main

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1 MATH 3660 Final Project

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1.1 Introduction

- We got the dataset from https://www.kaggle.com/cnic92/200-financial-indicators-of-us-stocks-20142018
- It contains about ~200 columns for each of the companies from their 10-K filings.

1.1.1 Question

Can we use machine learning and deep learning techniques to predict the price variance of a company?

1.2 Data Processing

- Here, we're processing the data to clean up some issues where there are NaN (Not a Number) and crazy outliers.

```python
import pandas as pd
import numpy as np
from sklearn.impute import KNNImputer
from sklearn.preprocessing import RobustScaler
from sklearn.svm import SVC
from sklearn.metrics import classification_report
from sklearn.model_selection import train_test_split
import seaborn as sns
import matplotlib.pyplot as plt
sns.set_theme(style="whitegrid")
```

```python
# Import the data as dataframes for each year
df1=pd.read_csv("./data/2014_Financial_Data.csv")
df2=pd.read_csv("./data/2015_Financial_Data.csv")
df3=pd.read_csv("./data/2016_Financial_Data.csv")
df4=pd.read_csv("./data/2017_Financial_Data.csv")
df5=pd.read_csv("./data/2018_Financial_Data.csv")
```

```python
df1.head()
```

```
[3]:    Unnamed: 0        Revenue  Revenue Growth  Cost of Revenue  Gross Profit  \
     0          PG  7.440100e+10         -0.0713     3.903000e+10  3.537100e+10
     1        VIPS  3.734148e+09          1.1737     2.805625e+09  9.285226e+08
     2          KR  9.837500e+10          0.0182     7.813800e+10  2.023700e+10
     3         RAD  2.552641e+10          0.0053     1.820268e+10  7.323734e+09
     4         GIS  1.790960e+10          0.0076     1.153980e+10  6.369800e+09

        R&D Expenses  SG&A Expense  Operating Expenses  Operating Income  \
     0  0.000000e+00  2.146100e+10        2.146100e+10      1.391000e+10
     1  1.083303e+08  3.441414e+08        7.939267e+08      1.345959e+08
     2  0.000000e+00  1.519600e+10        1.751200e+10      2.725000e+09
     3  0.000000e+00  6.561162e+09        6.586482e+09      7.372520e+08
     4  0.000000e+00  3.474300e+09        3.412400e+09      2.957400e+09

        Interest Expense  ...  Receivables growth  Inventory Growth  Asset Growth  \
     0      7.090000e+08  ...             -0.0187           -0.0217        0.0359
     1      1.214869e+07  ...                NaN               NaN           NaN
     2      4.430000e+08  ...              0.0618            0.0981        0.1886
     3      4.245910e+08  ...              0.0211           -0.0510       -0.0189
     4      3.024000e+08  ...              0.0257            0.0090        0.0215

        Book Value per Share Growth  Debt Growth  R&D Expense Growth  \
     0                       0.0316       0.1228              0.0000
     1                          NaN          NaN              1.6484
     2                       0.3268       0.2738              0.0000
     3                       0.1963      -0.0458              0.0000
     4                       0.0274       0.1025              0.0000

        SG&A Expenses Growth              Sector  2015 PRICE VAR [%]  Class
     0               -0.1746  Consumer Defensive           -9.323276      0
     1                1.7313  Consumer Defensive          -25.512193      0
     2                0.0234  Consumer Defensive           33.118297      1
     3               -0.0060  Consumer Defensive            2.752291      1
     4               -0.0220  Consumer Defensive           12.897715      1

     [5 rows x 225 columns]
```

```python
[4]: def better_than_spy(row, spy_var):
         price_var = row['PRICE_VAR']
         if price_var > spy_var:
             return 1
         else:
             return 0
```

```python
[5]: # Drop stock ticker and sector
     df1 = df1.drop(df1.columns[0], axis = 1)
     df2 = df2.drop(df2.columns[0], axis = 1)
```

```
df3 = df3.drop(df3.columns[0], axis = 1)
df4 = df4.drop(df4.columns[0], axis = 1)
df5 = df5.drop(df5.columns[0], axis = 1)

df1.drop(['Sector'], axis=1, inplace=True)
df2.drop(['Sector'], axis=1, inplace=True)
df3.drop(['Sector'], axis=1, inplace=True)
df4.drop(['Sector'], axis=1, inplace=True)
df5.drop(['Sector'], axis=1, inplace=True)

df1['Year'] = 2014
df2['Year'] = 2015
df3['Year'] = 2016
df4['Year'] = 2017
df5['Year'] = 2018

# Rename price var
df1.rename(columns={"2015 PRICE VAR [%]": "PRICE_VAR"},inplace=True)
df2.rename(columns={"2016 PRICE VAR [%]": "PRICE_VAR"},inplace=True)
df3.rename(columns={"2017 PRICE VAR [%]": "PRICE_VAR"},inplace=True)
df4.rename(columns={"2018 PRICE VAR [%]": "PRICE_VAR"},inplace=True)
df5.rename(columns={"2019 PRICE VAR [%]": "PRICE_VAR"},inplace=True)
```

```
[6]:  # Use SPY as another metric for looking at change, calculating its variance
      →over the course of the year and using that.
      spy = pd.read_csv("./data/SPY.csv", index_col='Date')

      spy2015 = spy.loc[['2015-01-01','2016-01-01']]['Open']
      spy2015change = ((spy2015[1] - spy2015[0]) / spy2015[0]) * 100
      df1['Beat Spy'] = df1.apply(lambda row: better_than_spy(row, spy2015change),
      →axis=1)

      spy2016 = spy.loc[['2016-01-01','2017-01-01']]['Open']
      spy2016change = ((spy2016[1] - spy2016[0]) / spy2016[0]) * 100
      df2['Beat Spy'] = df2.apply(lambda row: better_than_spy(row, spy2016change),
      →axis=1)

      spy2017 = spy.loc[['2017-01-01','2018-01-01']]['Open']
      spy2017change = ((spy2017[1] - spy2017[0]) / spy2017[0]) * 100
      df3['Beat Spy'] = df3.apply(lambda row: better_than_spy(row, spy2017change),
      →axis=1)

      spy2018 = spy.loc[['2018-01-01','2019-01-01']]['Open']
      spy2018change = ((spy2018[1] - spy2018[0]) / spy2018[0]) * 100
      df4['Beat Spy'] = df4.apply(lambda row: better_than_spy(row, spy2018change),
      →axis=1)
```

```
spy2019 = spy.loc[['2019-01-01','2020-01-01']]['Open']
spy2019change = ((spy2019[1] - spy2019[0]) / spy2019[0]) * 100
df5['Beat Spy'] = df5.apply(lambda row: better_than_spy(row, spy2019change),␣
 ↪axis=1)
```

[7]:
```
# Clean the data, removing NaN values and completing them using KNN
imputer = KNNImputer(n_neighbors=10, weights='distance',␣
 ↪metric='nan_euclidean', copy=True)

df1_clean = imputer.fit_transform(df1)
df1_clean = pd.DataFrame(df1_clean)
df1_clean.columns = list(df1)

df2_clean = imputer.fit_transform(df2)
df2_clean = pd.DataFrame(df2_clean)
df2_clean.columns = list(df2)

df3_clean = imputer.fit_transform(df3)
df3_clean = pd.DataFrame(df3_clean)
df3_clean.columns = list(df3)

df4_clean = imputer.fit_transform(df4)
df4_clean = pd.DataFrame(df4_clean)
df4_clean.columns = list(df4)

df5_clean = imputer.fit_transform(df5)
df5_clean = pd.DataFrame(df5_clean)
df5_clean.columns = list(df5)
```

[8]:
```
# Then, concatenate all of the dataframes into a single dataframe
data = pd.concat([df1_clean, df2_clean, df3_clean, df4_clean, df5_clean])
```

[9]:
```
# Plot the data for each of the years, graphing what their returns are like
fig, axs = plt.subplots(3, 2, figsize=(15, 15))
fig.subplots_adjust(hspace=1)
sns.histplot(data=df1['PRICE_VAR'], binrange=(-300,300), stat='count',␣
 ↪color='blue', ax=axs[0, 0]).set_title('2015 Returns')
sns.histplot(data=df2['PRICE_VAR'], binrange=(-300,300), stat='count',␣
 ↪color='green', ax=axs[0, 1]).set_title('2016 Returns')
sns.histplot(data=df3['PRICE_VAR'], binrange=(-300,300), stat='count',␣
 ↪color='orange', ax=axs[1, 0]).set_title('2017 Returns')
sns.histplot(data=df4['PRICE_VAR'], binrange=(-300,300), stat='count',␣
 ↪color='purple', ax=axs[1, 1]).set_title('2018 Returns')
sns.histplot(data=df5['PRICE_VAR'], binrange=(-300,300), stat='count',␣
 ↪color='red', ax=axs[2, 0]).set_title('2019 Returns')
```

Text(0.5, 1.0, '2019 Returns')
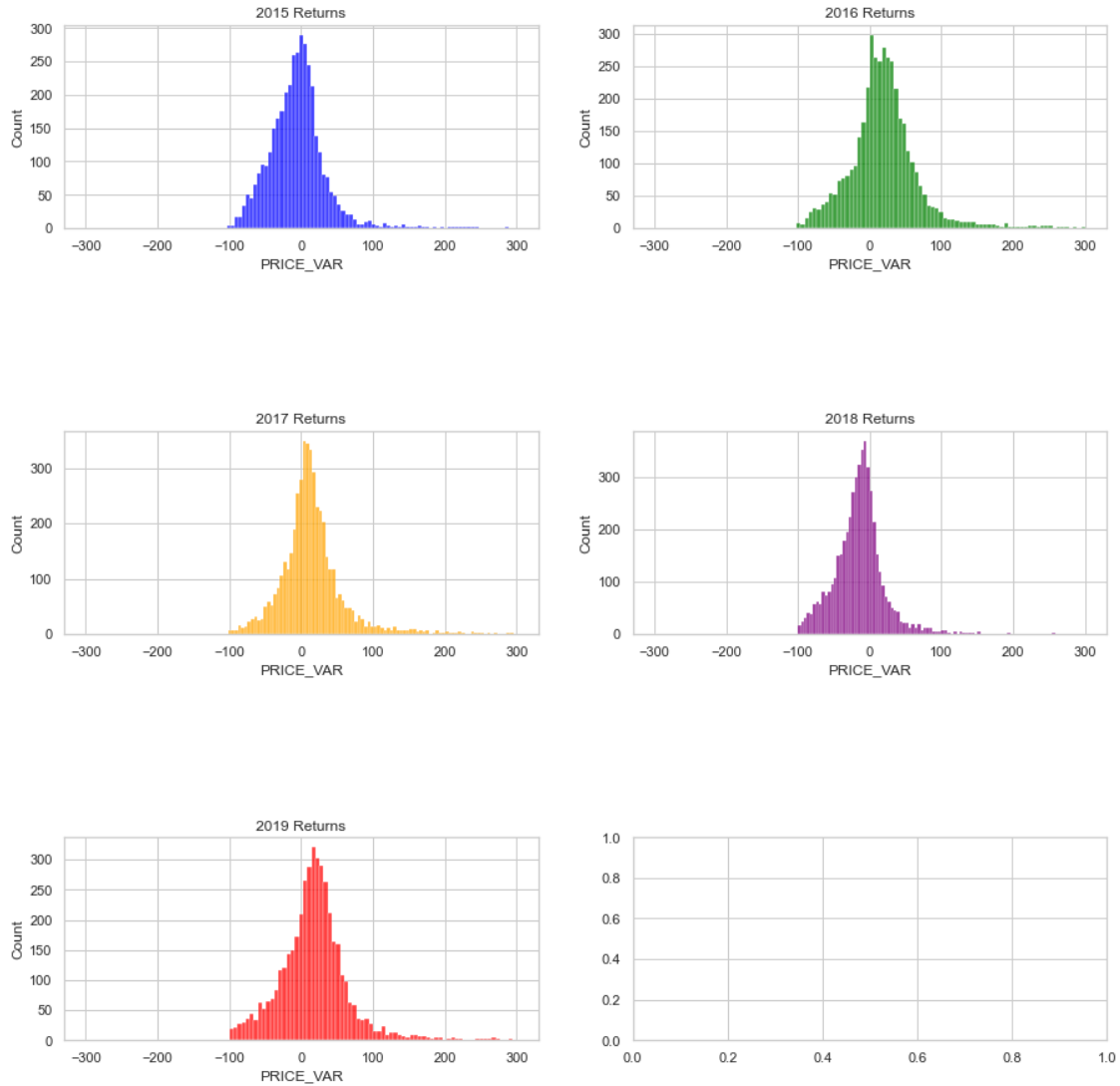

```
[10]: sns.histplot(
          data=data, x='PRICE_VAR', hue='Year',
          element="step", fill=False,
          cumulative=True, common_norm=False, stat='density', binrange=(-50,300)
      )
```

[10]: <AxesSubplot:xlabel='PRICE_VAR', ylabel='Density'>
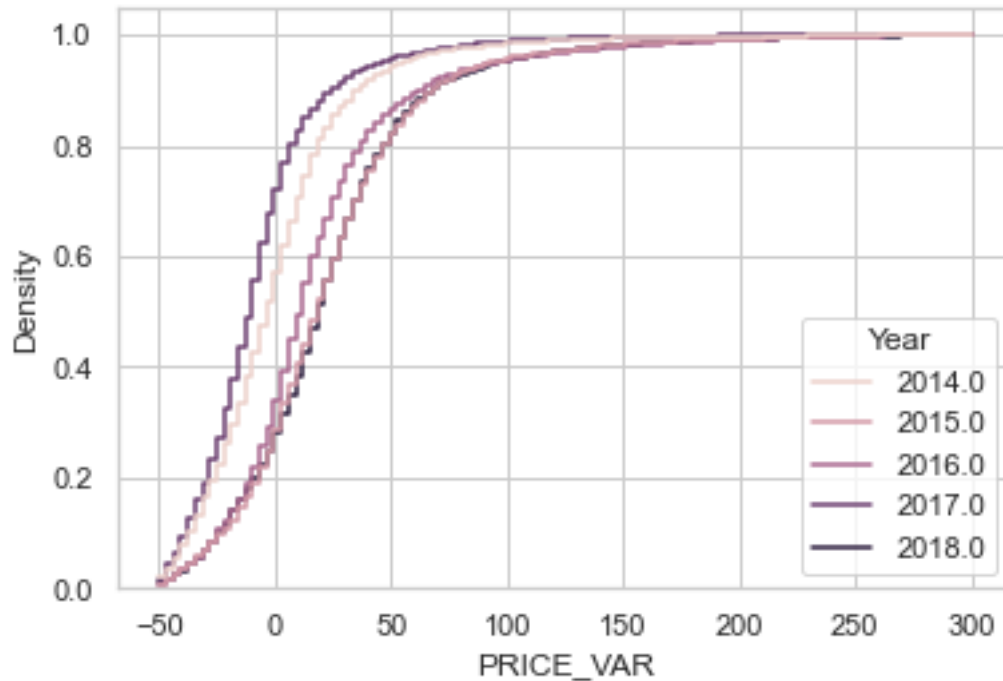
```
[11]: print(f"In {df1['Year'][0]}, {(sum(df1['Beat Spy'] == 1) / len(df1['Beat␣
      ↪Spy']))*100}% of companies had better performance than SPY the next year")
      print(f"In {df2['Year'][0]}, {(sum(df2['Beat Spy'] == 1) / len(df2['Beat␣
      ↪Spy']))*100}% of companies had better performance than SPY the next year")
      print(f"In {df3['Year'][0]}, {(sum(df3['Beat Spy'] == 1) / len(df3['Beat␣
      ↪Spy']))*100}% of companies had better performance than SPY the next year")
      print(f"In {df4['Year'][0]}, {(sum(df4['Beat Spy'] == 1) / len(df4['Beat␣
      ↪Spy']))*100}% of companies had better performance than SPY the next year")
      print(f"In {df5['Year'][0]}, {(sum(df5['Beat Spy'] == 1) / len(df5['Beat␣
      ↪Spy']))*100}% of companies had better performance than SPY the next year")
      print("\n")
      print(f"In {df1['Year'][0]}, {(sum(df1['Class'] == 1) /␣
      ↪len(df1['Class']))*100}% of companies had positive stock growth the next␣
      ↪year")
      print(f"In {df2['Year'][0]}, {(sum(df2['Class'] == 1) /␣
      ↪len(df2['Class']))*100}% of companies had positive stock growth the next␣
      ↪year")
      print(f"In {df3['Year'][0]}, {(sum(df3['Class'] == 1) /␣
      ↪len(df3['Class']))*100}% of companies had positive stock growth the next␣
      ↪year")
      print(f"In {df4['Year'][0]}, {(sum(df4['Class'] == 1) /␣
      ↪len(df4['Class']))*100}% of companies had positive stock growth the next␣
      ↪year")
```

```
print(f"In {df5['Year'][0]}, {(sum(df5['Class'] == 1) /␣
 ↪len(df5['Class']))*100}% of companies had positive stock growth the next␣
 ↪year")
```

In 2014, 46.58613445378151% of companies had better performance than SPY the
next year
In 2015, 55.46116504854369% of companies had better performance than SPY the
next year
In 2016, 37.91953304148426% of companies had better performance than SPY the
next year
In 2017, 41.16935483870968% of companies had better performance than SPY the
next year
In 2018, 33.310564663023676% of companies had better performance than SPY the
next year

In 2014, 42.909663865546214% of companies had positive stock growth the next
year
In 2015, 70.16990291262137% of companies had positive stock growth the next year
In 2016, 67.0835939128622% of companies had positive stock growth the next year
In 2017, 27.62096774193548% of companies had positive stock growth the next year
In 2018, 69.35336976320583% of companies had positive stock growth the next year

2 Training a Model with SVC

- C-Support Vector Classification, as seen in this: https://scikit-learn.org/stable/modules/generated/sklearn.svm.SVC.html

```
[12]: # We get all but the last four rows of the data
      X = data.iloc[:,:-4]
      y = data.iloc[:,-1:] # for spy, do -3 for buy/sell
      y = np.array([int(i[0]) for i in y.values.tolist()])

      # Look at dimensions for sanity check
      print("Dimensions of X: {}".format(X.shape))
      print("Dimensions of y: {}".format(y.shape))
```

