 - val_loss: 0.6041 - val_binary_accuracy: 0.6617
Epoch 112/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5828 - binary_accurac
y: 0.6841 - val_loss: 0.6041 - val_binary_accuracy: 0.6611
Epoch 113/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5797 - binary_accurac
y: 0.6841 - val_loss: 0.6058 - val_binary_accuracy: 0.6615
Epoch 114/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5804 - binary_accurac
y: 0.6810 - val_loss: 0.6027 - val_binary_accuracy: 0.6640
Epoch 115/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5825 - binary_accurac
y: 0.6811 - val_loss: 0.6036 - val_binary_accuracy: 0.6714
Epoch 116/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5829 - binary_accura
cy: 0.6817 - val_loss: 0.6036 - val_binary_accuracy: 0.6663
Epoch 117/200
44/44 [==============================] - 0s 11ms/step - loss: 0.5803 - binary_accura
cy: 0.6846 - val_loss: 0.6015 - val_binary_accuracy: 0.6667
Epoch 118/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5790 - binary_accurac
y: 0.6867 - val_loss: 0.6019 - val_binary_accuracy: 0.6623
Epoch 119/200
44/44 [==============================] - 0s 6ms/step - loss: 0.5784 - binary_accurac
y: 0.6897 - val_loss: 0.6022 - val_binary_accuracy: 0.6654
Epoch 120/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5752 - binary_accurac
y: 0.6861 - val_loss: 0.6044 - val_binary_accuracy: 0.6667
Epoch 121/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5785 - binary_accurac
y: 0.6877 - val_loss: 0.6020 - val_binary_accuracy: 0.6667
Epoch 122/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5797 - binary_accurac
y: 0.6860 - val_loss: 0.6006 - val_binary_accuracy: 0.6652
Epoch 123/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5778 - binary_accurac
y: 0.6864 - val_loss: 0.5996 - val_binary_accuracy: 0.6692
Epoch 124/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5760 - binary_accurac
y: 0.6850 - val_loss: 0.5984 - val_binary_accuracy: 0.6654
Epoch 125/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5726 - binary_accurac
y: 0.6886 - val_loss: 0.5997 - val_binary_accuracy: 0.6675
Epoch 126/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5748 - binary_accurac
y: 0.6864 - val_loss: 0.6008 - val_binary_accuracy: 0.6627
Epoch 127/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5699 - binary_accurac
y: 0.6900 - val_loss: 0.5973 - val_binary_accuracy: 0.6708
Epoch 128/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5726 - binary_accurac
y: 0.6899 - val_loss: 0.6024 - val_binary_accuracy: 0.6721
Epoch 129/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5768 - binary_accurac
y: 0.6879 - val_loss: 0.6035 - val_binary_accuracy: 0.6692
```