Dimensions of X: (22077, 221)
Dimensions of y: (22077,)

```
[13]: # Canonical 80/20% train_test_split
      X_train, X_test, y_train, y_test = train_test_split(X, y)
```

```
[14]: transformer = RobustScaler(unit_variance=True).fit(X_train)
      X_train = transformer.transform(X_train)
      X_test = transformer.transform(X_test)
```

```
[15]: svm = SVC(C=1, gamma='scale', class_weight='balanced')
      svm.fit(X_train, y_train)
      y_pred = svm.predict(X_test)
```

```
[16]: target_names = ['Doesnt Beat SPY', 'Beats SPY']
      print(classification_report(y_test, y_pred, target_names=target_names))
```

```
                   precision    recall  f1-score   support

 Doesnt Beat SPY        0.58      0.98      0.73      3192
       Beats SPY        0.42      0.02      0.04      2328

        accuracy                            0.57      5520
       macro avg        0.50      0.50      0.39      5520
    weighted avg        0.51      0.57      0.44      5520
```

3 Deep Learning Approach

- Next, we take a look at using a deep learning model.

```
[41]: import tensorflow as tf

      from tensorflow import keras
      from tensorflow.keras import layers
      from tensorflow import feature_column
```

```
[81]: # We gotta grab out the feature columns as well
      feature_columns = X.columns.values
      feature_columns = [feature_column.numeric_column(val) for val in␣
       ↪feature_columns]

      feature_layer = tf.keras.layers.DenseFeatures(feature_columns)


      model = keras.Sequential([
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(1, activation=tf.nn.sigmoid),
      ])
```

```
[82]: y_train.shape
```

```
[82]: (16557,)
```

```
[83]: model.compile(optimizer='adam',
                    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
```

```
              metrics=['accuracy'])

history = model.fit(X_train, y_train, epochs=50)
test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/50
16557/16557 [==============================] - 2s 103us/sample - loss: 0.6980 -
accuracy: 0.5698
Epoch 2/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6933 -
accuracy: 0.5738
Epoch 3/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6930 -
accuracy: 0.5740
Epoch 4/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6925 -
accuracy: 0.5748
Epoch 5/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6923 -
accuracy: 0.5762
Epoch 6/50
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6917 -
accuracy: 0.5788
Epoch 7/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6915 -
accuracy: 0.5810
Epoch 8/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6908 -
accuracy: 0.5828
Epoch 9/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6896 -
accuracy: 0.5856
Epoch 10/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6886 -
accuracy: 0.5912
Epoch 11/50
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6871 -
accuracy: 0.5948
Epoch 12/50
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6860 -
accuracy: 0.5980
Epoch 13/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6857 -
accuracy: 0.5999
Epoch 14/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6850 -
```

```
accuracy: 0.6015
Epoch 15/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6844 -
accuracy: 0.6032
Epoch 16/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6831 -
accuracy: 0.6063
Epoch 17/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6822 -
accuracy: 0.6088
Epoch 18/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6825 -
accuracy: 0.6080
Epoch 19/50
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6812 -
accuracy: 0.6112
Epoch 20/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6806 -
accuracy: 0.6124
Epoch 21/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6803 -
accuracy: 0.6134
Epoch 22/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6803 -
accuracy: 0.6146
Epoch 23/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6803 -
accuracy: 0.6132
Epoch 24/50
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6791 -
accuracy: 0.6170
Epoch 25/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6788 -
accuracy: 0.6179
Epoch 26/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6789 -
accuracy: 0.6173
Epoch 27/50
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6781 -
accuracy: 0.6190
Epoch 28/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6780 -
accuracy: 0.6197
Epoch 29/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6781 -
accuracy: 0.6196
Epoch 30/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6789 -
```

```
accuracy: 0.6185
Epoch 31/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6777 -
accuracy: 0.6201
Epoch 32/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6773 -
accuracy: 0.6212
Epoch 33/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6776 -
accuracy: 0.6195
Epoch 34/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6767 -
accuracy: 0.6223
Epoch 35/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6762 -
accuracy: 0.6230
Epoch 36/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6759 -
accuracy: 0.6241
Epoch 37/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6774 -
accuracy: 0.6215
Epoch 38/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6769 -
accuracy: 0.6225
Epoch 39/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6765 -
accuracy: 0.6232
Epoch 40/50
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6760 -
accuracy: 0.6251
Epoch 41/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6760 -
accuracy: 0.6253
Epoch 42/50
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6760 -
accuracy: 0.6245
Epoch 43/50
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6763 -
accuracy: 0.6241
Epoch 44/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6759 -
accuracy: 0.6247
Epoch 45/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6754 -
accuracy: 0.6261
Epoch 46/50
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6750 -
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```
accuracy: 0.6273
Epoch 47/50
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6751 -
accuracy: 0.6266
Epoch 48/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6760 -
accuracy: 0.6236
Epoch 49/50
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6766 -
accuracy: 0.6231
Epoch 50/50
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6753 -
accuracy: 0.6259
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========] - 0s 57us/sample - loss: 0.7433 - accuracy: 0.5855
```

```
[84]: print("Accuracy: {}".format(test_acc))
```

```
Accuracy: 0.5855072736740112
```

```python
[58]: # Code sourced from https://machinelearningmastery.com/
      ↪display-deep-learning-model-training-history-in-keras/
      def plot_history(history):
          # list all data in history
          # print(history.history.keys())
          # summarize history for accuracy
          plt.plot(history.history['accuracy'])
          # plt.plot(history.history['val_accuracy'])
          plt.title('model accuracy')
          plt.ylabel('accuracy')
          plt.xlabel('epoch')
          plt.legend(['train', 'test'], loc='upper left')
          plt.show()
          # summarize history for loss
          plt.plot(history.history['loss'])
          # plt.plot(history.history['val_loss'])
          plt.title('model loss')
          plt.ylabel('loss')
          plt.xlabel('epoch')
          plt.legend(['train', 'test'], loc='upper left')
          plt.show()
```

```
[57]: plot_history(history)
```

dict_keys(['loss', 'accuracy'])
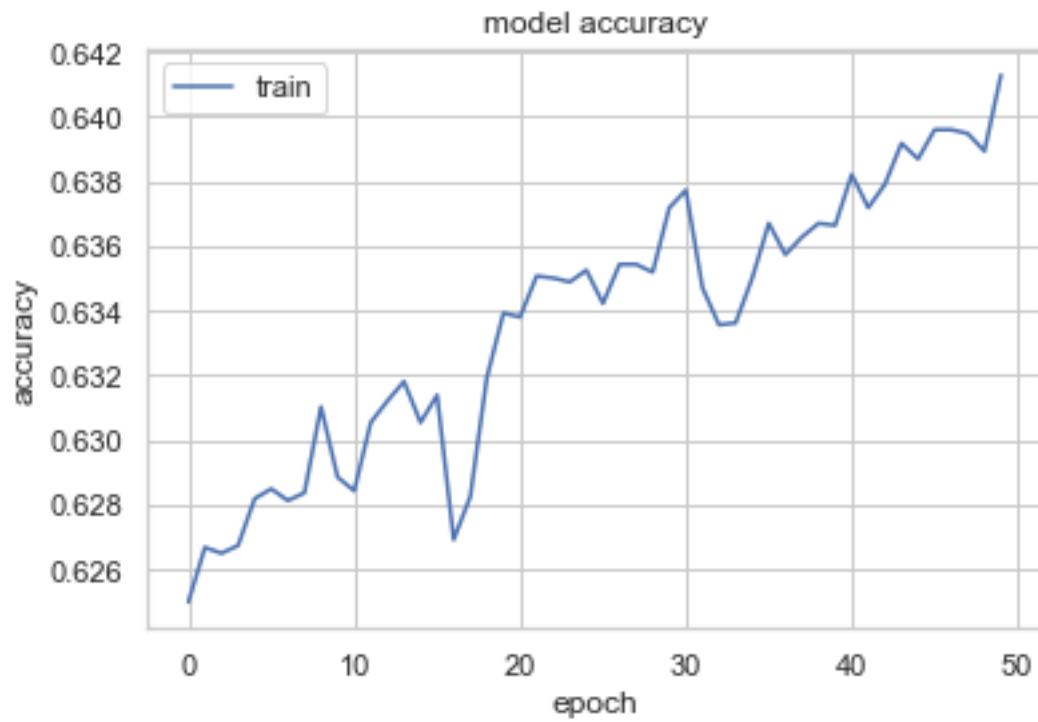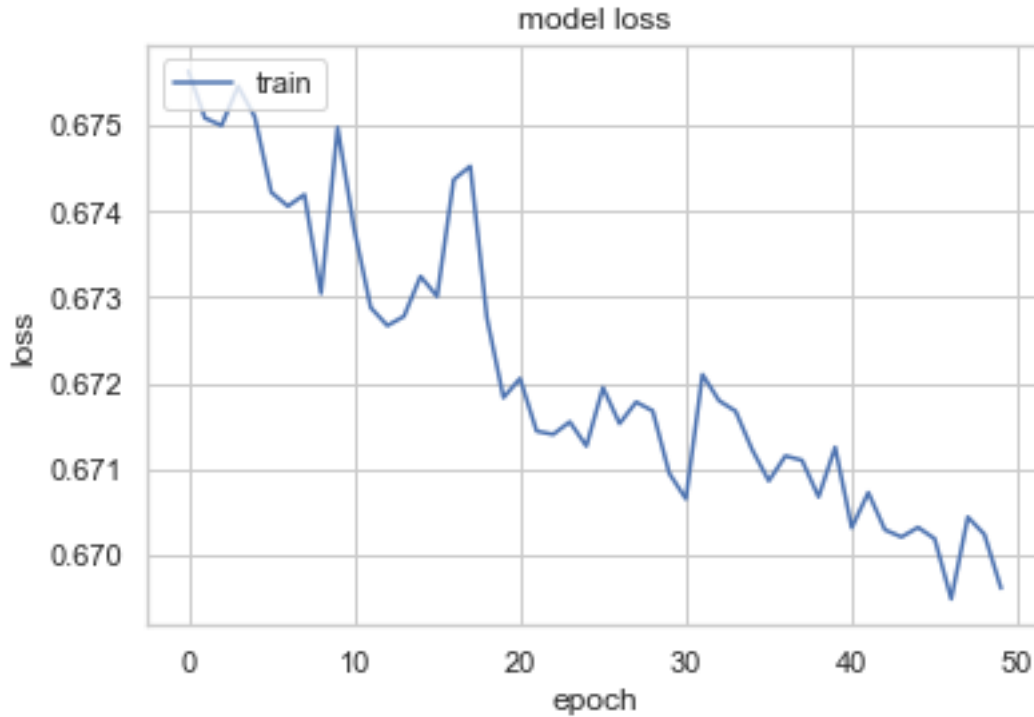
3.0.1 Results

- This isn't awful, but it isn't great. The total training time isn't great, but it could be worse. We see that the loss graph isn't bottoming out – maybe our naive model has more space to go?

3.1 Make a more complex model and try it again

```
[59]: model = keras.Sequential([

          keras.layers.Dense(128, activation=tf.nn.relu),
              keras.layers.Dense(128, activation=tf.nn.relu),
          keras.layers.Dense(1, activation=tf.nn.sigmoid),
      ])
```

```
[60]: model.compile(optimizer='adam',
                    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                    metrics=['accuracy'])

      history = model.fit(X_train, y_train, epochs=50)
      test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/50
```

```
16557/16557 [==============================] - 2s 143us/sample - loss: 0.6946 -
accuracy: 0.5732
Epoch 2/50
16557/16557 [==============================] - 2s 106us/sample - loss: 0.6931 -
accuracy: 0.5739
Epoch 3/50
16557/16557 [==============================] - 2s 106us/sample - loss: 0.6933 -
accuracy: 0.5743
Epoch 4/50
16557/16557 [==============================] - 2s 107us/sample - loss: 0.6934 -
accuracy: 0.5751
Epoch 5/50
16557/16557 [==============================] - 2s 109us/sample - loss: 0.6924 -
accuracy: 0.5776
Epoch 6/50
16557/16557 [==============================] - 2s 109us/sample - loss: 0.6917 -
accuracy: 0.5790
Epoch 7/50
16557/16557 [==============================] - 2s 110us/sample - loss: 0.6910 -
accuracy: 0.5805
Epoch 8/50
16557/16557 [==============================] - 2s 108us/sample - loss: 0.6906 -
accuracy: 0.5817
Epoch 9/50
16557/16557 [==============================] - 2s 107us/sample - loss: 0.6911 -
accuracy: 0.5818
Epoch 10/50
16557/16557 [==============================] - 2s 107us/sample - loss: 0.6908 -
accuracy: 0.5819
Epoch 11/50
16557/16557 [==============================] - 2s 107us/sample - loss: 0.6901 -
accuracy: 0.5830
Epoch 12/50
16557/16557 [==============================] - 2s 111us/sample - loss: 0.6901 -
accuracy: 0.5831
Epoch 13/50
16557/16557 [==============================] - 2s 111us/sample - loss: 0.6899 -
accuracy: 0.5834
Epoch 14/50
16557/16557 [==============================] - 2s 110us/sample - loss: 0.6898 -
accuracy: 0.5837
Epoch 15/50
16557/16557 [==============================] - 2s 117us/sample - loss: 0.6896 -
accuracy: 0.5843
Epoch 16/50
16557/16557 [==============================] - 2s 113us/sample - loss: 0.6898 -
accuracy: 0.5858
Epoch 17/50
```

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16557/16557 [==============================] - 2s 115us/sample - loss: 0.6898 -
accuracy: 0.5860
Epoch 18/50
16557/16557 [==============================] - 2s 105us/sample - loss: 0.6895 -
accuracy: 0.5865
Epoch 19/50
16557/16557 [==============================] - 2s 106us/sample - loss: 0.6892 -
accuracy: 0.5850
Epoch 20/50
16557/16557 [==============================] - 2s 105us/sample - loss: 0.6892 -
accuracy: 0.5860
Epoch 21/50
16557/16557 [==============================] - 2s 104us/sample - loss: 0.6887 -
accuracy: 0.5867
Epoch 22/50
16557/16557 [==============================] - 2s 104us/sample - loss: 0.6932 -
accuracy: 0.5851
Epoch 23/50
16557/16557 [==============================] - 2s 105us/sample - loss: 0.6885 -
accuracy: 0.5876
Epoch 24/50
16557/16557 [==============================] - 2s 104us/sample - loss: 0.6886 -
accuracy: 0.5874
Epoch 25/50
16557/16557 [==============================] - 2s 108us/sample - loss: 0.6886 -
accuracy: 0.5900
Epoch 26/50
16557/16557 [==============================] - 2s 112us/sample - loss: 0.6882 -
accuracy: 0.5882
Epoch 27/50
16557/16557 [==============================] - 2s 112us/sample - loss: 0.6885 -
accuracy: 0.5865
Epoch 28/50
16557/16557 [==============================] - 2s 113us/sample - loss: 0.6880 -
accuracy: 0.5884
Epoch 29/50
16557/16557 [==============================] - 2s 109us/sample - loss: 0.6876 -
accuracy: 0.5891
Epoch 30/50
16557/16557 [==============================] - 2s 109us/sample - loss: 0.6876 -
accuracy: 0.5893
Epoch 31/50
16557/16557 [==============================] - 2s 105us/sample - loss: 0.6873 -
accuracy: 0.5899
Epoch 32/50
16557/16557 [==============================] - 2s 108us/sample - loss: 0.6880 -
accuracy: 0.5886
Epoch 33/50
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16557/16557 [==============================] - 2s 110us/sample - loss: 0.6872 -
accuracy: 0.5903
Epoch 34/50
16557/16557 [==============================] - 2s 121us/sample - loss: 0.6874 -
accuracy: 0.5900
Epoch 35/50
16557/16557 [==============================] - 2s 132us/sample - loss: 0.6878 -
accuracy: 0.5897
Epoch 36/50
16557/16557 [==============================] - 2s 141us/sample - loss: 0.6875 -
accuracy: 0.5903
Epoch 37/50
16557/16557 [==============================] - 2s 132us/sample - loss: 0.6887 -
accuracy: 0.5903
Epoch 38/50
16557/16557 [==============================] - 2s 138us/sample - loss: 0.6875 -
accuracy: 0.5917
Epoch 39/50
16557/16557 [==============================] - 2s 141us/sample - loss: 0.6884 -
accuracy: 0.5921
Epoch 40/50
16557/16557 [==============================] - 2s 140us/sample - loss: 0.6911 -
accuracy: 0.5893
Epoch 41/50
16557/16557 [==============================] - 2s 142us/sample - loss: 0.6906 -
accuracy: 0.5892
Epoch 42/50
16557/16557 [==============================] - 2s 140us/sample - loss: 0.6886 -
accuracy: 0.5924
Epoch 43/50
16557/16557 [==============================] - 2s 143us/sample - loss: 0.6896 -
accuracy: 0.5936
Epoch 44/50
16557/16557 [==============================] - 2s 143us/sample - loss: 0.6892 -
accuracy: 0.5935
Epoch 45/50
16557/16557 [==============================] - 2s 150us/sample - loss: 0.6901 -
accuracy: 0.5944
Epoch 46/50
16557/16557 [==============================] - 2s 141us/sample - loss: 0.6913 -
accuracy: 0.5933
Epoch 47/50
16557/16557 [==============================] - 2s 145us/sample - loss: 0.6920 -
accuracy: 0.5935
Epoch 48/50
16557/16557 [==============================] - 2s 139us/sample - loss: 0.6903 -
accuracy: 0.5940
Epoch 49/50
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16557/16557 [==============================] - 2s 137us/sample - loss: 0.6873 -
accuracy: 0.5975
Epoch 50/50
16557/16557 [==============================] - 2s 136us/sample - loss: 0.6876 -
accuracy: 0.5978
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========] - 1s 96us/sample - loss: 0.6964 - accuracy: 0.5862
```

```
[61]: print("Accuracy: {}".format(test_acc))
      plot_history(history)
```

Accuracy: 0.5862318873405457
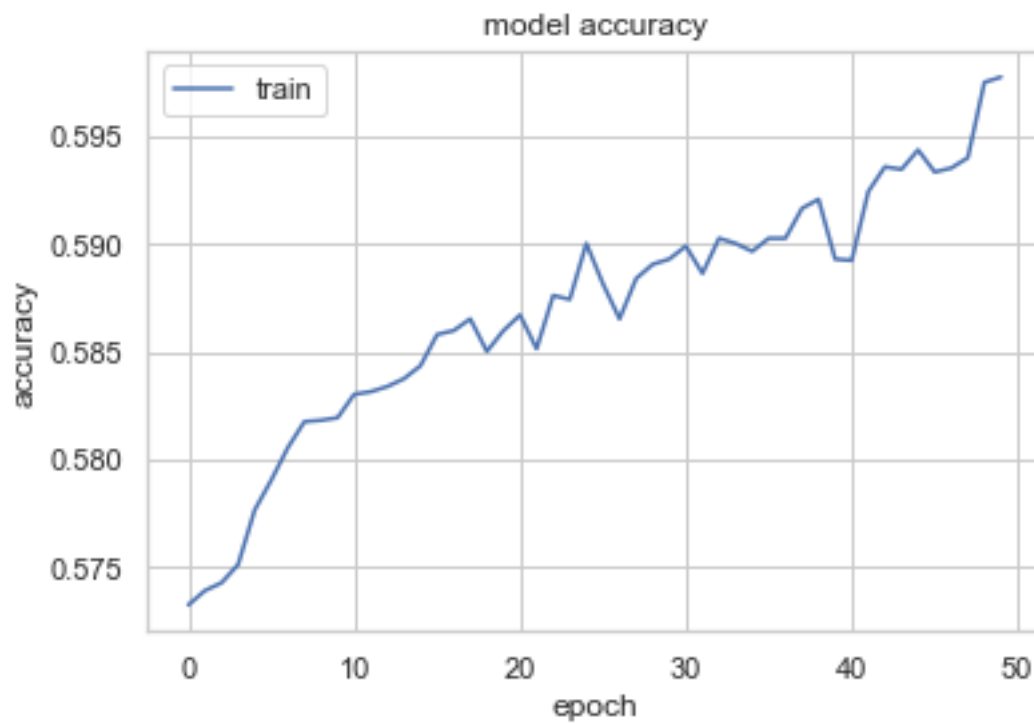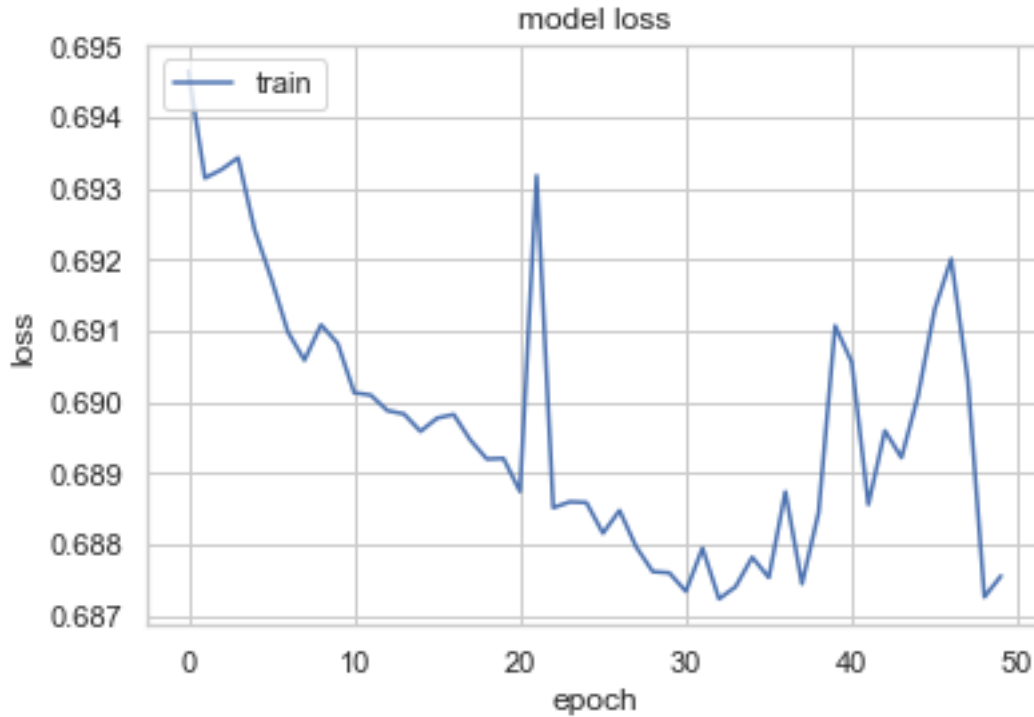
3.2 Results

- Making it a more "complex" model just make it train very slowly and work poorly. Let's just try using more epochs.

4 1000 Epochs, 16 RELU / 16 RELU

```
[62]: model = keras.Sequential([

          keras.layers.Dense(16, activation=tf.nn.relu),
              keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(1, activation=tf.nn.sigmoid),
      ])
```

```
[63]: model.compile(optimizer='adam',
                    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                    metrics=['accuracy'])

      history = model.fit(X_train, y_train, epochs=1000)
      test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/1000
```

```
16557/16557 [==============================] - 2s 101us/sample - loss: 0.6938 -
accuracy: 0.5740
Epoch 2/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6930 -
accuracy: 0.5741
Epoch 3/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6928 -
accuracy: 0.5748
Epoch 4/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6919 -
accuracy: 0.5775
Epoch 5/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6916 -
accuracy: 0.5798
Epoch 6/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6911 -
accuracy: 0.5824
Epoch 7/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6899 -
accuracy: 0.5871
Epoch 8/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6895 -
accuracy: 0.5887
Epoch 9/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6882 -
accuracy: 0.5913
Epoch 10/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6872 -
accuracy: 0.5947
Epoch 11/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6863 -
accuracy: 0.5976
Epoch 12/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6851 -
accuracy: 0.5995
Epoch 13/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6846 -
accuracy: 0.6025
Epoch 14/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6843 -
accuracy: 0.6030
Epoch 15/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6836 -
accuracy: 0.6047
Epoch 16/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6837 -
accuracy: 0.6046
Epoch 17/1000
```

```
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6838 -
accuracy: 0.6053
Epoch 18/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6833 -
accuracy: 0.6054
Epoch 19/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6820 -
accuracy: 0.6095
Epoch 20/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6818 -
accuracy: 0.6092
Epoch 21/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6812 -
accuracy: 0.6106
Epoch 22/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6808 -
accuracy: 0.6110
Epoch 23/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6804 -
accuracy: 0.6116
Epoch 24/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6801 -
accuracy: 0.6128
Epoch 25/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6812 -
accuracy: 0.6126
Epoch 26/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6810 -
accuracy: 0.6104
Epoch 27/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6796 -
accuracy: 0.6145
Epoch 28/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6797 -
accuracy: 0.6156
Epoch 29/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6789 -
accuracy: 0.6164
Epoch 30/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6793 -
accuracy: 0.6151
Epoch 31/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6782 -
accuracy: 0.6171
Epoch 32/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6779 -
accuracy: 0.6183
Epoch 33/1000
```

```
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6790 -
accuracy: 0.6164
Epoch 34/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6781 -
accuracy: 0.6187
Epoch 35/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6777 -
accuracy: 0.6191
Epoch 36/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6773 -
accuracy: 0.6205
Epoch 37/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6775 -
accuracy: 0.6199
Epoch 38/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6772 -
accuracy: 0.6206
Epoch 39/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6775 -
accuracy: 0.6191
Epoch 40/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6788 -
accuracy: 0.6157
Epoch 41/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6771 -
accuracy: 0.6200
Epoch 42/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6770 -
accuracy: 0.6202
Epoch 43/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6764 -
accuracy: 0.6213
Epoch 44/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6760 -
accuracy: 0.6223
Epoch 45/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6765 -
accuracy: 0.6220
Epoch 46/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6764 -
accuracy: 0.6227
Epoch 47/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6757 -
accuracy: 0.6225
Epoch 48/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6759 -
accuracy: 0.6232
Epoch 49/1000
```

```
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6762 -
accuracy: 0.6226
Epoch 50/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6760 -
accuracy: 0.6228
Epoch 51/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6763 -
accuracy: 0.6220
Epoch 52/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6760 -
accuracy: 0.6223
Epoch 53/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6755 -
accuracy: 0.6238
Epoch 54/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6755 -
accuracy: 0.6234
Epoch 55/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6754 -
accuracy: 0.6240
Epoch 56/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6750 -
accuracy: 0.6248
Epoch 57/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6749 -
accuracy: 0.6246
Epoch 58/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6748 -
accuracy: 0.6253
Epoch 59/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6753 -
accuracy: 0.6234
Epoch 60/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6754 -
accuracy: 0.6231
Epoch 61/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6756 -
accuracy: 0.6234
Epoch 62/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6747 -
accuracy: 0.6258
Epoch 63/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6754 -
accuracy: 0.6239
Epoch 64/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6744 -
accuracy: 0.6258
Epoch 65/1000
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16557/16557 [==============================] - 1s 54us/sample - loss: 0.6741 -
accuracy: 0.6272
Epoch 66/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6744 -
accuracy: 0.6257
Epoch 67/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6757 -
accuracy: 0.6240
Epoch 68/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6750 -
accuracy: 0.6252
Epoch 69/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6746 -
accuracy: 0.6260
Epoch 70/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6749 -
accuracy: 0.6252
Epoch 71/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6746 -
accuracy: 0.6257
Epoch 72/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6743 -
accuracy: 0.6262
Epoch 73/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6740 -
accuracy: 0.6272
Epoch 74/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6743 -
accuracy: 0.6263
Epoch 75/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6748 -
accuracy: 0.6251
Epoch 76/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6746 -
accuracy: 0.6252
Epoch 77/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6746 -
accuracy: 0.6258
Epoch 78/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6742 -
accuracy: 0.6264
Epoch 79/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6746 -
accuracy: 0.6256
Epoch 80/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6742 -
accuracy: 0.6265
Epoch 81/1000
```

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16557/16557 [==============================] - 1s 51us/sample - loss: 0.6745 -
accuracy: 0.6263
Epoch 82/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6745 -
accuracy: 0.6258
Epoch 83/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6743 -
accuracy: 0.6264
Epoch 84/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6736 -
accuracy: 0.6283
Epoch 85/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6733 -
accuracy: 0.6287
Epoch 86/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6735 -
accuracy: 0.6278
Epoch 87/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6736 -
accuracy: 0.6277
Epoch 88/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6741 -
accuracy: 0.6267
Epoch 89/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6737 -
accuracy: 0.6284
Epoch 90/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6734 -
accuracy: 0.6286
Epoch 91/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6729 -
accuracy: 0.6302
Epoch 92/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6731 -
accuracy: 0.6294
Epoch 93/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6733 -
accuracy: 0.6290
Epoch 94/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6741 -
accuracy: 0.6281
Epoch 95/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6740 -
accuracy: 0.6273
Epoch 96/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6730 -
accuracy: 0.6293
Epoch 97/1000
```

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16557/16557 [==============================] - 1s 50us/sample - loss: 0.6730 -
accuracy: 0.6296
Epoch 98/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6736 -
accuracy: 0.6281
Epoch 99/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6742 -
accuracy: 0.6270
Epoch 100/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6740 -
accuracy: 0.6281
Epoch 101/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6732 -
accuracy: 0.6302
Epoch 102/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6733 -
accuracy: 0.6293
Epoch 103/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6734 -
accuracy: 0.6304
Epoch 104/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6746 -
accuracy: 0.6275
Epoch 105/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6734 -
accuracy: 0.6285
Epoch 106/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6731 -
accuracy: 0.6296
Epoch 107/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6730 -
accuracy: 0.6302
Epoch 108/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6737 -
accuracy: 0.6288
Epoch 109/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6736 -
accuracy: 0.6288
Epoch 110/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6726 -
accuracy: 0.6308
Epoch 111/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6726 -
accuracy: 0.6310
Epoch 112/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6728 -
accuracy: 0.6310
Epoch 113/1000
```

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16557/16557 [==============================] - 1s 58us/sample - loss: 0.6729 -
accuracy: 0.6302
Epoch 114/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6729 -
accuracy: 0.6302
Epoch 115/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6730 -
accuracy: 0.6301
Epoch 116/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6732 -
accuracy: 0.6298
Epoch 117/1000
16557/16557 [==============================] - 1s 47us/sample - loss: 0.6729 -
accuracy: 0.6305
Epoch 118/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6726 -
accuracy: 0.6316
Epoch 119/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6728 -
accuracy: 0.6309
Epoch 120/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6730 -
accuracy: 0.6300
Epoch 121/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6725 -
accuracy: 0.6312
Epoch 122/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6722 -
accuracy: 0.6313
Epoch 123/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6724 -
accuracy: 0.6306
Epoch 124/1000
16557/16557 [==============================] - 1s 48us/sample - loss: 0.6722 -
accuracy: 0.6311
Epoch 125/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6717 -
accuracy: 0.6328
Epoch 126/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6716 -
accuracy: 0.6328
Epoch 127/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6715 -
accuracy: 0.6331
Epoch 128/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6722 -
accuracy: 0.6322
Epoch 129/1000
```

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16557/16557 [==============================] - 1s 49us/sample - loss: 0.6724 -
accuracy: 0.6316
Epoch 130/1000
16557/16557 [==============================] - 1s 49us/sample - loss: 0.6732 -
accuracy: 0.6304
Epoch 131/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6729 -
accuracy: 0.6309
Epoch 132/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6729 -
accuracy: 0.6309
Epoch 133/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6722 -
accuracy: 0.6317
Epoch 134/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6719 -
accuracy: 0.6334
Epoch 135/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6715 -
accuracy: 0.6339
Epoch 136/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6727 -
accuracy: 0.6312
Epoch 137/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6727 -
accuracy: 0.6319
Epoch 138/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6734 -
accuracy: 0.6301
Epoch 139/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6724 -
accuracy: 0.6319
Epoch 140/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6790 -
accuracy: 0.6305
Epoch 141/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6717 -
accuracy: 0.6337
Epoch 142/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6725 -
accuracy: 0.6323
Epoch 143/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6793 -
accuracy: 0.6324
Epoch 144/1000
16557/16557 [==============================] - 1s 50us/sample - loss: 0.6720 -
accuracy: 0.6330
Epoch 145/1000
```

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16557/16557 [==============================] - 1s 50us/sample - loss: 0.6720 -
accuracy: 0.6335
Epoch 146/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6721 -
accuracy: 0.6325
Epoch 147/1000
16557/16557 [==============================] - 1s 51us/sample - loss: 0.6714 -
accuracy: 0.6342
Epoch 148/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6715 -
accuracy: 0.6344
Epoch 149/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6724 -
accuracy: 0.6313
Epoch 150/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6726 -
accuracy: 0.6307
Epoch 151/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6719 -
accuracy: 0.6325
Epoch 152/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6715 -
accuracy: 0.6339
Epoch 153/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6712 -
accuracy: 0.6347
Epoch 154/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6715 -
accuracy: 0.6339
Epoch 155/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6710 -
accuracy: 0.6353
Epoch 156/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6711 -
accuracy: 0.6346
Epoch 157/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6715 -
accuracy: 0.6340
Epoch 158/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6716 -
accuracy: 0.6341
Epoch 159/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6716 -
accuracy: 0.6344
Epoch 160/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6711 -
accuracy: 0.6352
Epoch 161/1000
```

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16557/16557 [==============================] - 1s 53us/sample - loss: 0.6716 -
accuracy: 0.6334
Epoch 162/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6704 -
accuracy: 0.6365
Epoch 163/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6705 -
accuracy: 0.6362
Epoch 164/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6707 -
accuracy: 0.6366
Epoch 165/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6702 -
accuracy: 0.6369
Epoch 166/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6703 -
accuracy: 0.6370
Epoch 167/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6707 -
accuracy: 0.6359
Epoch 168/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6707 -
accuracy: 0.6364
Epoch 169/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6711 -
accuracy: 0.6360
Epoch 170/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6715 -
accuracy: 0.6347
Epoch 171/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6712 -
accuracy: 0.6359
Epoch 172/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6716 -
accuracy: 0.6350
Epoch 173/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6724 -
accuracy: 0.6330
Epoch 174/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6724 -
accuracy: 0.6316
Epoch 175/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6714 -
accuracy: 0.6346
Epoch 176/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6717 -
accuracy: 0.6352
Epoch 177/1000
```

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16557/16557 [==============================] - 1s 54us/sample - loss: 0.6711 -
accuracy: 0.6363
Epoch 178/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6720 -
accuracy: 0.6346
Epoch 179/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6718 -
accuracy: 0.6341
Epoch 180/1000
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6715 -
accuracy: 0.6343
Epoch 181/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6712 -
accuracy: 0.6348
Epoch 182/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6706 -
accuracy: 0.6368
Epoch 183/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6702 -
accuracy: 0.6376
Epoch 184/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6712 -
accuracy: 0.6359
Epoch 185/1000
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6719 -
accuracy: 0.6351
Epoch 186/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6724 -
accuracy: 0.6344
Epoch 187/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6732 -
accuracy: 0.6326
Epoch 188/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6721 -
accuracy: 0.6345
Epoch 189/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6715 -
accuracy: 0.6356
Epoch 190/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6712 -
accuracy: 0.6356
Epoch 191/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6715 -
accuracy: 0.6344
Epoch 192/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6716 -
accuracy: 0.6343
Epoch 193/1000
```