```
Epoch 130/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5767 - binary_accurac
y: 0.6848 - val_loss: 0.5999 - val_binary_accuracy: 0.6685
Epoch 131/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5699 - binary_accurac
y: 0.6922 - val_loss: 0.5990 - val_binary_accuracy: 0.6706
Epoch 132/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5751 - binary_accurac
y: 0.6929 - val_loss: 0.5973 - val_binary_accuracy: 0.6696
Epoch 133/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5699 - binary_accurac
y: 0.6900 - val_loss: 0.5978 - val_binary_accuracy: 0.6801
Epoch 134/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5716 - binary_accurac
y: 0.6903 - val_loss: 0.5995 - val_binary_accuracy: 0.6679
Epoch 135/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5708 - binary_accurac
y: 0.6893 - val_loss: 0.5968 - val_binary_accuracy: 0.6689
Epoch 136/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5741 - binary_accurac
y: 0.6845 - val_loss: 0.5981 - val_binary_accuracy: 0.6708
Epoch 137/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5649 - binary_accurac
y: 0.6961 - val_loss: 0.5969 - val_binary_accuracy: 0.6689
Epoch 138/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5666 - binary_accurac
y: 0.6941 - val_loss: 0.5931 - val_binary_accuracy: 0.6700
Epoch 139/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5721 - binary_accurac
y: 0.6933 - val_loss: 0.5993 - val_binary_accuracy: 0.6694
Epoch 140/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5709 - binary_accurac
y: 0.6893 - val_loss: 0.5966 - val_binary_accuracy: 0.6714
Epoch 141/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5690 - binary_accurac
y: 0.6884 - val_loss: 0.5947 - val_binary_accuracy: 0.6692
Epoch 142/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5708 - binary_accurac
y: 0.6932 - val_loss: 0.5926 - val_binary_accuracy: 0.6741
Epoch 143/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5681 - binary_accurac
y: 0.6962 - val_loss: 0.5944 - val_binary_accuracy: 0.6733
Epoch 144/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5697 - binary_accurac
y: 0.6931 - val_loss: 0.5972 - val_binary_accuracy: 0.6737
Epoch 145/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5672 - binary_accurac
y: 0.6948 - val_loss: 0.5938 - val_binary_accuracy: 0.6739
Epoch 146/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5656 - binary_accurac
y: 0.7006 - val_loss: 0.5938 - val_binary_accuracy: 0.6698
Epoch 147/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5655 - binary_accurac
y: 0.6952 - val_loss: 0.5971 - val_binary_accuracy: 0.6750
Epoch 148/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5679 - binary_accurac
y: 0.6983 - val_loss: 0.5984 - val_binary_accuracy: 0.6710
Epoch 149/200
44/44 [==============================] - 0s 6ms/step - loss: 0.5679 - binary_accurac
y: 0.6971 - val_loss: 0.5919 - val_binary_accuracy: 0.6754
Epoch 150/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5667 - binary_accurac
y: 0.6987 - val_loss: 0.5945 - val_binary_accuracy: 0.6679
Epoch 151/200
```

```
44/44 [==============================] - 0s 7ms/step - loss: 0.5668 - binary_accurac
y: 0.6943 - val_loss: 0.5936 - val_binary_accuracy: 0.6743
Epoch 152/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5657 - binary_accurac
y: 0.6975 - val_loss: 0.5910 - val_binary_accuracy: 0.6727
Epoch 153/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5643 - binary_accurac
y: 0.6949 - val_loss: 0.5922 - val_binary_accuracy: 0.6766
Epoch 154/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5618 - binary_accurac
y: 0.7011 - val_loss: 0.5893 - val_binary_accuracy: 0.6824
Epoch 155/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5643 - binary_accurac
y: 0.6967 - val_loss: 0.5916 - val_binary_accuracy: 0.6750
Epoch 156/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5606 - binary_accurac
y: 0.7000 - val_loss: 0.5906 - val_binary_accuracy: 0.6824
Epoch 157/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5619 - binary_accurac
y: 0.6990 - val_loss: 0.5889 - val_binary_accuracy: 0.6745
Epoch 158/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5604 - binary_accurac
y: 0.6986 - val_loss: 0.5897 - val_binary_accuracy: 0.6801
Epoch 159/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5631 - binary_accurac
y: 0.6924 - val_loss: 0.5857 - val_binary_accuracy: 0.6750
Epoch 160/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5643 - binary_accurac
y: 0.6947 - val_loss: 0.5885 - val_binary_accuracy: 0.6801
Epoch 161/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5608 - binary_accurac
y: 0.6979 - val_loss: 0.5894 - val_binary_accuracy: 0.6824
Epoch 162/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5623 - binary_accurac
y: 0.7040 - val_loss: 0.5881 - val_binary_accuracy: 0.6795
Epoch 163/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5604 - binary_accurac
y: 0.7040 - val_loss: 0.5882 - val_binary_accuracy: 0.6805
Epoch 164/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5598 - binary_accurac
y: 0.6995 - val_loss: 0.5900 - val_binary_accuracy: 0.6828
Epoch 165/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5618 - binary_accurac
y: 0.6986 - val_loss: 0.5872 - val_binary_accuracy: 0.6783
Epoch 166/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5597 - binary_accurac
y: 0.6967 - val_loss: 0.5873 - val_binary_accuracy: 0.6820
Epoch 167/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5593 - binary_accurac
y: 0.7043 - val_loss: 0.5864 - val_binary_accuracy: 0.6830
Epoch 168/200
44/44 [==============================] - 0s 6ms/step - loss: 0.5585 - binary_accurac
y: 0.7052 - val_loss: 0.5878 - val_binary_accuracy: 0.6808
Epoch 169/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5607 - binary_accurac
y: 0.6970 - val_loss: 0.5809 - val_binary_accuracy: 0.6847
Epoch 170/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5567 - binary_accurac
y: 0.7017 - val_loss: 0.5856 - val_binary_accuracy: 0.6824
Epoch 171/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5573 - binary_accurac
y: 0.7002 - val_loss: 0.5857 - val_binary_accuracy: 0.6754
Epoch 172/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5550 - binary_accurac
```