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16557/16557 [==============================] - 1s 56us/sample - loss: 0.6717 -
accuracy: 0.6348
Epoch 194/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6710 -
accuracy: 0.6357
Epoch 195/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6705 -
accuracy: 0.6369
Epoch 196/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6703 -
accuracy: 0.6374
Epoch 197/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6703 -
accuracy: 0.6374
Epoch 198/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6700 -
accuracy: 0.6380
Epoch 199/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6697 -
accuracy: 0.6385
Epoch 200/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6698 -
accuracy: 0.6380
Epoch 201/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6709 -
accuracy: 0.6361
Epoch 202/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6716 -
accuracy: 0.6340
Epoch 203/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6703 -
accuracy: 0.6376
Epoch 204/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6703 -
accuracy: 0.6377
Epoch 205/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6708 -
accuracy: 0.6371
Epoch 206/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6703 -
accuracy: 0.6376
Epoch 207/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6697 -
accuracy: 0.6387
Epoch 208/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6696 -
accuracy: 0.6391
Epoch 209/1000
```

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16557/16557 [==============================] - 1s 58us/sample - loss: 0.6703 -
accuracy: 0.6370
Epoch 210/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6698 -
accuracy: 0.6388
Epoch 211/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6696 -
accuracy: 0.6386
Epoch 212/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6699 -
accuracy: 0.6383
Epoch 213/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6708 -
accuracy: 0.6366
Epoch 214/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6697 -
accuracy: 0.6388
Epoch 215/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6703 -
accuracy: 0.6379
Epoch 216/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6698 -
accuracy: 0.6385
Epoch 217/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6699 -
accuracy: 0.6389
Epoch 218/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6707 -
accuracy: 0.6372
Epoch 219/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6703 -
accuracy: 0.6381
Epoch 220/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6695 -
accuracy: 0.6396
Epoch 221/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6700 -
accuracy: 0.6385
Epoch 222/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6702 -
accuracy: 0.6384
Epoch 223/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6697 -
accuracy: 0.6391
Epoch 224/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6700 -
accuracy: 0.6388
Epoch 225/1000
```

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16557/16557 [==============================] - 1s 56us/sample - loss: 0.6699 -
accuracy: 0.6391
Epoch 226/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6695 -
accuracy: 0.6399
Epoch 227/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6692 -
accuracy: 0.6405
Epoch 228/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6693 -
accuracy: 0.6400
Epoch 229/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6697 -
accuracy: 0.6395
Epoch 230/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6699 -
accuracy: 0.6389
Epoch 231/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6707 -
accuracy: 0.6369
Epoch 232/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6703 -
accuracy: 0.6380
Epoch 233/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6700 -
accuracy: 0.6389
Epoch 234/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6698 -
accuracy: 0.6391
Epoch 235/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6702 -
accuracy: 0.6380
Epoch 236/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6694 -
accuracy: 0.6400
Epoch 237/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6710 -
accuracy: 0.6365
Epoch 238/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6706 -
accuracy: 0.6366
Epoch 239/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6697 -
accuracy: 0.6389
Epoch 240/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6697 -
accuracy: 0.6389
Epoch 241/1000
```

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16557/16557 [==============================] - 1s 54us/sample - loss: 0.6694 -
accuracy: 0.6399
Epoch 242/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6694 -
accuracy: 0.6395
Epoch 243/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6689 -
accuracy: 0.6405
Epoch 244/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6694 -
accuracy: 0.6397
Epoch 245/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6695 -
accuracy: 0.6395
Epoch 246/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6696 -
accuracy: 0.6393
Epoch 247/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6697 -
accuracy: 0.6390
Epoch 248/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6702 -
accuracy: 0.6373
Epoch 249/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6702 -
accuracy: 0.6378
Epoch 250/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6700 -
accuracy: 0.6388
Epoch 251/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6699 -
accuracy: 0.6385
Epoch 252/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6399
Epoch 253/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6692 -
accuracy: 0.6399
Epoch 254/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6399
Epoch 255/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6691 -
accuracy: 0.6405
Epoch 256/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6697 -
accuracy: 0.6392
Epoch 257/1000
```

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16557/16557 [==============================] - 1s 55us/sample - loss: 0.6695 -
accuracy: 0.6395
Epoch 258/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6694 -
accuracy: 0.6398
Epoch 259/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6401
Epoch 260/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6692 -
accuracy: 0.6404
Epoch 261/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6405
Epoch 262/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6698 -
accuracy: 0.6386
Epoch 263/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6698 -
accuracy: 0.6386
Epoch 264/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6694 -
accuracy: 0.6402
Epoch 265/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6690 -
accuracy: 0.6409
Epoch 266/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6688 -
accuracy: 0.6415
Epoch 267/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6687 -
accuracy: 0.6415
Epoch 268/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6406
Epoch 269/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6695 -
accuracy: 0.6403
Epoch 270/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6701 -
accuracy: 0.6388
Epoch 271/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6699 -
accuracy: 0.6381
Epoch 272/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6693 -
accuracy: 0.6399
Epoch 273/1000
```

```
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6702 -
accuracy: 0.6376
Epoch 274/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6690 -
accuracy: 0.6409
Epoch 275/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6686 -
accuracy: 0.6417
Epoch 276/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6687 -
accuracy: 0.6418
Epoch 277/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6689 -
accuracy: 0.6409
Epoch 278/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6693 -
accuracy: 0.6407
Epoch 279/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6690 -
accuracy: 0.6406
Epoch 280/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6686 -
accuracy: 0.6417
Epoch 281/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6690 -
accuracy: 0.6408
Epoch 282/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6687 -
accuracy: 0.6414
Epoch 283/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6690 -
accuracy: 0.6404
Epoch 284/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6691 -
accuracy: 0.6410
Epoch 285/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6691 -
accuracy: 0.6410
Epoch 286/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6694 -
accuracy: 0.6399
Epoch 287/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6699 -
accuracy: 0.6389
Epoch 288/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6694 -
accuracy: 0.6397
Epoch 289/1000
```

```
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6698 -
accuracy: 0.6392
Epoch 290/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6695 -
accuracy: 0.6400
Epoch 291/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6689 -
accuracy: 0.6409
Epoch 292/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6690 -
accuracy: 0.6407
Epoch 293/1000
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6688 -
accuracy: 0.6408
Epoch 294/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6681 -
accuracy: 0.6431
Epoch 295/1000
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6682 -
accuracy: 0.6425
Epoch 296/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6684 -
accuracy: 0.6420
Epoch 297/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6687 -
accuracy: 0.6410
Epoch 298/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6678 -
accuracy: 0.6432
Epoch 299/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6686 -
accuracy: 0.6418
Epoch 300/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6684 -
accuracy: 0.6423
Epoch 301/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6682 -
accuracy: 0.6425
Epoch 302/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6683 -
accuracy: 0.6422
Epoch 303/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6686 -
accuracy: 0.6413
Epoch 304/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6692 -
accuracy: 0.6402
Epoch 305/1000
```

```
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6683 -
accuracy: 0.6420
Epoch 306/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6685 -
accuracy: 0.6417
Epoch 307/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6678 -
accuracy: 0.6433
Epoch 308/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6683 -
accuracy: 0.6419
Epoch 309/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6686 -
accuracy: 0.6412
Epoch 310/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6690 -
accuracy: 0.6402
Epoch 311/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6684 -
accuracy: 0.6418
Epoch 312/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6680 -
accuracy: 0.6426
Epoch 313/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6682 -
accuracy: 0.6423
Epoch 314/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6683 -
accuracy: 0.6421
Epoch 315/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6682 -
accuracy: 0.6421
Epoch 316/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6686 -
accuracy: 0.6417
Epoch 317/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6682 -
accuracy: 0.6424
Epoch 318/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6684 -
accuracy: 0.6419
Epoch 319/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6686 -
accuracy: 0.6409
Epoch 320/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6681 -
accuracy: 0.6423
Epoch 321/1000
```

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16557/16557 [==============================] - 1s 56us/sample - loss: 0.6676 -
accuracy: 0.6437
Epoch 322/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6683 -
accuracy: 0.6418
Epoch 323/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6687 -
accuracy: 0.6413
Epoch 324/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6683 -
accuracy: 0.6420
Epoch 325/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6682 -
accuracy: 0.6424
Epoch 326/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6685 -
accuracy: 0.6415
Epoch 327/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6690 -
accuracy: 0.6403
Epoch 328/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6686 -
accuracy: 0.6409
Epoch 329/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6679 -
accuracy: 0.6426
Epoch 330/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6682 -
accuracy: 0.6415
Epoch 331/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6685 -
accuracy: 0.6411
Epoch 332/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6680 -
accuracy: 0.6423
Epoch 333/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6671 -
accuracy: 0.6443
Epoch 334/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6679 -
accuracy: 0.6427
Epoch 335/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6677 -
accuracy: 0.6432
Epoch 336/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6675 -
accuracy: 0.6437
Epoch 337/1000
```

```
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6679 -
accuracy: 0.6429
Epoch 338/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6675 -
accuracy: 0.6438
Epoch 339/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6681 -
accuracy: 0.6428
Epoch 340/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6681 -
accuracy: 0.6429
Epoch 341/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6676 -
accuracy: 0.6440
Epoch 342/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6679 -
accuracy: 0.6429
Epoch 343/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6682 -
accuracy: 0.6433
Epoch 344/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6675 -
accuracy: 0.6438
Epoch 345/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6671 -
accuracy: 0.6444
Epoch 346/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6677 -
accuracy: 0.6434
Epoch 347/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6693 -
accuracy: 0.6412
Epoch 348/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6683 -
accuracy: 0.6429
Epoch 349/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6677 -
accuracy: 0.6441
Epoch 350/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6683 -
accuracy: 0.6431
Epoch 351/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6679 -
accuracy: 0.6436
Epoch 352/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6677 -
accuracy: 0.6436
Epoch 353/1000
```

```
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6674 -
accuracy: 0.6440
Epoch 354/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6676 -
accuracy: 0.6437
Epoch 355/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6676 -
accuracy: 0.6439
Epoch 356/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6692 -
accuracy: 0.6414
Epoch 357/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6679 -
accuracy: 0.6438
Epoch 358/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6677 -
accuracy: 0.6435
Epoch 359/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6681 -
accuracy: 0.6433
Epoch 360/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6673 -
accuracy: 0.6444
Epoch 361/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6672 -
accuracy: 0.6446
Epoch 362/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6671 -
accuracy: 0.6449
Epoch 363/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6673 -
accuracy: 0.6447
Epoch 364/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6676 -
accuracy: 0.6440
Epoch 365/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6679 -
accuracy: 0.6430
Epoch 366/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6687 -
accuracy: 0.6419
Epoch 367/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6695 -
accuracy: 0.6400
Epoch 368/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6684 -
accuracy: 0.6429
Epoch 369/1000
```

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16557/16557 [==============================] - 1s 58us/sample - loss: 0.6683 -
accuracy: 0.6426
Epoch 370/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6678 -
accuracy: 0.6435
Epoch 371/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6673 -
accuracy: 0.6445
Epoch 372/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6672 -
accuracy: 0.6448
Epoch 373/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6672 -
accuracy: 0.6446
Epoch 374/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6670 -
accuracy: 0.6451
Epoch 375/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6667 -
accuracy: 0.6458
Epoch 376/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6669 -
accuracy: 0.6450
Epoch 377/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6678 -
accuracy: 0.6432
Epoch 378/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6675 -
accuracy: 0.6446
Epoch 379/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6673 -
accuracy: 0.6450
Epoch 380/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6673 -
accuracy: 0.6450
Epoch 381/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6668 -
accuracy: 0.6458
Epoch 382/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6667 -
accuracy: 0.6460
Epoch 383/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6673 -
accuracy: 0.6445
Epoch 384/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6676 -
accuracy: 0.6444
Epoch 385/1000
```

```
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6682 -
accuracy: 0.6427
Epoch 386/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6677 -
accuracy: 0.6444
Epoch 387/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6666 -
accuracy: 0.6466
Epoch 388/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6676 -
accuracy: 0.6443
Epoch 389/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6680 -
accuracy: 0.6438
Epoch 390/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6674 -
accuracy: 0.6445
Epoch 391/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6670 -
accuracy: 0.6458
Epoch 392/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6674 -
accuracy: 0.6447
Epoch 393/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6668 -
accuracy: 0.6462
Epoch 394/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6669 -
accuracy: 0.6461
Epoch 395/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6670 -
accuracy: 0.6455
Epoch 396/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6688 -
accuracy: 0.6408
Epoch 397/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6686 -
accuracy: 0.6407
Epoch 398/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6674 -
accuracy: 0.6442
Epoch 399/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6674 -
accuracy: 0.6437
Epoch 400/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6667 -
accuracy: 0.6455
Epoch 401/1000
```

```
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6667 -
accuracy: 0.6463
Epoch 402/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6667 -
accuracy: 0.6458
Epoch 403/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6663 -
accuracy: 0.6469
Epoch 404/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6666 -
accuracy: 0.6466
Epoch 405/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6671 -
accuracy: 0.6455
Epoch 406/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6666 -
accuracy: 0.6459
Epoch 407/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6665 -
accuracy: 0.6466
Epoch 408/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6672 -
accuracy: 0.6456
Epoch 409/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6672 -
accuracy: 0.6452
Epoch 410/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6667 -
accuracy: 0.6465
Epoch 411/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6668 -
accuracy: 0.6460
Epoch 412/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6665 -
accuracy: 0.6463
Epoch 413/1000
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6663 -
accuracy: 0.6471
Epoch 414/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6666 -
accuracy: 0.6466
Epoch 415/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6668 -
accuracy: 0.6457
Epoch 416/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6670 -
accuracy: 0.6456
Epoch 417/1000
```

```
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6673 -
accuracy: 0.6452
Epoch 418/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6666 -
accuracy: 0.6463
Epoch 419/1000
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6668 -
accuracy: 0.6461
Epoch 420/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6673 -
accuracy: 0.6450
Epoch 421/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6671 -
accuracy: 0.6454
Epoch 422/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6667 -
accuracy: 0.6461
Epoch 423/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6666 -
accuracy: 0.6460
Epoch 424/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6663 -
accuracy: 0.6472
Epoch 425/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6670 -
accuracy: 0.6458
Epoch 426/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6675 -
accuracy: 0.6441
Epoch 427/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6665 -
accuracy: 0.6464
Epoch 428/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6663 -
accuracy: 0.6469
Epoch 429/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6668 -
accuracy: 0.6458
Epoch 430/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6666 -
accuracy: 0.6463
Epoch 431/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6664 -
accuracy: 0.6470
Epoch 432/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6660 -
accuracy: 0.6475
Epoch 433/1000
```

```
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6667 -
accuracy: 0.6461
Epoch 434/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6662 -
accuracy: 0.6468
Epoch 435/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6662 -
accuracy: 0.6476
Epoch 436/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6659 -
accuracy: 0.6481
Epoch 437/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6670 -
accuracy: 0.6452
Epoch 438/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6675 -
accuracy: 0.6439
Epoch 439/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6669 -
accuracy: 0.6457
Epoch 440/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6659 -
accuracy: 0.6479
Epoch 441/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6659 -
accuracy: 0.6478
Epoch 442/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6656 -
accuracy: 0.6487
Epoch 443/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6661 -
accuracy: 0.6475
Epoch 444/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6668 -
accuracy: 0.6456
Epoch 445/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6670 -
accuracy: 0.6449
Epoch 446/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6668 -
accuracy: 0.6459
Epoch 447/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6665 -
accuracy: 0.6472
Epoch 448/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6669 -
accuracy: 0.6463
Epoch 449/1000
```

```
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6666 -
accuracy: 0.6467
Epoch 450/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6664 -
accuracy: 0.6475
Epoch 451/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6664 -
accuracy: 0.6472
Epoch 452/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6656 -
accuracy: 0.6485
Epoch 453/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6655 -
accuracy: 0.6488
Epoch 454/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6655 -
accuracy: 0.6490
Epoch 455/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6660 -
accuracy: 0.6479
Epoch 456/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6664 -
accuracy: 0.6476
Epoch 457/1000
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6660 -
accuracy: 0.6483
Epoch 458/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6657 -
accuracy: 0.6490
Epoch 459/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6660 -
accuracy: 0.6482
Epoch 460/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6656 -
accuracy: 0.6488
Epoch 461/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6660 -
accuracy: 0.6482
Epoch 462/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6664 -
accuracy: 0.6469
Epoch 463/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6664 -
accuracy: 0.6473
Epoch 464/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6660 -
accuracy: 0.6484
Epoch 465/1000
```

```
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6662 -
accuracy: 0.6477
Epoch 466/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6663 -
accuracy: 0.6476
Epoch 467/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6663 -
accuracy: 0.6478
Epoch 468/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6659 -
accuracy: 0.6484
Epoch 469/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6670 -
accuracy: 0.6460
Epoch 470/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6665 -
accuracy: 0.6470
Epoch 471/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6656 -
accuracy: 0.6490
Epoch 472/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6655 -
accuracy: 0.6492
Epoch 473/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6665 -
accuracy: 0.6477
Epoch 474/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6666 -
accuracy: 0.6470
Epoch 475/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6670 -
accuracy: 0.6458
Epoch 476/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6665 -
accuracy: 0.6472
Epoch 477/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6667 -
accuracy: 0.6472
Epoch 478/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6667 -
accuracy: 0.6471
Epoch 479/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6663 -
accuracy: 0.6481
Epoch 480/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6660 -
accuracy: 0.6482
Epoch 481/1000
```

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16557/16557 [==============================] - 1s 63us/sample - loss: 0.6656 -
accuracy: 0.6493
Epoch 482/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6650 -
accuracy: 0.6503
Epoch 483/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6654 -
accuracy: 0.6497
Epoch 484/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6652 -
accuracy: 0.6503
Epoch 485/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6653 -
accuracy: 0.6496
Epoch 486/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6661 -
accuracy: 0.6481
Epoch 487/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6657 -
accuracy: 0.6493
Epoch 488/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6659 -
accuracy: 0.6487
Epoch 489/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6655 -
accuracy: 0.6494
Epoch 490/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6655 -
accuracy: 0.6498
Epoch 491/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6660 -
accuracy: 0.6490
Epoch 492/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6663 -
accuracy: 0.6492
Epoch 493/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6656 -
accuracy: 0.6492
Epoch 494/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6657 -
accuracy: 0.6494
Epoch 495/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6653 -
accuracy: 0.6498
Epoch 496/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6649 -
accuracy: 0.6502
Epoch 497/1000
```

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16557/16557 [==============================] - 1s 62us/sample - loss: 0.6653 -
accuracy: 0.6495
Epoch 498/1000
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6657 -
accuracy: 0.6495
Epoch 499/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6655 -
accuracy: 0.6499
Epoch 500/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6648 -
accuracy: 0.6510
Epoch 501/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6655 -
accuracy: 0.6493
Epoch 502/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6660 -
accuracy: 0.6485
Epoch 503/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6654 -
accuracy: 0.6496
Epoch 504/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6652 -
accuracy: 0.6505
Epoch 505/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6652 -
accuracy: 0.6504
Epoch 506/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6661 -
accuracy: 0.6479
Epoch 507/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6660 -
accuracy: 0.6484
Epoch 508/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6654 -
accuracy: 0.6496
Epoch 509/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6654 -
accuracy: 0.6497
Epoch 510/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6650 -
accuracy: 0.6504
Epoch 511/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6650 -
accuracy: 0.6505
Epoch 512/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6649 -
accuracy: 0.6504
Epoch 513/1000
```

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16557/16557 [==============================] - 1s 62us/sample - loss: 0.6654 -
accuracy: 0.6499
Epoch 514/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6667 -
accuracy: 0.6467
Epoch 515/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6663 -
accuracy: 0.6477
Epoch 516/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6661 -
accuracy: 0.6479
Epoch 517/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6657 -
accuracy: 0.6490
Epoch 518/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6661 -
accuracy: 0.6484
Epoch 519/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6660 -
accuracy: 0.6498
Epoch 520/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6655 -
accuracy: 0.6504
Epoch 521/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6653 -
accuracy: 0.6500
Epoch 522/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6655 -
accuracy: 0.6504
Epoch 523/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6656 -
accuracy: 0.6500
Epoch 524/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6661 -
accuracy: 0.6500
Epoch 525/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6666 -
accuracy: 0.6486
Epoch 526/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6661 -
accuracy: 0.6493
Epoch 527/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6648 -
accuracy: 0.6508
Epoch 528/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6654 -
accuracy: 0.6502
Epoch 529/1000
```

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16557/16557 [==============================] - 1s 60us/sample - loss: 0.6661 -
accuracy: 0.6498
Epoch 530/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6658 -
accuracy: 0.6494
Epoch 531/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6655 -
accuracy: 0.6494
Epoch 532/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6651 -
accuracy: 0.6506
Epoch 533/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6653 -
accuracy: 0.6505
Epoch 534/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6644 -
accuracy: 0.6522
Epoch 535/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6653 -
accuracy: 0.6506
Epoch 536/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6652 -
accuracy: 0.6509
Epoch 537/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6654 -
accuracy: 0.6499
Epoch 538/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6658 -
accuracy: 0.6497
Epoch 539/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6648 -
accuracy: 0.6517
Epoch 540/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6653 -
accuracy: 0.6498
Epoch 541/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6663 -
accuracy: 0.6474
Epoch 542/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6661 -
accuracy: 0.6488
Epoch 543/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6656 -
accuracy: 0.6496
Epoch 544/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6649 -
accuracy: 0.6514
Epoch 545/1000
```

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16557/16557 [==============================] - 1s 59us/sample - loss: 0.6648 -
accuracy: 0.6515
Epoch 546/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6644 -
accuracy: 0.6525
Epoch 547/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6644 -
accuracy: 0.6524
Epoch 548/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6646 -
accuracy: 0.6519
Epoch 549/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6651 -
accuracy: 0.6502
Epoch 550/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6651 -
accuracy: 0.6504
Epoch 551/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6653 -
accuracy: 0.6496
Epoch 552/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6655 -
accuracy: 0.6499
Epoch 553/1000
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6652 -
accuracy: 0.6507
Epoch 554/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6648 -
accuracy: 0.6516
Epoch 555/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6644 -
accuracy: 0.6518
Epoch 556/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6643 -
accuracy: 0.6526
Epoch 557/1000
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6637 -
accuracy: 0.6534
Epoch 558/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6642 -
accuracy: 0.6522
Epoch 559/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6639 -
accuracy: 0.6528
Epoch 560/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6647 -
accuracy: 0.6514
Epoch 561/1000
```

```
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6651 -
accuracy: 0.6507
Epoch 562/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6677 -
accuracy: 0.6465
Epoch 563/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6654 -
accuracy: 0.6507
Epoch 564/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6649 -
accuracy: 0.6517
Epoch 565/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6660 -
accuracy: 0.6488
Epoch 566/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6649 -
accuracy: 0.6512
Epoch 567/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6652 -
accuracy: 0.6507
Epoch 568/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6647 -
accuracy: 0.6519
Epoch 569/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6644 -
accuracy: 0.6527
Epoch 570/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6652 -
accuracy: 0.6508
Epoch 571/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6651 -
accuracy: 0.6507
Epoch 572/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6658 -
accuracy: 0.6494
Epoch 573/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6649 -
accuracy: 0.6517
Epoch 574/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6643 -
accuracy: 0.6527
Epoch 575/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6636 -
accuracy: 0.6537
Epoch 576/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6642 -
accuracy: 0.6527
Epoch 577/1000
```

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16557/16557 [==============================] - 1s 63us/sample - loss: 0.6648 -
accuracy: 0.6514
Epoch 578/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6664 -
accuracy: 0.6470
Epoch 579/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6656 -
accuracy: 0.6493
Epoch 580/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6652 -
accuracy: 0.6501
Epoch 581/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6647 -
accuracy: 0.6515
Epoch 582/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6652 -
accuracy: 0.6502
Epoch 583/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6652 -
accuracy: 0.6505
Epoch 584/1000
16557/16557 [==============================] - 1s 75us/sample - loss: 0.6647 -
accuracy: 0.6514
Epoch 585/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6643 -
accuracy: 0.6524
Epoch 586/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6642 -
accuracy: 0.6528
Epoch 587/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6644 -
accuracy: 0.6528
Epoch 588/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6644 -
accuracy: 0.6521
Epoch 589/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6637 -
accuracy: 0.6538
Epoch 590/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6634 -
accuracy: 0.6545
Epoch 591/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6645 -
accuracy: 0.6522
Epoch 592/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6650 -
accuracy: 0.6512
Epoch 593/1000
```

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16557/16557 [==============================] - 1s 68us/sample - loss: 0.6648 -
accuracy: 0.6511
Epoch 594/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6649 -
accuracy: 0.6510
Epoch 595/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6649 -
accuracy: 0.6514
Epoch 596/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6647 -
accuracy: 0.6519
Epoch 597/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6642 -
accuracy: 0.6532
Epoch 598/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6640 -
accuracy: 0.6535
Epoch 599/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6635 -
accuracy: 0.6547
Epoch 600/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6640 -
accuracy: 0.6536
Epoch 601/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6640 -
accuracy: 0.6536
Epoch 602/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6641 -
accuracy: 0.6533
Epoch 603/1000
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6636 -
accuracy: 0.6545
Epoch 604/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6640 -
accuracy: 0.6533
Epoch 605/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6641 -
accuracy: 0.6528
Epoch 606/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6649 -
accuracy: 0.6521
Epoch 607/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6643 -
accuracy: 0.6528
Epoch 608/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6642 -
accuracy: 0.6529
Epoch 609/1000
```

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16557/16557 [==============================] - 1s 66us/sample - loss: 0.6639 -
accuracy: 0.6537
Epoch 610/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6642 -
accuracy: 0.6531
Epoch 611/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6645 -
accuracy: 0.6529
Epoch 612/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6642 -
accuracy: 0.6533
Epoch 613/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6642 -
accuracy: 0.6528
Epoch 614/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6642 -
accuracy: 0.6531
Epoch 615/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6640 -
accuracy: 0.6533
Epoch 616/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6639 -
accuracy: 0.6539
Epoch 617/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6636 -
accuracy: 0.6546
Epoch 618/1000
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6644 -
accuracy: 0.6531
Epoch 619/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6641 -
accuracy: 0.6530
Epoch 620/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6638 -
accuracy: 0.6539
Epoch 621/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6637 -
accuracy: 0.6542
Epoch 622/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6635 -
accuracy: 0.6542
Epoch 623/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6637 -
accuracy: 0.6535
Epoch 624/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6632 -
accuracy: 0.6554
Epoch 625/1000
```

```
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6634 -
accuracy: 0.6545
Epoch 626/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6638 -
accuracy: 0.6533
Epoch 627/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6644 -
accuracy: 0.6526
Epoch 628/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6645 -
accuracy: 0.6529
Epoch 629/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6645 -
accuracy: 0.6533
Epoch 630/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6641 -
accuracy: 0.6537
Epoch 631/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6641 -
accuracy: 0.6536
Epoch 632/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6638 -
accuracy: 0.6541
Epoch 633/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6634 -
accuracy: 0.6548
Epoch 634/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6640 -
accuracy: 0.6537
Epoch 635/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6640 -
accuracy: 0.6538
Epoch 636/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6636 -
accuracy: 0.6548
Epoch 637/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6635 -
accuracy: 0.6543
Epoch 638/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6635 -
accuracy: 0.6543
Epoch 639/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6643 -
accuracy: 0.6520
Epoch 640/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6643 -
accuracy: 0.6525
Epoch 641/1000
```

```
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6639 -
accuracy: 0.6531
Epoch 642/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6636 -
accuracy: 0.6543
Epoch 643/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6630 -
accuracy: 0.6556
Epoch 644/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6626 -
accuracy: 0.6565
Epoch 645/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6629 -
accuracy: 0.6559
Epoch 646/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6633 -
accuracy: 0.6551
Epoch 647/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6632 -
accuracy: 0.6556
Epoch 648/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6630 -
accuracy: 0.6556
Epoch 649/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6642 -
accuracy: 0.6525
Epoch 650/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6631 -
accuracy: 0.6549
Epoch 651/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6645 -
accuracy: 0.6516
Epoch 652/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6639 -
accuracy: 0.6539
Epoch 653/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6638 -
accuracy: 0.6540
Epoch 654/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6645 -
accuracy: 0.6530
Epoch 655/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6646 -
accuracy: 0.6524
Epoch 656/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6637 -
accuracy: 0.6543
Epoch 657/1000
```

```
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6632 -
accuracy: 0.6554
Epoch 658/1000
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6634 -
accuracy: 0.6546
Epoch 659/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6628 -
accuracy: 0.6560
Epoch 660/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6637 -
accuracy: 0.6535
Epoch 661/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6649 -
accuracy: 0.6519
Epoch 662/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6646 -
accuracy: 0.6532
Epoch 663/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6641 -
accuracy: 0.6543
Epoch 664/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6639 -
accuracy: 0.6536
Epoch 665/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6640 -
accuracy: 0.6533
Epoch 666/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6641 -
accuracy: 0.6537
Epoch 667/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6636 -
accuracy: 0.6549
Epoch 668/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6636 -
accuracy: 0.6553
Epoch 669/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6630 -
accuracy: 0.6559
Epoch 670/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6638 -
accuracy: 0.6539
Epoch 671/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6636 -
accuracy: 0.6545
Epoch 672/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6638 -
accuracy: 0.6533
Epoch 673/1000
```

```
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6634 -
accuracy: 0.6549
Epoch 674/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6629 -
accuracy: 0.6560
Epoch 675/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6634 -
accuracy: 0.6548
Epoch 676/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6632 -
accuracy: 0.6556
Epoch 677/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6647 -
accuracy: 0.6513
Epoch 678/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6633 -
accuracy: 0.6546
Epoch 679/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6633 -
accuracy: 0.6552
Epoch 680/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6640 -
accuracy: 0.6539
Epoch 681/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6647 -
accuracy: 0.6516
Epoch 682/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6636 -
accuracy: 0.6538
Epoch 683/1000
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6634 -
accuracy: 0.6545
Epoch 684/1000
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6636 -
accuracy: 0.6543
Epoch 685/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6633 -
accuracy: 0.6551
Epoch 686/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6629 -
accuracy: 0.6556
Epoch 687/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6638 -
accuracy: 0.6533
Epoch 688/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6642 -
accuracy: 0.6521
Epoch 689/1000
```

```
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6640 -
accuracy: 0.6531
Epoch 690/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6650 -
accuracy: 0.6502
Epoch 691/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6638 -
accuracy: 0.6534
Epoch 692/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6632 -
accuracy: 0.6553
Epoch 693/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6636 -
accuracy: 0.6546
Epoch 694/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6638 -
accuracy: 0.6543
Epoch 695/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6639 -
accuracy: 0.6534
Epoch 696/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6635 -
accuracy: 0.6546
Epoch 697/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6637 -
accuracy: 0.6546
Epoch 698/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6643 -
accuracy: 0.6532
Epoch 699/1000
16557/16557 [==============================] - 1s 75us/sample - loss: 0.6661 -
accuracy: 0.6498
Epoch 700/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6647 -
accuracy: 0.6527
Epoch 701/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6637 -
accuracy: 0.6550
Epoch 702/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6638 -
accuracy: 0.6546
Epoch 703/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6635 -
accuracy: 0.6553
Epoch 704/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6636 -
accuracy: 0.6553
Epoch 705/1000
```

```
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6632 -
accuracy: 0.6559
Epoch 706/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6630 -
accuracy: 0.6560
Epoch 707/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6629 -
accuracy: 0.6564
Epoch 708/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6631 -
accuracy: 0.6559
Epoch 709/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6631 -
accuracy: 0.6558
Epoch 710/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6633 -
accuracy: 0.6549
Epoch 711/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6641 -
accuracy: 0.6538
Epoch 712/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6637 -
accuracy: 0.6548
Epoch 713/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6638 -
accuracy: 0.6544
Epoch 714/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6633 -
accuracy: 0.6547
Epoch 715/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6635 -
accuracy: 0.6550
Epoch 716/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6641 -
accuracy: 0.6540
Epoch 717/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6634 -
accuracy: 0.6550
Epoch 718/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6634 -
accuracy: 0.6555
Epoch 719/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6632 -
accuracy: 0.6560
Epoch 720/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6627 -
accuracy: 0.6565
Epoch 721/1000
```

```
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6640 -
accuracy: 0.6539
Epoch 722/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6634 -
accuracy: 0.6548
Epoch 723/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6632 -
accuracy: 0.6554
Epoch 724/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6631 -
accuracy: 0.6558
Epoch 725/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6637 -
accuracy: 0.6542
Epoch 726/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6633 -
accuracy: 0.6559
Epoch 727/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6636 -
accuracy: 0.6554
Epoch 728/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6632 -
accuracy: 0.6557
Epoch 729/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6629 -
accuracy: 0.6562
Epoch 730/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6630 -
accuracy: 0.6560
Epoch 731/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6625 -
accuracy: 0.6570
Epoch 732/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6638 -
accuracy: 0.6551
Epoch 733/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6628 -
accuracy: 0.6566
Epoch 734/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6628 -
accuracy: 0.6563
Epoch 735/1000
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6623 -
accuracy: 0.6573
Epoch 736/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6623 -
accuracy: 0.6572
Epoch 737/1000
```

```
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6630 -
accuracy: 0.6556
Epoch 738/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6624 -
accuracy: 0.6571
Epoch 739/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6631 -
accuracy: 0.6553
Epoch 740/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6639 -
accuracy: 0.6541
Epoch 741/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6636 -
accuracy: 0.6550
Epoch 742/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6634 -
accuracy: 0.6545
Epoch 743/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6628 -
accuracy: 0.6564
Epoch 744/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6627 -
accuracy: 0.6563
Epoch 745/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6632 -
accuracy: 0.6553
Epoch 746/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6630 -
accuracy: 0.6559
Epoch 747/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6640 -
accuracy: 0.6530
Epoch 748/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6634 -
accuracy: 0.6550
Epoch 749/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6634 -
accuracy: 0.6542
Epoch 750/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6626 -
accuracy: 0.6564
Epoch 751/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6636 -
accuracy: 0.6540
Epoch 752/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6634 -
accuracy: 0.6552
Epoch 753/1000
```

```
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6629 -
accuracy: 0.6563
Epoch 754/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6635 -
accuracy: 0.6546
Epoch 755/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6635 -
accuracy: 0.6549
Epoch 756/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6635 -
accuracy: 0.6554
Epoch 757/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6636 -
accuracy: 0.6550
Epoch 758/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6638 -
accuracy: 0.6551
Epoch 759/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6637 -
accuracy: 0.6551
Epoch 760/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6632 -
accuracy: 0.6562
Epoch 761/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6632 -
accuracy: 0.6568
Epoch 762/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6631 -
accuracy: 0.6565
Epoch 763/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6638 -
accuracy: 0.6553
Epoch 764/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6626 -
accuracy: 0.6576
Epoch 765/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6630 -
accuracy: 0.6565
Epoch 766/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6636 -
accuracy: 0.6552
Epoch 767/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6635 -
accuracy: 0.6557
Epoch 768/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6636 -
accuracy: 0.6549
Epoch 769/1000
```

```
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6629 -
accuracy: 0.6569
Epoch 770/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6629 -
accuracy: 0.6569
Epoch 771/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6624 -
accuracy: 0.6576
Epoch 772/1000
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6633 -
accuracy: 0.6554
Epoch 773/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6622 -
accuracy: 0.6581
Epoch 774/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6623 -
accuracy: 0.6580
Epoch 775/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6626 -
accuracy: 0.6574
Epoch 776/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6628 -
accuracy: 0.6568
Epoch 777/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6630 -
accuracy: 0.6559
Epoch 778/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6636 -
accuracy: 0.6553
Epoch 779/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6624 -
accuracy: 0.6575
Epoch 780/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6627 -
accuracy: 0.6568
Epoch 781/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6625 -
accuracy: 0.6572
Epoch 782/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6629 -
accuracy: 0.6565
Epoch 783/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6626 -
accuracy: 0.6575
Epoch 784/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6627 -
accuracy: 0.6571
Epoch 785/1000
```

```
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6636 -
accuracy: 0.6551
Epoch 786/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6635 -
accuracy: 0.6548
Epoch 787/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6627 -
accuracy: 0.6565
Epoch 788/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6625 -
accuracy: 0.6572
Epoch 789/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6628 -
accuracy: 0.6563
Epoch 790/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6644 -
accuracy: 0.6522
Epoch 791/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6633 -
accuracy: 0.6550
Epoch 792/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6626 -
accuracy: 0.6569
Epoch 793/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6625 -
accuracy: 0.6573
Epoch 794/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6587
Epoch 795/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6628 -
accuracy: 0.6570
Epoch 796/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6632 -
accuracy: 0.6562
Epoch 797/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6623 -
accuracy: 0.6580
Epoch 798/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6619 -
accuracy: 0.6591
Epoch 799/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6618 -
accuracy: 0.6589
Epoch 800/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6623 -
accuracy: 0.6578
Epoch 801/1000
```