```
y: 0.7003 - val_loss: 0.5843 - val_binary_accuracy: 0.6861
Epoch 173/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5596 - binary_accurac
y: 0.6995 - val_loss: 0.5838 - val_binary_accuracy: 0.6855
Epoch 174/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5586 - binary_accurac
y: 0.6968 - val_loss: 0.5825 - val_binary_accuracy: 0.6830
Epoch 175/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5580 - binary_accurac
y: 0.7052 - val_loss: 0.5829 - val_binary_accuracy: 0.6859
Epoch 176/200
44/44 [==============================] - 0s 6ms/step - loss: 0.5519 - binary_accurac
y: 0.7069 - val_loss: 0.5800 - val_binary_accuracy: 0.6888
Epoch 177/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5534 - binary_accura
cy: 0.7043 - val_loss: 0.5856 - val_binary_accuracy: 0.6874
Epoch 178/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5553 - binary_accura
cy: 0.6971 - val_loss: 0.5838 - val_binary_accuracy: 0.6857
Epoch 179/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5620 - binary_accurac
y: 0.7032 - val_loss: 0.5859 - val_binary_accuracy: 0.6810
Epoch 180/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5542 - binary_accurac
y: 0.7035 - val_loss: 0.5864 - val_binary_accuracy: 0.6805
Epoch 181/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5535 - binary_accurac
y: 0.7052 - val_loss: 0.5848 - val_binary_accuracy: 0.6851
Epoch 182/200
44/44 [==============================] - 0s 9ms/step - loss: 0.5543 - binary_accurac
y: 0.7047 - val_loss: 0.5801 - val_binary_accuracy: 0.6839
Epoch 183/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5530 - binary_accurac
y: 0.7066 - val_loss: 0.5821 - val_binary_accuracy: 0.6872
Epoch 184/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5511 - binary_accurac
y: 0.7077 - val_loss: 0.5818 - val_binary_accuracy: 0.6915
Epoch 185/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5551 - binary_accurac
y: 0.7074 - val_loss: 0.5786 - val_binary_accuracy: 0.6868
Epoch 186/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5507 - binary_accurac
y: 0.7051 - val_loss: 0.5785 - val_binary_accuracy: 0.6903
Epoch 187/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5473 - binary_accurac
y: 0.7120 - val_loss: 0.5841 - val_binary_accuracy: 0.6797
Epoch 188/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5555 - binary_accurac
y: 0.7024 - val_loss: 0.5778 - val_binary_accuracy: 0.6878
Epoch 189/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5512 - binary_accurac
y: 0.7097 - val_loss: 0.5769 - val_binary_accuracy: 0.6849
Epoch 190/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5489 - binary_accurac
y: 0.7088 - val_loss: 0.5790 - val_binary_accuracy: 0.6868
Epoch 191/200
44/44 [==============================] - 0s 10ms/step - loss: 0.5469 - binary_accura
cy: 0.7051 - val_loss: 0.5786 - val_binary_accuracy: 0.6901
Epoch 192/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5500 - binary_accurac
y: 0.7057 - val_loss: 0.5802 - val_binary_accuracy: 0.6884
Epoch 193/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5504 - binary_accurac
y: 0.7104 - val_loss: 0.5804 - val_binary_accuracy: 0.6932
```

```
Epoch 194/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5496 - binary_accurac
y: 0.7089 - val_loss: 0.5772 - val_binary_accuracy: 0.6882
Epoch 195/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5514 - binary_accurac
y: 0.7034 - val_loss: 0.5813 - val_binary_accuracy: 0.6859
Epoch 196/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5480 - binary_accurac
y: 0.7090 - val_loss: 0.5754 - val_binary_accuracy: 0.6859
Epoch 197/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5499 - binary_accurac
y: 0.7066 - val_loss: 0.5784 - val_binary_accuracy: 0.6870
Epoch 198/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5470 - binary_accurac
y: 0.7109 - val_loss: 0.5796 - val_binary_accuracy: 0.6907
Epoch 199/200
44/44 [==============================] - 0s 8ms/step - loss: 0.5439 - binary_accurac
y: 0.7129 - val_loss: 0.5730 - val_binary_accuracy: 0.6928
Epoch 200/200
44/44 [==============================] - 0s 7ms/step - loss: 0.5478 - binary_accurac
y: 0.7124 - val_loss: 0.5759 - val_binary_accuracy: 0.6919
```

Out[48]:

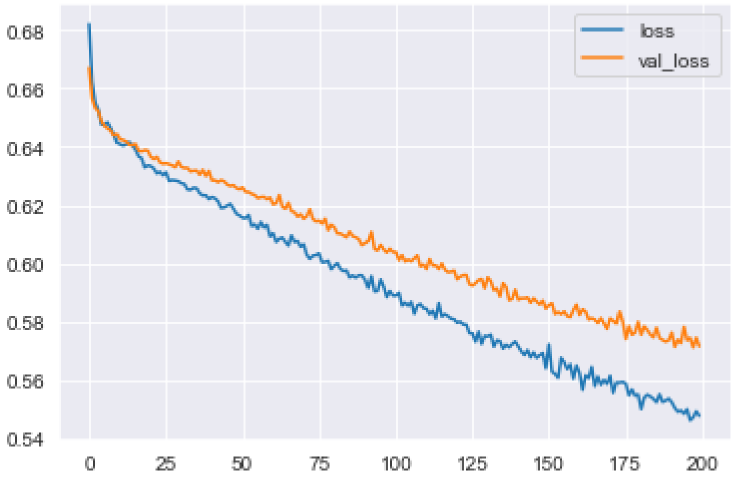
```
<keras.callbacks.History at 0x2082e087850>
```

In [42]:

```
pd.DataFrame(model_new.history.history)[['loss','val_loss']].plot()
```

Out[42]:

```
<AxesSubplot:>
```



In [44]:

```
predictions_new = (model.predict(X_test) >= 0.2).astype("int")
print(confusion_matrix(y_test,predictions_new),'\n',classification_report(y_test,pre
```

```
[[ 874 1563]
 [  73 2317]]
              precision    recall  f1-score   support

           0       0.92      0.36      0.52      2437
           1       0.60      0.97      0.74      2390

    accuracy                           0.66      4827
   macro avg       0.76      0.66      0.63      4827
weighted avg       0.76      0.66      0.63      4827
```

In [45]:

```
dump(scaler, open('scaler.pkl', 'wb'))
model_new.save('my_model_lending_club.h5')
```

In [46]:
```
later_scaler = load(open('scaler.pkl', 'rb'))
later_model = load_model('my_model_lending_club.h5')
```

In [47]:
```
X_OOT = to_pred.drop('not.fully.paid', axis=1).values
to_pred.drop('not.fully.paid', axis=1).values
print(X_OOT.shape)
```

```
(0, 15)
```