```
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6621 -
accuracy: 0.6586
Epoch 802/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6635 -
accuracy: 0.6551
Epoch 803/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6621 -
accuracy: 0.6579
Epoch 804/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6584
Epoch 805/1000
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6623 -
accuracy: 0.6572
Epoch 806/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6625 -
accuracy: 0.6572
Epoch 807/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6624 -
accuracy: 0.6575
Epoch 808/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6623 -
accuracy: 0.6575
Epoch 809/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6577
Epoch 810/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6585
Epoch 811/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6621 -
accuracy: 0.6581
Epoch 812/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6625 -
accuracy: 0.6573
Epoch 813/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6626 -
accuracy: 0.6572
Epoch 814/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6629 -
accuracy: 0.6566
Epoch 815/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6635 -
accuracy: 0.6553
Epoch 816/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6629 -
accuracy: 0.6568
Epoch 817/1000
```

```
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6629 -
accuracy: 0.6562
Epoch 818/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6577
Epoch 819/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6624 -
accuracy: 0.6576
Epoch 820/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6635 -
accuracy: 0.6567
Epoch 821/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6630 -
accuracy: 0.6574
Epoch 822/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6624 -
accuracy: 0.6581
Epoch 823/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6621 -
accuracy: 0.6588
Epoch 824/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6588
Epoch 825/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6626 -
accuracy: 0.6576
Epoch 826/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6631 -
accuracy: 0.6566
Epoch 827/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6623 -
accuracy: 0.6583
Epoch 828/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6620 -
accuracy: 0.6588
Epoch 829/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6625 -
accuracy: 0.6572
Epoch 830/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6628 -
accuracy: 0.6568
Epoch 831/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6624 -
accuracy: 0.6577
Epoch 832/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6582
Epoch 833/1000
```

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16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6583
Epoch 834/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6588
Epoch 835/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6620 -
accuracy: 0.6587
Epoch 836/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6618 -
accuracy: 0.6588
Epoch 837/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 838/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6581
Epoch 839/1000
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6632 -
accuracy: 0.6565
Epoch 840/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6628 -
accuracy: 0.6568
Epoch 841/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6621 -
accuracy: 0.6587
Epoch 842/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6626 -
accuracy: 0.6581
Epoch 843/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6625 -
accuracy: 0.6582
Epoch 844/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6640 -
accuracy: 0.6553
Epoch 845/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6592
Epoch 846/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6586
Epoch 847/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6578
Epoch 848/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6619 -
accuracy: 0.6586
Epoch 849/1000
```

```
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6586
Epoch 850/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6617 -
accuracy: 0.6589
Epoch 851/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6586
Epoch 852/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6588
Epoch 853/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6617 -
accuracy: 0.6594
Epoch 854/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6629 -
accuracy: 0.6577
Epoch 855/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6624 -
accuracy: 0.6581
Epoch 856/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6617 -
accuracy: 0.6596
Epoch 857/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6621 -
accuracy: 0.6588
Epoch 858/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6624 -
accuracy: 0.6579
Epoch 859/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6599
Epoch 860/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6585
Epoch 861/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6598
Epoch 862/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6593
Epoch 863/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6618 -
accuracy: 0.6585
Epoch 864/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6589
Epoch 865/1000
```

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16557/16557 [==============================] - 1s 67us/sample - loss: 0.6614 -
accuracy: 0.6601
Epoch 866/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6628 -
accuracy: 0.6569
Epoch 867/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6618 -
accuracy: 0.6587
Epoch 868/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6596
Epoch 869/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6624 -
accuracy: 0.6583
Epoch 870/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6592
Epoch 871/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6617 -
accuracy: 0.6597
Epoch 872/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6621 -
accuracy: 0.6581
Epoch 873/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6595
Epoch 874/1000
16557/16557 [==============================] - 1s 75us/sample - loss: 0.6615 -
accuracy: 0.6597
Epoch 875/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6589
Epoch 876/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6582
Epoch 877/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6621 -
accuracy: 0.6585
Epoch 878/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6595
Epoch 879/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6615 -
accuracy: 0.6600
Epoch 880/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6615 -
accuracy: 0.6600
Epoch 881/1000
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16557/16557 [==============================] - 1s 68us/sample - loss: 0.6623 -
accuracy: 0.6578
Epoch 882/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6615 -
accuracy: 0.6592
Epoch 883/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6628 -
accuracy: 0.6574
Epoch 884/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6585
Epoch 885/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6586
Epoch 886/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6585
Epoch 887/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6617 -
accuracy: 0.6592
Epoch 888/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6620 -
accuracy: 0.6582
Epoch 889/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6617 -
accuracy: 0.6589
Epoch 890/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 891/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6613 -
accuracy: 0.6599
Epoch 892/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6624 -
accuracy: 0.6578
Epoch 893/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6614 -
accuracy: 0.6599
Epoch 894/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6621 -
accuracy: 0.6588
Epoch 895/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6621 -
accuracy: 0.6589
Epoch 896/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6621 -
accuracy: 0.6586
Epoch 897/1000
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16557/16557 [==============================] - 1s 64us/sample - loss: 0.6619 -
accuracy: 0.6588
Epoch 898/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6632 -
accuracy: 0.6557
Epoch 899/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6622 -
accuracy: 0.6579
Epoch 900/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6616 -
accuracy: 0.6594
Epoch 901/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6616 -
accuracy: 0.6592
Epoch 902/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6613 -
accuracy: 0.6602
Epoch 903/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6617 -
accuracy: 0.6592
Epoch 904/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6615 -
accuracy: 0.6597
Epoch 905/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6614 -
accuracy: 0.6598
Epoch 906/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6583
Epoch 907/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6619 -
accuracy: 0.6592
Epoch 908/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6627 -
accuracy: 0.6572
Epoch 909/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6623 -
accuracy: 0.6579
Epoch 910/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6622 -
accuracy: 0.6580
Epoch 911/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6585
Epoch 912/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6619 -
accuracy: 0.6595
Epoch 913/1000
```

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16557/16557 [==============================] - 1s 62us/sample - loss: 0.6619 -
accuracy: 0.6591
Epoch 914/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 915/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6618 -
accuracy: 0.6597
Epoch 916/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6618 -
accuracy: 0.6593
Epoch 917/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6617 -
accuracy: 0.6600
Epoch 918/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6613 -
accuracy: 0.6603
Epoch 919/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6610 -
accuracy: 0.6612
Epoch 920/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6610 -
accuracy: 0.6609
Epoch 921/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6608 -
accuracy: 0.6614
Epoch 922/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6608 -
accuracy: 0.6612
Epoch 923/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6612 -
accuracy: 0.6603
Epoch 924/1000
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6621 -
accuracy: 0.6586
Epoch 925/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6620 -
accuracy: 0.6588
Epoch 926/1000
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6618 -
accuracy: 0.6588
Epoch 927/1000
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6616 -
accuracy: 0.6594
Epoch 928/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6619 -
accuracy: 0.6588
Epoch 929/1000
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16557/16557 [==============================] - 1s 66us/sample - loss: 0.6635 -
accuracy: 0.6542
Epoch 930/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6575
Epoch 931/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6629 -
accuracy: 0.6571
Epoch 932/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6620 -
accuracy: 0.6587
Epoch 933/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6620 -
accuracy: 0.6587
Epoch 934/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6599
Epoch 935/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6614 -
accuracy: 0.6597
Epoch 936/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6621 -
accuracy: 0.6577
Epoch 937/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6625 -
accuracy: 0.6571
Epoch 938/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6631 -
accuracy: 0.6567
Epoch 939/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6639 -
accuracy: 0.6549
Epoch 940/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6626 -
accuracy: 0.6579
Epoch 941/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6616 -
accuracy: 0.6597
Epoch 942/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6614 -
accuracy: 0.6603
Epoch 943/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6627 -
accuracy: 0.6570
Epoch 944/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6622 -
accuracy: 0.6574
Epoch 945/1000
```

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16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 946/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6600
Epoch 947/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6616 -
accuracy: 0.6595
Epoch 948/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6589
Epoch 949/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6613 -
accuracy: 0.6602
Epoch 950/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 951/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6622 -
accuracy: 0.6584
Epoch 952/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6614 -
accuracy: 0.6600
Epoch 953/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6610 -
accuracy: 0.6614
Epoch 954/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6612 -
accuracy: 0.6607
Epoch 955/1000
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6616 -
accuracy: 0.6598
Epoch 956/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6620 -
accuracy: 0.6594
Epoch 957/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6631 -
accuracy: 0.6572
Epoch 958/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6617 -
accuracy: 0.6596
Epoch 959/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6612 -
accuracy: 0.6607
Epoch 960/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6618 -
accuracy: 0.6590
Epoch 961/1000
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16557/16557 [==============================] - 1s 65us/sample - loss: 0.6613 -
accuracy: 0.6604
Epoch 962/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6611 -
accuracy: 0.6609
Epoch 963/1000
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6613 -
accuracy: 0.6606
Epoch 964/1000
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6618 -
accuracy: 0.6603
Epoch 965/1000
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6618 -
accuracy: 0.6600
Epoch 966/1000
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6612 -
accuracy: 0.6613
Epoch 967/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6612 -
accuracy: 0.6611
Epoch 968/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6620 -
accuracy: 0.6591
Epoch 969/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6622 -
accuracy: 0.6591
Epoch 970/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6621 -
accuracy: 0.6592
Epoch 971/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6615 -
accuracy: 0.6604
Epoch 972/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6615 -
accuracy: 0.6606
Epoch 973/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6615 -
accuracy: 0.6606
Epoch 974/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6621 -
accuracy: 0.6587
Epoch 975/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6620 -
accuracy: 0.6585
Epoch 976/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6633 -
accuracy: 0.6572
Epoch 977/1000
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16557/16557 [==============================] - 1s 68us/sample - loss: 0.6621 -
accuracy: 0.6588
Epoch 978/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6620 -
accuracy: 0.6592
Epoch 979/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6616 -
accuracy: 0.6602
Epoch 980/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6614 -
accuracy: 0.6610
Epoch 981/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6613 -
accuracy: 0.6613
Epoch 982/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6610 -
accuracy: 0.6615
Epoch 983/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6609 -
accuracy: 0.6618
Epoch 984/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6614 -
accuracy: 0.6606
Epoch 985/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6628 -
accuracy: 0.6581
Epoch 986/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6623 -
accuracy: 0.6587
Epoch 987/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6620 -
accuracy: 0.6590
Epoch 988/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6635 -
accuracy: 0.6539
Epoch 989/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6624 -
accuracy: 0.6573
Epoch 990/1000
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6618 -
accuracy: 0.6588
Epoch 991/1000
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6617 -
accuracy: 0.6599
Epoch 992/1000
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6615 -
accuracy: 0.6604
Epoch 993/1000
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16557/16557 [==============================] - 1s 67us/sample - loss: 0.6614 -
accuracy: 0.6602
Epoch 994/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6615 -
accuracy: 0.6598
Epoch 995/1000
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6609 -
accuracy: 0.6615
Epoch 996/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6607 -
accuracy: 0.6619
Epoch 997/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6610 -
accuracy: 0.6611
Epoch 998/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6614 -
accuracy: 0.6603
Epoch 999/1000
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6619 -
accuracy: 0.6588
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16557/16557 [==============================] - 1s 65us/sample - loss: 0.6623 -
accuracy: 0.6586
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===============================================================================
========] - 0s 71us/sample - loss: 0.7369 - accuracy: 0.5830
```

```python
print("Accuracy: {}".format(test_acc))
plot_history(history)
```

```
Accuracy: 0.5829710364341736
```

model accuracy

model loss
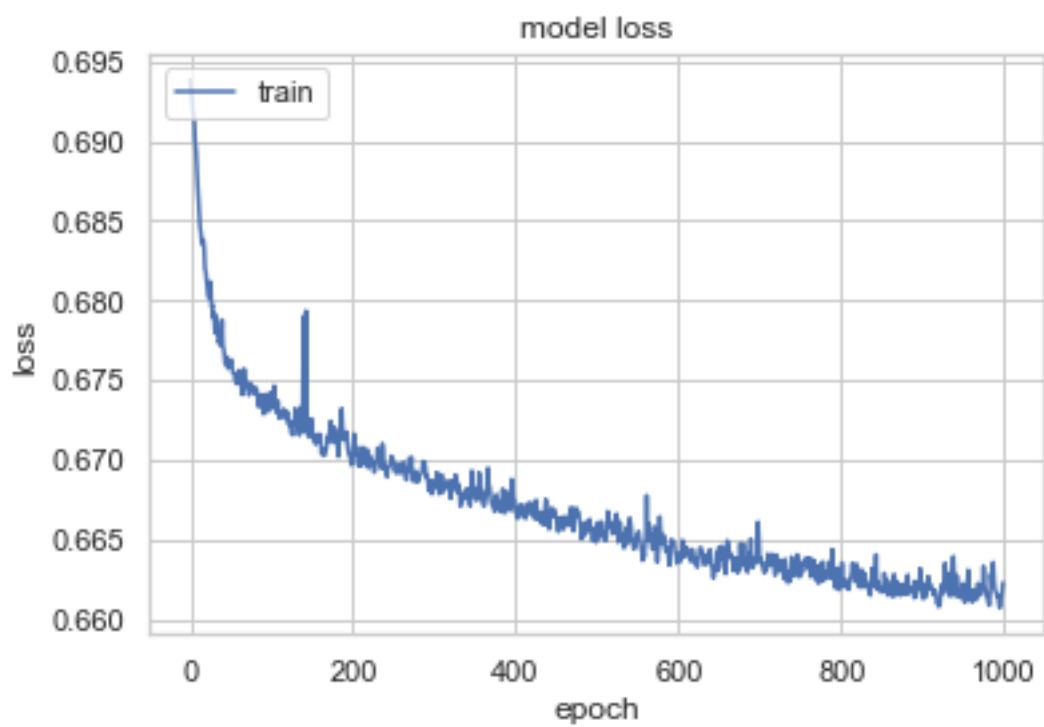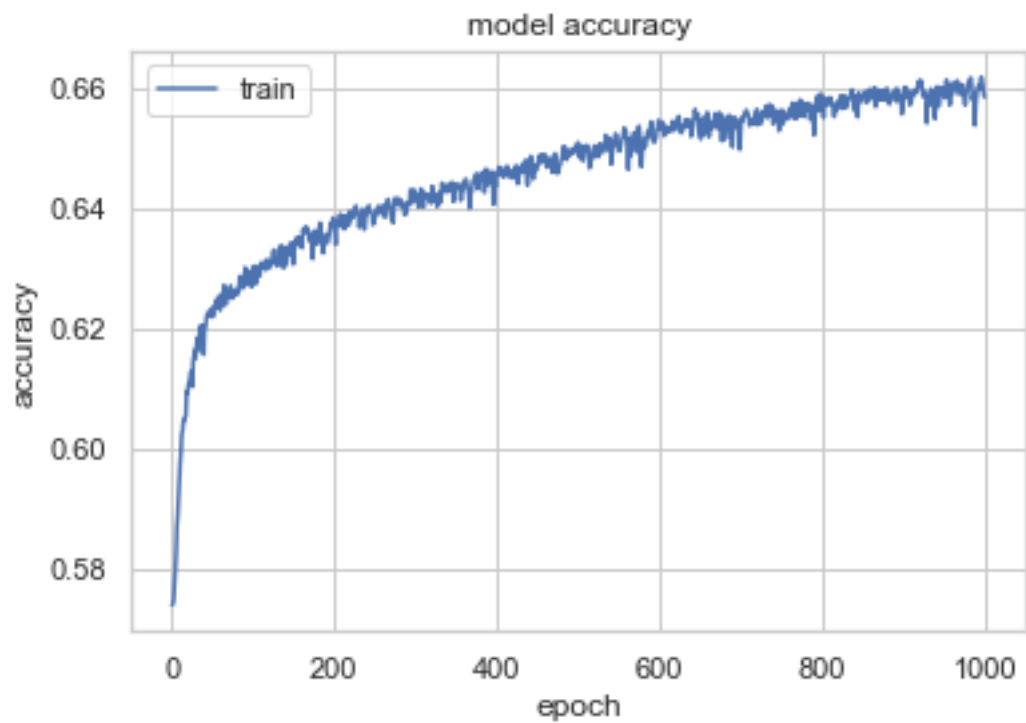
4.1 Try with dropout layers if some values just don't matter

- Essentially, dropout layers just make some values randomly disappear with a given probability, so if some values don't matter when trying to make predictions, then those values in our nodes might be sent to 0, simplifying our overall model.

```python
[65]: model = keras.Sequential([
          keras.layers.Dense(16, activation=tf.nn.relu),
              keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dropout(.1),
          keras.layers.Dense(1, activation=tf.nn.sigmoid),
      ])
```

```python
[66]: model.compile(optimizer='adam',
                    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                    metrics=['accuracy'])

      history = model.fit(X_train, y_train, epochs=100)
      test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/100
16557/16557 [==============================] - 2s 94us/sample - loss: 0.7160 -
accuracy: 0.5576
Epoch 2/100
16557/16557 [==============================] - 1s 52us/sample - loss: 0.6947 -
accuracy: 0.5731
Epoch 3/100
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6945 -
accuracy: 0.5744
Epoch 4/100
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6944 -
accuracy: 0.5744
Epoch 5/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6928 -
accuracy: 0.5775
Epoch 6/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6922 -
accuracy: 0.5791
Epoch 7/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6913 -
accuracy: 0.5810
Epoch 8/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6908 -
accuracy: 0.5812
Epoch 9/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6904 -
accuracy: 0.5831
```

```
Epoch 10/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6902 -
accuracy: 0.5862
Epoch 11/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6896 -
accuracy: 0.5874
Epoch 12/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6895 -
accuracy: 0.5906
Epoch 13/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6891 -
accuracy: 0.5914
Epoch 14/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6880 -
accuracy: 0.5948
Epoch 15/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6877 -
accuracy: 0.5978
Epoch 16/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6933 -
accuracy: 0.5933
Epoch 17/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6966 -
accuracy: 0.5912
Epoch 18/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6967 -
accuracy: 0.5946
Epoch 19/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6942 -
accuracy: 0.5964
Epoch 20/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6846 -
accuracy: 0.6050
Epoch 21/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6839 -
accuracy: 0.6072
Epoch 22/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6839 -
accuracy: 0.6058
Epoch 23/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6817 -
accuracy: 0.6115
Epoch 24/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6819 -
accuracy: 0.6105
Epoch 25/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6817 -
accuracy: 0.6122
```

```
Epoch 26/100
16557/16557 [==============================] - 1s 66us/sample - loss: 0.6811 -
accuracy: 0.6142
Epoch 27/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6817 -
accuracy: 0.6119
Epoch 28/100
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6806 -
accuracy: 0.6153
Epoch 29/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6814 -
accuracy: 0.6148
Epoch 30/100
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6807 -
accuracy: 0.6165
Epoch 31/100
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6796 -
accuracy: 0.6174
Epoch 32/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6781 -
accuracy: 0.6206
Epoch 33/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6792 -
accuracy: 0.6179
Epoch 34/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6786 -
accuracy: 0.6199
Epoch 35/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6775 -
accuracy: 0.6227
Epoch 36/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6763 -
accuracy: 0.6257
Epoch 37/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6773 -
accuracy: 0.6232
Epoch 38/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6766 -
accuracy: 0.6252
Epoch 39/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6766 -
accuracy: 0.6261
Epoch 40/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6767 -
accuracy: 0.6253
Epoch 41/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6761 -
accuracy: 0.6263
```

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Epoch 42/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6750 -
accuracy: 0.6287
Epoch 43/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6756 -
accuracy: 0.6278
Epoch 44/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6754 -
accuracy: 0.6276
Epoch 45/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6749 -
accuracy: 0.6297
Epoch 46/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6759 -
accuracy: 0.6297
Epoch 47/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6746 -
accuracy: 0.6305
Epoch 48/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6742 -
accuracy: 0.6315
Epoch 49/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6745 -
accuracy: 0.6295
Epoch 50/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6749 -
accuracy: 0.6280
Epoch 51/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6747 -
accuracy: 0.6299
Epoch 52/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6742 -
accuracy: 0.6312
Epoch 53/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6745 -
accuracy: 0.6316
Epoch 54/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6736 -
accuracy: 0.6319
Epoch 55/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6743 -
accuracy: 0.6310
Epoch 56/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6736 -
accuracy: 0.6328
Epoch 57/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6730 -
accuracy: 0.6337
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Epoch 58/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6740 -
accuracy: 0.6322
Epoch 59/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6728 -
accuracy: 0.6352
Epoch 60/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6737 -
accuracy: 0.6339
Epoch 61/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6743 -
accuracy: 0.6331
Epoch 62/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6738 -
accuracy: 0.6332
Epoch 63/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6731 -
accuracy: 0.6342
Epoch 64/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6718 -
accuracy: 0.6368
Epoch 65/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6731 -
accuracy: 0.6339
Epoch 66/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6726 -
accuracy: 0.6364s - loss: 0.6727 - ac
Epoch 67/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6740 -
accuracy: 0.6342
Epoch 68/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6734 -
accuracy: 0.6338
Epoch 69/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6739 -
accuracy: 0.6313
Epoch 70/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6725 -
accuracy: 0.6339
Epoch 71/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6716 -
accuracy: 0.6367
Epoch 72/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6714 -
accuracy: 0.6376
Epoch 73/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6716 -
accuracy: 0.6386
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Epoch 74/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6710 -
accuracy: 0.6383
Epoch 75/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6706 -
accuracy: 0.6391
Epoch 76/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6707 -
accuracy: 0.6395
Epoch 77/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6711 -
accuracy: 0.6379
Epoch 78/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6716 -
accuracy: 0.6362
Epoch 79/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6714 -
accuracy: 0.6373
Epoch 80/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6710 -
accuracy: 0.6394
Epoch 81/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6716 -
accuracy: 0.6386
Epoch 82/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6713 -
accuracy: 0.6378
Epoch 83/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6706 -
accuracy: 0.6390
Epoch 84/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6720 -
accuracy: 0.6367
Epoch 85/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6710 -
accuracy: 0.6386
Epoch 86/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6715 -
accuracy: 0.6382
Epoch 87/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6714 -
accuracy: 0.6389
Epoch 88/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6705 -
accuracy: 0.6400
Epoch 89/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6712 -
accuracy: 0.6377
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Epoch 90/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6706 -
accuracy: 0.6401
Epoch 91/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6703 -
accuracy: 0.6413
Epoch 92/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6708 -
accuracy: 0.6397
Epoch 93/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6708 -
accuracy: 0.6397
Epoch 94/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6701 -
accuracy: 0.6400
Epoch 95/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6702 -
accuracy: 0.6414
Epoch 96/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6710 -
accuracy: 0.6397
Epoch 97/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6706 -
accuracy: 0.6402
Epoch 98/100
16557/16557 [==============================] - 1s 59us/sample - loss: 0.6709 -
accuracy: 0.6391
Epoch 99/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6708 -
accuracy: 0.6393
Epoch 100/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6705 -
accuracy: 0.6403
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========] - 0s 55us/sample - loss: 0.7168 - accuracy: 0.5821
```

```
[67]: print("Accuracy: {}".format(test_acc))
      plot_history(history)
```

```
Accuracy: 0.582065224647522
```

model accuracy

model loss
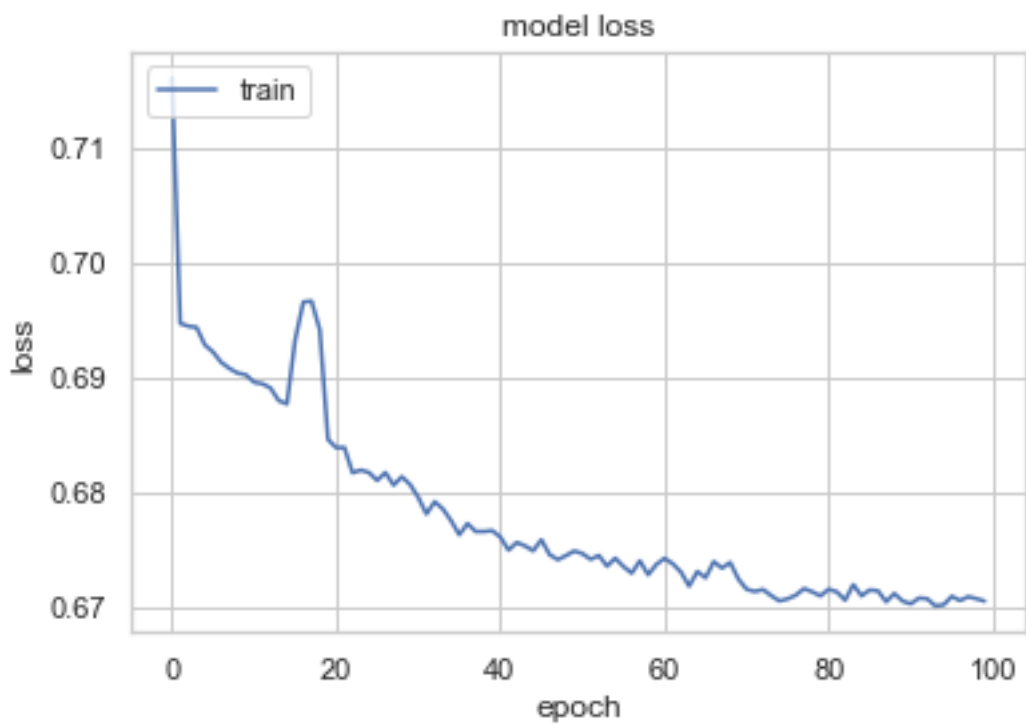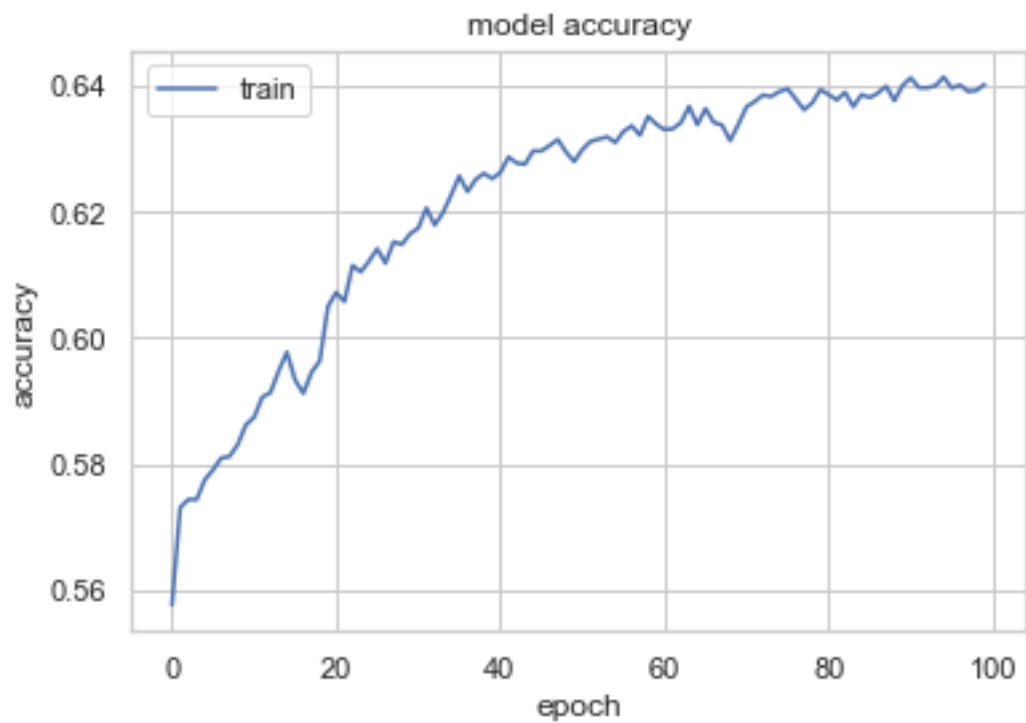
4.2 Try using tanh as activation to send to extreme values

- In the output layer, try using tanh to send values to -1 or 1, so we can maybe try to make our output more extreme (honestly this probably would have worked better with making it a strict binary classification problem)

```
[68]: model = keras.Sequential([
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dropout(.1),
          keras.layers.Dense(1, activation=tf.nn.tanh),
      ])
```

```
[69]: model.compile(optimizer='adam',
                     loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                     metrics=['accuracy'])

      history = model.fit(X_train, y_train, epochs=100)
      test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/100
16557/16557 [==============================] - 2s 97us/sample - loss: 0.7421 -
accuracy: 0.5636
Epoch 2/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.7255 -
accuracy: 0.5759
Epoch 3/100
16557/16557 [==============================] - 1s 52us/sample - loss: 0.7184 -
accuracy: 0.5800
Epoch 4/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.7133 -
accuracy: 0.5850
Epoch 5/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.7075 -
accuracy: 0.5885
Epoch 6/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.7065 -
accuracy: 0.5901
Epoch 7/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.7022 -
accuracy: 0.5914
Epoch 8/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.7021 -
accuracy: 0.5927
Epoch 9/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6985 -
accuracy: 0.5944
```

```
Epoch 10/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6953 -
accuracy: 0.5961
Epoch 11/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6949 -
accuracy: 0.5995
Epoch 12/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6925 -
accuracy: 0.6013
Epoch 13/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6890 -
accuracy: 0.6038
Epoch 14/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6903 -
accuracy: 0.6025
Epoch 15/100
16557/16557 [==============================] - 1s 53us/sample - loss: 0.6867 -
accuracy: 0.6058
Epoch 16/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6850 -
accuracy: 0.6052
Epoch 17/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6870 -
accuracy: 0.6089
Epoch 18/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6833 -
accuracy: 0.6097
Epoch 19/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6824 -
accuracy: 0.6053
Epoch 20/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6805 -
accuracy: 0.6101
Epoch 21/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6779 -
accuracy: 0.6129
Epoch 22/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6762 -
accuracy: 0.6108
Epoch 23/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6754 -
accuracy: 0.6115
Epoch 24/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6734 -
accuracy: 0.6136
Epoch 25/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6721 -
accuracy: 0.6165
```

```
Epoch 26/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6692 -
accuracy: 0.6187
Epoch 27/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6681 -
accuracy: 0.6226
Epoch 28/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6687 -
accuracy: 0.6212
Epoch 29/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6713 -
accuracy: 0.6221
Epoch 30/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6692 -
accuracy: 0.6209
Epoch 31/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6690 -
accuracy: 0.6223
Epoch 32/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6638 -
accuracy: 0.6252
Epoch 33/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6644 -
accuracy: 0.6254
Epoch 34/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6622 -
accuracy: 0.6285
Epoch 35/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6582 -
accuracy: 0.6316
Epoch 36/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6596 -
accuracy: 0.6316
Epoch 37/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6597 -
accuracy: 0.6319
Epoch 38/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6593 -
accuracy: 0.6326
Epoch 39/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6599 -
accuracy: 0.6320
Epoch 40/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6636 -
accuracy: 0.6312
Epoch 41/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6628 -
accuracy: 0.6347
```

```
Epoch 42/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6627 -
accuracy: 0.6318
Epoch 43/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6586 -
accuracy: 0.6359
Epoch 44/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6605 -
accuracy: 0.6325
Epoch 45/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6582 -
accuracy: 0.6376
Epoch 46/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6565 -
accuracy: 0.6382
Epoch 47/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6569 -
accuracy: 0.6417
Epoch 48/100
16557/16557 [==============================] - 1s 54us/sample - loss: 0.6566 -
accuracy: 0.6418
Epoch 49/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6594 -
accuracy: 0.6386
Epoch 50/100
16557/16557 [==============================] - 1s 55us/sample - loss: 0.6562 -
accuracy: 0.6418
Epoch 51/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6563 -
accuracy: 0.6415
Epoch 52/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6578 -
accuracy: 0.6399
Epoch 53/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6557 -
accuracy: 0.6417
Epoch 54/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6560 -
accuracy: 0.6433
Epoch 55/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6562 -
accuracy: 0.6408
Epoch 56/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6510 -
accuracy: 0.6469
Epoch 57/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6580 -
accuracy: 0.6403
```

```
Epoch 58/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6550 -
accuracy: 0.6416
Epoch 59/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6549 -
accuracy: 0.6424
Epoch 60/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6551 -
accuracy: 0.6429
Epoch 61/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6572 -
accuracy: 0.6421
Epoch 62/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6532 -
accuracy: 0.6446
Epoch 63/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6521 -
accuracy: 0.6460
Epoch 64/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6514 -
accuracy: 0.6440
Epoch 65/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6501 -
accuracy: 0.6451
Epoch 66/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6496 -
accuracy: 0.6462
Epoch 67/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6463 -
accuracy: 0.6501
Epoch 68/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6461 -
accuracy: 0.6491
Epoch 69/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6487 -
accuracy: 0.6476
Epoch 70/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6470 -
accuracy: 0.6485
Epoch 71/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6455 -
accuracy: 0.6496
Epoch 72/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6493 -
accuracy: 0.6469
Epoch 73/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6448 -
accuracy: 0.6510
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Epoch 74/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6468 -
accuracy: 0.6486
Epoch 75/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6446 -
accuracy: 0.6511
Epoch 76/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6456 -
accuracy: 0.6491
Epoch 77/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6439 -
accuracy: 0.6521
Epoch 78/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6456 -
accuracy: 0.6506
Epoch 79/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6488 -
accuracy: 0.6475
Epoch 80/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6455 -
accuracy: 0.6499
Epoch 81/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6446 -
accuracy: 0.6520
Epoch 82/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6440 -
accuracy: 0.6530
Epoch 83/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6449 -
accuracy: 0.6527
Epoch 84/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6436 -
accuracy: 0.6534
Epoch 85/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6439 -
accuracy: 0.6537
Epoch 86/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6446 -
accuracy: 0.6528
Epoch 87/100
16557/16557 [==============================] - 1s 58us/sample - loss: 0.6424 -
accuracy: 0.6552
Epoch 88/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6443 -
accuracy: 0.6537
Epoch 89/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6480 -
accuracy: 0.6509
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Epoch 90/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6507 -
accuracy: 0.6505
Epoch 91/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6526 -
accuracy: 0.6487
Epoch 92/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6536 -
accuracy: 0.6467
Epoch 93/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6515 -
accuracy: 0.6500
Epoch 94/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6524 -
accuracy: 0.6487
Epoch 95/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6519 -
accuracy: 0.6511
Epoch 96/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6495 -
accuracy: 0.6523
Epoch 97/100
16557/16557 [==============================] - 1s 56us/sample - loss: 0.6495 -
accuracy: 0.6530
Epoch 98/100
16557/16557 [==============================] - 1s 57us/sample - loss: 0.6478 -
accuracy: 0.6562
Epoch 99/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6440 -
accuracy: 0.6601
Epoch 100/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6461 -
accuracy: 0.6576
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=======] - 0s 58us/sample - loss: 0.7524 - accuracy: 0.5734
```

[70]:
```python
print("Accuracy: {}".format(test_acc))
plot_history(history)
```

```
Accuracy: 0.573369562625885
```

model accuracy

model loss
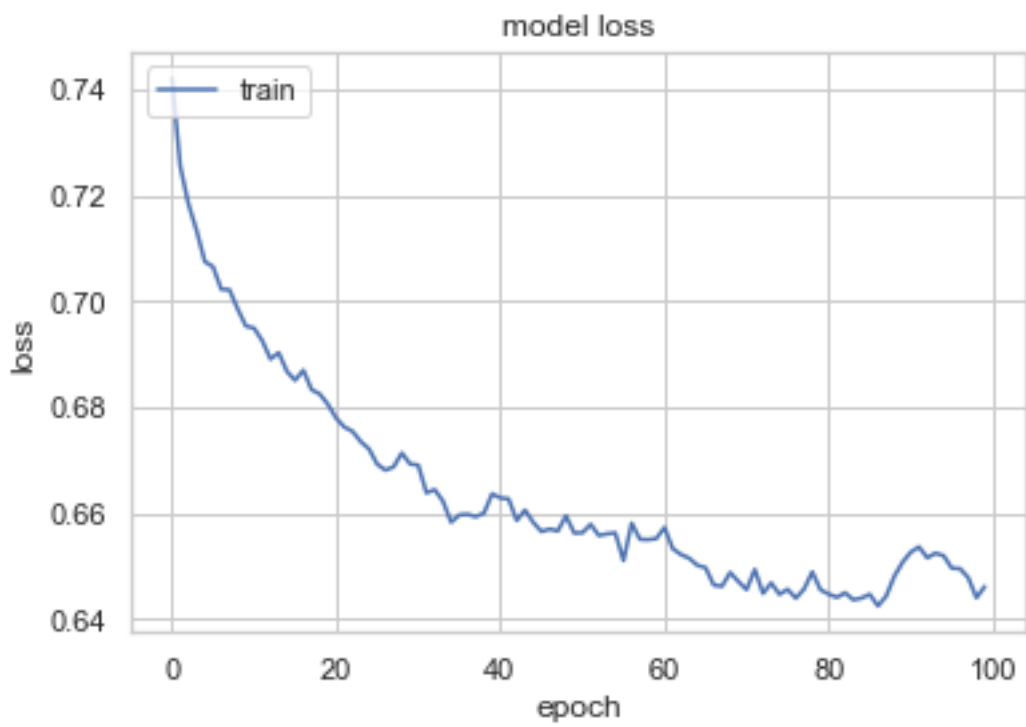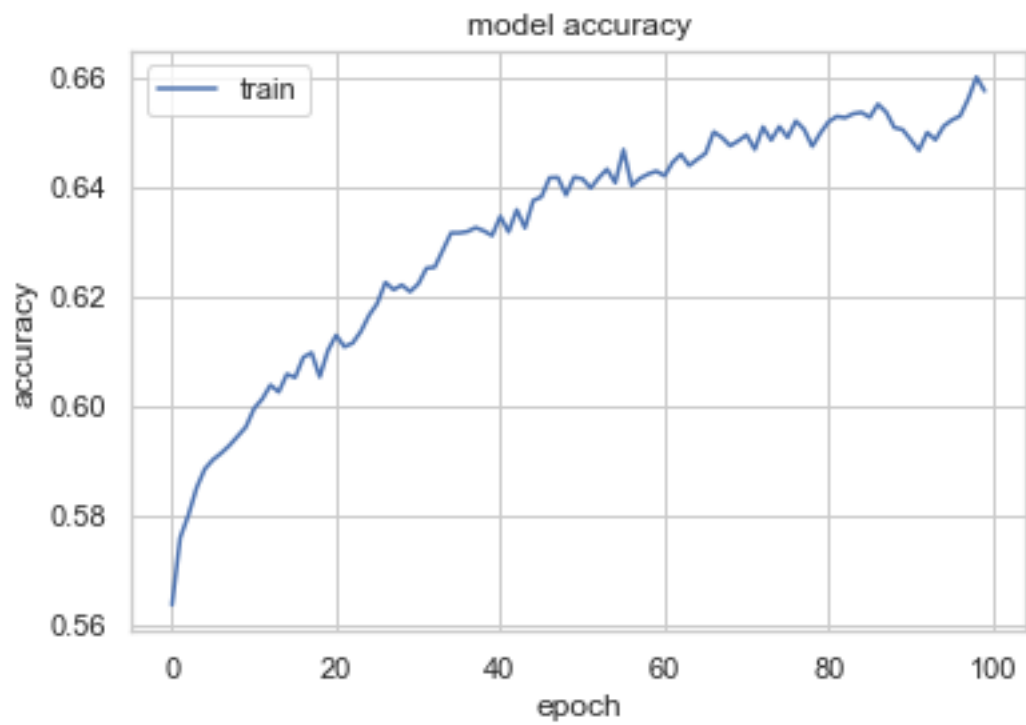
4.3 Try adding more layers

- We can maybe add more layers to try to capture additional complexity

```
[75]: model = keras.Sequential([
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dense(16, activation=tf.nn.relu),
          keras.layers.Dropout(.1),
          keras.layers.Dense(1, activation=tf.nn.sigmoid),
      ])
```

```
[76]: model.compile(optimizer='adam',
                    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
                    metrics=['accuracy'])

      history = model.fit(X_train, y_train, epochs=100)
      test_loss, test_acc = model.evaluate(X_test, y_test)
```

```
Train on 16557 samples
Epoch 1/100
16557/16557 [==============================] - 2s 122us/sample - loss: 0.6940 -
accuracy: 0.5738
Epoch 2/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6931 -
accuracy: 0.5739
Epoch 3/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6927 -
accuracy: 0.5739
Epoch 4/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6920 -
accuracy: 0.5764
Epoch 5/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6912 -
accuracy: 0.5806
Epoch 6/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6905 -
accuracy: 0.5837
Epoch 7/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6896 -
accuracy: 0.5875
Epoch 8/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6897 -
accuracy: 0.5890
Epoch 9/100
16557/16557 [==============================] - 1s 61us/sample - loss: 0.6887 -
accuracy: 0.5909
Epoch 10/100
```

```
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6878 -
accuracy: 0.5924
Epoch 11/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6879 -
accuracy: 0.5933
Epoch 12/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6880 -
accuracy: 0.5927
Epoch 13/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6879 -
accuracy: 0.5920
Epoch 14/100
16557/16557 [==============================] - 1s 60us/sample - loss: 0.6863 -
accuracy: 0.5956
Epoch 15/100
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6859 -
accuracy: 0.5980
Epoch 16/100
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6854 -
accuracy: 0.5994
Epoch 17/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6851 -
accuracy: 0.6003
Epoch 18/100
16557/16557 [==============================] - 1s 84us/sample - loss: 0.6859 -
accuracy: 0.5995
Epoch 19/100
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6843 -
accuracy: 0.6017
Epoch 20/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6839 -
accuracy: 0.6045
Epoch 21/100
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6834 -
accuracy: 0.6055
Epoch 22/100
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6829 -
accuracy: 0.6060
Epoch 23/100
16557/16557 [==============================] - 1s 84us/sample - loss: 0.6824 -
accuracy: 0.6071
Epoch 24/100
16557/16557 [==============================] - 1s 79us/sample - loss: 0.6824 -
accuracy: 0.6078
Epoch 25/100
16557/16557 [==============================] - 1s 82us/sample - loss: 0.6816 -
accuracy: 0.6091
Epoch 26/100
```

```
16557/16557 [==============================] - 1s 68us/sample - loss: 0.6829 -
accuracy: 0.6078
Epoch 27/100
16557/16557 [==============================] - 1s 75us/sample - loss: 0.6836 -
accuracy: 0.6064
Epoch 28/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6829 -
accuracy: 0.6067
Epoch 29/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6830 -
accuracy: 0.6071
Epoch 30/100
16557/16557 [==============================] - 1s 67us/sample - loss: 0.6820 -
accuracy: 0.6083
Epoch 31/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6819 -
accuracy: 0.6088
Epoch 32/100
16557/16557 [==============================] - 1s 63us/sample - loss: 0.6820 -
accuracy: 0.6085
Epoch 33/100
16557/16557 [==============================] - 1s 65us/sample - loss: 0.6815 -
accuracy: 0.6100
Epoch 34/100
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6810 -
accuracy: 0.6119
Epoch 35/100
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6821 -
accuracy: 0.6069
Epoch 36/100
16557/16557 [==============================] - 1s 64us/sample - loss: 0.6814 -
accuracy: 0.6104
Epoch 37/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6799 -
accuracy: 0.6140
Epoch 38/100
16557/16557 [==============================] - 1s 62us/sample - loss: 0.6809 -
accuracy: 0.6138
Epoch 39/100
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6810 -
accuracy: 0.6138
Epoch 40/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6808 -
accuracy: 0.6119
Epoch 41/100
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6801 -
accuracy: 0.6130
Epoch 42/100
```

```
16557/16557 [==============================] - 2s 100us/sample - loss: 0.6806 -
accuracy: 0.6139
Epoch 43/100
16557/16557 [==============================] - 1s 79us/sample - loss: 0.6802 -
accuracy: 0.6128
Epoch 44/100
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6792 -
accuracy: 0.6162
Epoch 45/100
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6804 -
accuracy: 0.6153
Epoch 46/100
16557/16557 [==============================] - 1s 77us/sample - loss: 0.6807 -
accuracy: 0.6146
Epoch 47/100
16557/16557 [==============================] - 1s 79us/sample - loss: 0.6801 -
accuracy: 0.6180
Epoch 48/100
16557/16557 [==============================] - 1s 77us/sample - loss: 0.6799 -
accuracy: 0.6183
Epoch 49/100
16557/16557 [==============================] - 1s 80us/sample - loss: 0.6804 -
accuracy: 0.6174
Epoch 50/100
16557/16557 [==============================] - 1s 84us/sample - loss: 0.6803 -
accuracy: 0.6163
Epoch 51/100
16557/16557 [==============================] - 1s 84us/sample - loss: 0.6795 -
accuracy: 0.6180
Epoch 52/100
16557/16557 [==============================] - 1s 81us/sample - loss: 0.6790 -
accuracy: 0.6184
Epoch 53/100
16557/16557 [==============================] - 1s 87us/sample - loss: 0.6797 -
accuracy: 0.6142
Epoch 54/100
16557/16557 [==============================] - 2s 98us/sample - loss: 0.6785 -
accuracy: 0.6169
Epoch 55/100
16557/16557 [==============================] - 2s 103us/sample - loss: 0.6782 -
accuracy: 0.6177
Epoch 56/100
16557/16557 [==============================] - 2s 145us/sample - loss: 0.6778 -
accuracy: 0.6190
Epoch 57/100
16557/16557 [==============================] - 2s 101us/sample - loss: 0.6773 -
accuracy: 0.6210
Epoch 58/100
```

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16557/16557 [==============================] - 1s 90us/sample - loss: 0.6771 -
accuracy: 0.6222
Epoch 59/100
16557/16557 [==============================] - 2s 150us/sample - loss: 0.6777 -
accuracy: 0.6211
Epoch 60/100
16557/16557 [==============================] - 1s 85us/sample - loss: 0.6786 -
accuracy: 0.6196
Epoch 61/100
16557/16557 [==============================] - 2s 100us/sample - loss: 0.6781 -
accuracy: 0.6197
Epoch 62/100
16557/16557 [==============================] - 1s 83us/sample - loss: 0.6773 -
accuracy: 0.6226
Epoch 63/100
16557/16557 [==============================] - 1s 86us/sample - loss: 0.6790 -
accuracy: 0.6188
Epoch 64/100
16557/16557 [==============================] - 2s 94us/sample - loss: 0.6794 -
accuracy: 0.6163
Epoch 65/100
16557/16557 [==============================] - 1s 82us/sample - loss: 0.6778 -
accuracy: 0.6204
Epoch 66/100
16557/16557 [==============================] - 2s 91us/sample - loss: 0.6773 -
accuracy: 0.6212
Epoch 67/100
16557/16557 [==============================] - 2s 100us/sample - loss: 0.6778 -
accuracy: 0.6208
Epoch 68/100
16557/16557 [==============================] - 1s 89us/sample - loss: 0.6774 -
accuracy: 0.6219
Epoch 69/100
16557/16557 [==============================] - 1s 82us/sample - loss: 0.6770 -
accuracy: 0.6228
Epoch 70/100
16557/16557 [==============================] - 1s 78us/sample - loss: 0.6784 -
accuracy: 0.6193
Epoch 71/100
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6782 -
accuracy: 0.6195
Epoch 72/100
16557/16557 [==============================] - 1s 79us/sample - loss: 0.6777 -
accuracy: 0.6227
Epoch 73/100
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6802 -
accuracy: 0.6180
Epoch 74/100
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16557/16557 [==============================] - 1s 73us/sample - loss: 0.6793 -
accuracy: 0.6199
Epoch 75/100
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6792 -
accuracy: 0.6187
Epoch 76/100
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6787 -
accuracy: 0.6182
Epoch 77/100
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6791 -
accuracy: 0.6171
Epoch 78/100
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6779 -
accuracy: 0.6202
Epoch 79/100
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6783 -
accuracy: 0.6216
Epoch 80/100
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6777 -
accuracy: 0.6207
Epoch 81/100
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6777 -
accuracy: 0.6216
Epoch 82/100
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6782 -
accuracy: 0.6212
Epoch 83/100
16557/16557 [==============================] - 1s 72us/sample - loss: 0.6777 -
accuracy: 0.6229
Epoch 84/100
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6772 -
accuracy: 0.6243
Epoch 85/100
16557/16557 [==============================] - 1s 71us/sample - loss: 0.6764 -
accuracy: 0.6253
Epoch 86/100
16557/16557 [==============================] - 1s 69us/sample - loss: 0.6763 -
accuracy: 0.6249
Epoch 87/100
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6754 -
accuracy: 0.6268
Epoch 88/100
16557/16557 [==============================] - 1s 73us/sample - loss: 0.6755 -
accuracy: 0.6266s - loss: 0.6754 - accuracy: 0.
Epoch 89/100
16557/16557 [==============================] - 1s 70us/sample - loss: 0.6767 -
accuracy: 0.6252
Epoch 90/100
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16557/16557 [==============================] - 1s 71us/sample - loss: 0.6766 -
accuracy: 0.6241
Epoch 91/100
16557/16557 [==============================] - 1s 74us/sample - loss: 0.6772 -
accuracy: 0.6231
Epoch 92/100
16557/16557 [==============================] - 1s 75us/sample - loss: 0.6777 -
accuracy: 0.6231
Epoch 93/100
16557/16557 [==============================] - 1s 76us/sample - loss: 0.6773 -
accuracy: 0.6228
Epoch 94/100
16557/16557 [==============================] - 1s 79us/sample - loss: 0.6761 -
accuracy: 0.6257
Epoch 95/100
16557/16557 [==============================] - 1s 81us/sample - loss: 0.6758 -
accuracy: 0.6266
Epoch 96/100
16557/16557 [==============================] - 1s 85us/sample - loss: 0.6758 -
accuracy: 0.6259
Epoch 97/100
16557/16557 [==============================] - 1s 88us/sample - loss: 0.6771 -
accuracy: 0.6231
Epoch 98/100
16557/16557 [==============================] - 2s 105us/sample - loss: 0.6767 -
accuracy: 0.6249
Epoch 99/100
16557/16557 [==============================] - 1s 90us/sample - loss: 0.6763 -
accuracy: 0.6248
Epoch 100/100
16557/16557 [==============================] - 2s 148us/sample - loss: 0.6774 -
accuracy: 0.6244
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========] - 1s 97us/sample - loss: 0.7343 - accuracy: 0.5844
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[77]:
```python
print("Accuracy: {}".format(test_acc))
plot_history(history)
```

```
Accuracy: 0.5844202637672424
```

model accuracy

model loss
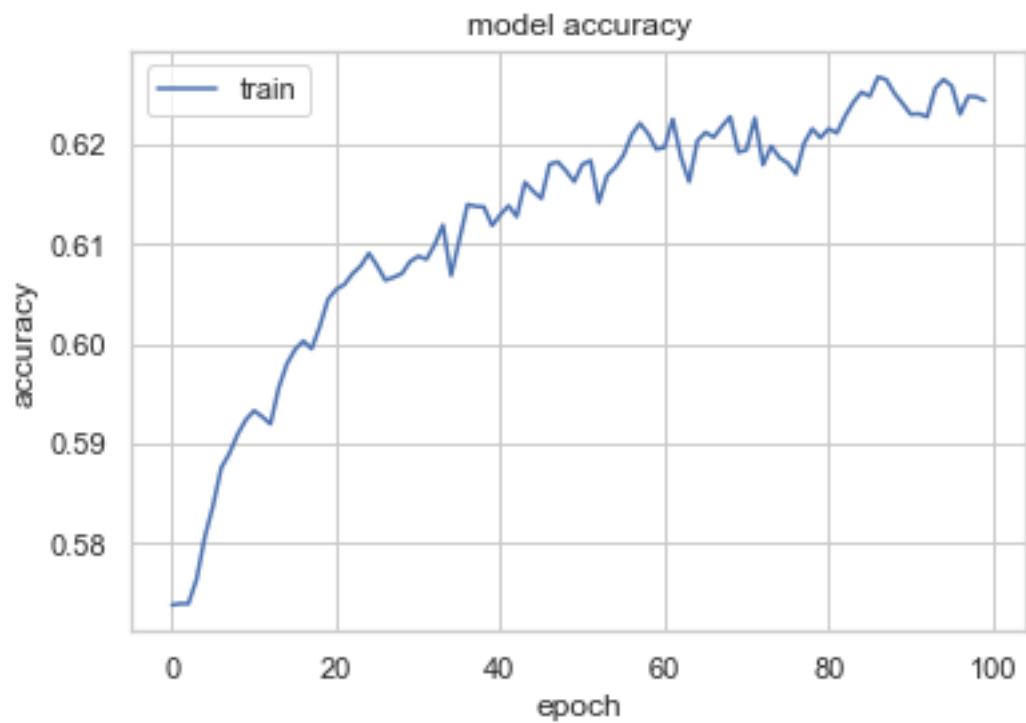
5 Conclusions and Future Directions

- The performance of SVC was around 50%, and the recall of if a stock didn't beat SPY was quite good.
- For deep learning, the first simple model achieved ~62% accuracy on the training set, and ~58% on the testing set.
    - Pumping up the amount of epochs for this model didn't really help – we see that the loss curve starts to flatten out at around 0.6750, which is very high loss. Thus, we probably need to make a much more complex model than the naive model.
- Making the layers much larger also didn't really help, it didn't significantly improve accuracy.
- Adding a dropout layer also didn't help the testing accuracy
- Adding further layers slightly helped the accuracy, but not by much

In sum, it's hard to predict the stock market – any potential alpha here is liekly already exhausted, as this is old data. Also, there's some shortcuts with data cleaning we did and reducing outliers that reduce the generalization capacity.

5.1 Future Directions

- Turning the problem into just a binary classification might work slightly better, but not by much – it's already pretty much like this
- Exploring more complex networks in general could also be beneficial. Perhaps at very high epochs with a more clevel model, we can derive more insights.

[ ]: