```
# Load the TensorBoard notebook extension
%load_ext tensorboard
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
```

# Import libraries:

```
import tensorflow as tf
import datetime, os
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import sys
import keras
from keras.models import Sequential
from keras.layers import Dense
# !pip install tensorflow==2.0.0-alpha0
np.set_printoptions(threshold=sys.maxsize)
```

# Import Data

```
dataset = pd.read_csv('./bp1.csv')
X = dataset.iloc[:,3:13].values
y = dataset.iloc[:,13].values
```

# Preprocessing

```
from sklearn.preprocessing import LabelEncoder
label_encoder_X = LabelEncoder()
X[:, 1] = label_encoder_X.fit_transform(X[:, 1])
X[:, 2] = label_encoder_X.fit_transform(X[:, 2])
```

```
from sklearn.preprocessing import OneHotEncoder
from sklearn.compose import ColumnTransformer
columnTransformer = ColumnTransformer([("encoder", OneHotEncoder(), [1])], remainder='pass
X = np.array(columnTransformer.fit_transform(X), dtype=np.str)
X = X[:, 1:]
```

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.20)
```

```
from sklearn.preprocessing import StandardScaler
sc_x = StandardScaler()
```

```
X_train = sc_x.fit_transform(X_train)
X_test = sc_x.transform(X_test)
```

## Create Model

```
classifier = Sequential()
classifier.add(Dense(input_shape=(11,), units = 6, kernel_initializer = 'random_uniform',
classifier.add(Dense(units = 10, kernel_initializer = 'random_uniform', activation = 'relu
classifier.add(Dense(units = 1, kernel_initializer = 'random_uniform', activation = 'sigmo
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'
# classifier.fit(X_train, y_train, batch_size = 10, epochs = 100)
```

## Train the model

```
def train_model():

  # model = create_model()
  classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accurac

  logdir = os.path.join("logs", datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
  tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)

  classifier.fit(x=X_train,
            y=y_train,
            batch_size=10,
            epochs=100,
            validation_data=(X_test, y_test),
            callbacks=[tensorboard_callback])

train_model()
```

```
Epoch 1/100
  2/800 [..............................] - ETA: 29s - loss: 0.6932 - accuracy: 0.650
800/800 [==============================] - 1s 1ms/step - loss: 0.4721 - accuracy: 0.
Epoch 2/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4231 - accuracy: 0.
Epoch 3/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4163 - accuracy: 0.
Epoch 4/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4126 - accuracy: 0.
Epoch 5/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4104 - accuracy: 0.
Epoch 6/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4085 - accuracy: 0.
Epoch 7/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4069 - accuracy: 0.
Epoch 8/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4050 - accuracy: 0.
Epoch 9/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4048 - accuracy: 0.
Epoch 10/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4033 - accuracy: 0.
Epoch 11/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4028 - accuracy: 0.
Epoch 12/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4024 - accuracy: 0.
Epoch 13/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4017 - accuracy: 0.
Epoch 14/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4012 - accuracy: 0.
Epoch 15/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4006 - accuracy: 0.
Epoch 16/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4002 - accuracy: 0.
Epoch 17/100
800/800 [==============================] - 1s 1ms/step - loss: 0.4003 - accuracy: 0.
Epoch 18/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3995 - accuracy: 0.
Epoch 19/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3992 - accuracy: 0.
Epoch 20/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3985 - accuracy: 0.
Epoch 21/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3978 - accuracy: 0.
Epoch 22/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3986 - accuracy: 0.
Epoch 23/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3978 - accuracy: 0.
Epoch 24/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3979 - accuracy: 0.
Epoch 25/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3977 - accuracy: 0.
Epoch 26/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3978 - accuracy: 0.
Epoch 27/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3979 - accuracy: 0.
Epoch 28/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3973 - accuracy: 0.
Epoch 29/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3959 - accuracy: 0.
Epoch 30/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3971 - accuracy: 0.
```

```
Epoch 31/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3965 - accuracy: 0.
Epoch 32/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3964 - accuracy: 0.
Epoch 33/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3965 - accuracy: 0.
Epoch 34/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3968 - accuracy: 0.
Epoch 35/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3962 - accuracy: 0.
Epoch 36/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3962 - accuracy: 0.
Epoch 37/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3963 - accuracy: 0.
Epoch 38/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3960 - accuracy: 0.
Epoch 39/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3963 - accuracy: 0.
Epoch 40/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3959 - accuracy: 0.
Epoch 41/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3962 - accuracy: 0.
Epoch 42/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3957 - accuracy: 0.
Epoch 43/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3959 - accuracy: 0.
Epoch 44/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3957 - accuracy: 0.
Epoch 45/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3959 - accuracy: 0.
Epoch 46/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3958 - accuracy: 0.
Epoch 47/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3956 - accuracy: 0.
Epoch 48/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3955 - accuracy: 0.
Epoch 49/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3950 - accuracy: 0.
Epoch 50/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3949 - accuracy: 0.
Epoch 51/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3947 - accuracy: 0.
Epoch 52/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3956 - accuracy: 0.
Epoch 53/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3953 - accuracy: 0.
Epoch 54/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3957 - accuracy: 0.
Epoch 55/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3955 - accuracy: 0.
Epoch 56/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3956 - accuracy: 0.
Epoch 57/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3953 - accuracy: 0.
Epoch 58/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 59/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3955 - accuracy: 0.
Epoch 60/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3947 - accuracy: 0.
Epoch 61/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
```

```
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
Epoch 62/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3949 - accuracy: 0.
Epoch 63/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 64/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3948 - accuracy: 0.
Epoch 65/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
Epoch 66/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3948 - accuracy: 0.
Epoch 67/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 68/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
Epoch 69/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3943 - accuracy: 0.
Epoch 70/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3949 - accuracy: 0.
Epoch 71/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3953 - accuracy: 0.
Epoch 72/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3948 - accuracy: 0.
Epoch 73/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 74/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
Epoch 75/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3947 - accuracy: 0.
Epoch 76/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3946 - accuracy: 0.
Epoch 77/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 78/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3944 - accuracy: 0.
Epoch 79/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3946 - accuracy: 0.
Epoch 80/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3942 - accuracy: 0.
Epoch 81/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3953 - accuracy: 0.
Epoch 82/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3944 - accuracy: 0.
Epoch 83/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3944 - accuracy: 0.
Epoch 84/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3944 - accuracy: 0.
Epoch 85/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3946 - accuracy: 0.
Epoch 86/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3951 - accuracy: 0.
Epoch 87/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3945 - accuracy: 0.
Epoch 88/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3948 - accuracy: 0.
Epoch 89/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3943 - accuracy: 0.
Epoch 90/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3942 - accuracy: 0.
Epoch 91/100
800/800 [==============================] - 1s 1ms/step - loss: 0.3942 - accuracy: 0.
Epoch 92/100
```

```
800/800 [==============================] - 1s 1ms/step - loss: 0.3950 - accuracy: 0.
Epoch 93/100
```

```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

```
Epoch 93/100
```

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
print((cm[0][0] + cm[1][1])/2000)
```

```
0.827
800/800 [==============================] - 1s 1ms/step - loss: 0.3942 - accuracy: 0.
```

```
%tensorboard --logdir logs
```

```
  classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accurac

  logdir = os.path.join("logs", datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
  tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)

  classifier.fit(x=X_train,
            y=y_train,
            batch_size=8,
            epochs=200,
            validation_data=(X_test, y_test),
            callbacks=[tensorboard_callback])

train_model()
```

```
Reusing TensorBoard on port 6006 (pid 558), started 2:48:13 ago. (Use '!kill 558' to
```

TensorBoard SCALARS GRAPHS INACTIVE

As shown above, Tensorboard has visualized the accuracy of out model and the cost function (J(theta)). as the epoch increases, the value of the cost function decreases; which means our model predicts correctly than before. therefore, the accuracy of the model will increase as epoch increases. this increasement in accuracy was observed at both train and validation data.

with Smoothing option at the left section, we can zoom in or zoom out on the details of the changes in epoch_accuracy and epoch_loss curves. as Smoothing value increases, the curves will be smoother and as Smoothing value decreases, the curves will be sharper and display the details of the changes more accurate. what can be said about the oscillation of train and test data in epoch _accuracy is that the oscillations in test data is more than the trains' one. this comparison can be different in other models and other data with respect to the nature of the data and also the behavior of the model. the remarkable point in epoch_loss is that the loss error in test data is less than the loss error in train data which means that the model performs better on test data than the train data. this better performance is not general in machine learning projects.

# Second model(more epochs, more bath size, same NN)

20200803-223410/train

```
classifier = Sequential()
classifier.add(Dense(input_shape=(11,), units = 6, kernel_initializer = 'random_uniform',
classifier.add(Dense(units = 10, kernel_initializer = 'random_uniform', activation = 'relu
classifier.add(Dense(units = 1, kernel_initializer = 'random_uniform', activation = 'sigmo
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'
```

20200803-224218/train 0.34

```
def train_model():

  # model = create_model()
  classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accurac

  logdir = os.path.join("logs", datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
  tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)

  classifier.fit(x=X_train,
            y=y_train,
            batch_size=64,
            epochs=200,
            validation_data=(X_test, y_test),
            callbacks=[tensorboard_callback])

train_model()
```

# Fourth model

```
classifier = Sequential()
classifier.add(Dense(input_shape=(11,), units = 16, kernel_initializer = 'random_uniform',
classifier.add(Dense(units = 8, kernel_initializer = 'random_uniform', activation = 'relu'
classifier.add(Dense(units = 8, kernel_initializer = 'random_uniform', activation = 'relu'
classifier.add(Dense(units = 1, kernel_initializer = 'random_uniform', activation = 'sigmo
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'
```

```
def train_model():

  # model = create_model()
  classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accurac

  logdir = os.path.join("logs", datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
  tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)

  classifier.fit(x=X_train,
            y=y_train,
            batch_size=2,
            epochs=200,
            validation_data=(X_test, y_test),
            callbacks=[tensorboard_callback])

train_model()
```

```
Epoch 1/200
  2/125 [..............................] - ETA: 4s - loss: 0.6930 - accuracy: 0.5234
125/125 [==============================] - 0s 3ms/step - loss: 0.6384 - accuracy: 0.
Epoch 2/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4543 - accuracy: 0.
Epoch 3/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4338 - accuracy: 0.
Epoch 4/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4289 - accuracy: 0.
Epoch 5/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4257 - accuracy: 0.
Epoch 6/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4232 - accuracy: 0.
Epoch 7/200
125/125 [==============================] - 0s 2ms/step - loss: 0.4204 - accuracy: 0.
Epoch 8/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4172 - accuracy: 0.
Epoch 9/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4142 - accuracy: 0.
Epoch 10/200
125/125 [==============================] - 0s 2ms/step - loss: 0.4112 - accuracy: 0.
Epoch 11/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4089 - accuracy: 0.
Epoch 12/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4068 - accuracy: 0.
Epoch 13/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4048 - accuracy: 0.
Epoch 14/200
125/125 [==============================] - 0s 1ms/step - loss: 0.4036 - accuracy: 0.
Epoch 15/200
125/125 [==============================] - 0s 2ms/step - loss: 0.4017 - accuracy: 0.
Epoch 16/200
125/125 [==============================] - 0s 2ms/step - loss: 0.4003 - accuracy: 0.
Epoch 17/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3993 - accuracy: 0.
Epoch 18/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3983 - accuracy: 0.
Epoch 19/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3973 - accuracy: 0.
Epoch 20/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3964 - accuracy: 0.
Epoch 21/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3960 - accuracy: 0.
Epoch 22/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3952 - accuracy: 0.
Epoch 23/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3948 - accuracy: 0.
Epoch 24/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3937 - accuracy: 0.
Epoch 25/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3938 - accuracy: 0.
Epoch 26/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3931 - accuracy: 0.
Epoch 27/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3929 - accuracy: 0.
Epoch 28/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3927 - accuracy: 0.
Epoch 29/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3921 - accuracy: 0.
Epoch 30/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3920 - accuracy: 0.
```

```
Epoch 31/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3918 - accuracy: 0.
Epoch 32/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3914 - accuracy: 0.
Epoch 33/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3912 - accuracy: 0.
Epoch 34/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3910 - accuracy: 0.
Epoch 35/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3909 - accuracy: 0.
Epoch 36/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3908 - accuracy: 0.
Epoch 37/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3904 - accuracy: 0.
Epoch 38/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3901 - accuracy: 0.
Epoch 39/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3903 - accuracy: 0.
Epoch 40/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3899 - accuracy: 0.
Epoch 41/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3897 - accuracy: 0.
Epoch 42/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3897 - accuracy: 0.
Epoch 43/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3895 - accuracy: 0.
Epoch 44/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3895 - accuracy: 0.
Epoch 45/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3893 - accuracy: 0.
Epoch 46/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3890 - accuracy: 0.
Epoch 47/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3888 - accuracy: 0.
Epoch 48/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3893 - accuracy: 0.
Epoch 49/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3887 - accuracy: 0.
Epoch 50/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3888 - accuracy: 0.
Epoch 51/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3888 - accuracy: 0.
Epoch 52/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3887 - accuracy: 0.
Epoch 53/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3885 - accuracy: 0.
Epoch 54/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3887 - accuracy: 0.
Epoch 55/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3883 - accuracy: 0.
Epoch 56/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3884 - accuracy: 0.
Epoch 57/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3884 - accuracy: 0.
Epoch 58/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3882 - accuracy: 0.
Epoch 59/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3883 - accuracy: 0.
Epoch 60/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3880 - accuracy: 0.
Epoch 61/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
```

```
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 62/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3885 - accuracy: 0.
Epoch 63/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3881 - accuracy: 0.
Epoch 64/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3881 - accuracy: 0.
Epoch 65/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3879 - accuracy: 0.
Epoch 66/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3884 - accuracy: 0.
Epoch 67/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3878 - accuracy: 0.
Epoch 68/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3881 - accuracy: 0.
Epoch 69/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3876 - accuracy: 0.
Epoch 70/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 71/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3883 - accuracy: 0.
Epoch 72/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3879 - accuracy: 0.
Epoch 73/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 74/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 75/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 76/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3879 - accuracy: 0.
Epoch 77/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 78/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3876 - accuracy: 0.
Epoch 79/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3876 - accuracy: 0.
Epoch 80/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3877 - accuracy: 0.
Epoch 81/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3878 - accuracy: 0.
Epoch 82/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3878 - accuracy: 0.
Epoch 83/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3874 - accuracy: 0.
Epoch 84/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 85/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3877 - accuracy: 0.
Epoch 86/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3876 - accuracy: 0.
Epoch 87/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3874 - accuracy: 0.
Epoch 88/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3873 - accuracy: 0.
Epoch 89/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3875 - accuracy: 0.
Epoch 90/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3875 - accuracy: 0.
Epoch 91/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3873 - accuracy: 0.
Epoch 92/200
```

```
125/125 [==============================] - 0s 1ms/step - loss: 0.3876 - accuracy: 0.
Epoch 93/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3875 - accuracy: 0.
Epoch 94/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3872 - accuracy: 0.
Epoch 95/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3874 - accuracy: 0.
Epoch 96/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3872 - accuracy: 0.
Epoch 97/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3873 - accuracy: 0.
Epoch 98/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3871 - accuracy: 0.
Epoch 99/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3870 - accuracy: 0.
Epoch 100/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3868 - accuracy: 0.
Epoch 101/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3870 - accuracy: 0.
Epoch 102/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3873 - accuracy: 0.
Epoch 103/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3868 - accuracy: 0.
Epoch 104/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3875 - accuracy: 0.
Epoch 105/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3870 - accuracy: 0.
Epoch 106/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3870 - accuracy: 0.
Epoch 107/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3868 - accuracy: 0.
Epoch 108/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3868 - accuracy: 0.
Epoch 109/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3867 - accuracy: 0.
Epoch 110/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3872 - accuracy: 0.
Epoch 111/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3867 - accuracy: 0.
Epoch 112/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3866 - accuracy: 0.
Epoch 113/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3869 - accuracy: 0.
Epoch 114/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3866 - accuracy: 0.
Epoch 115/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 116/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3866 - accuracy: 0.
Epoch 117/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 118/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3865 - accuracy: 0.
Epoch 119/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3867 - accuracy: 0.
Epoch 120/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3865 - accuracy: 0.
Epoch 121/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 122/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 123/200
```

```
Epoch 123/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3866 - accuracy: 0.
Epoch 124/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 125/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3864 - accuracy: 0.
Epoch 126/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 127/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 128/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3865 - accuracy: 0.
Epoch 129/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3864 - accuracy: 0.
Epoch 130/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3863 - accuracy: 0.
Epoch 131/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3863 - accuracy: 0.
Epoch 132/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 133/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 134/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3867 - accuracy: 0.
Epoch 135/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 136/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3860 - accuracy: 0.
Epoch 137/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 138/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3863 - accuracy: 0.
Epoch 139/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 140/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3859 - accuracy: 0.
Epoch 141/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3863 - accuracy: 0.
Epoch 142/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 143/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 144/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3865 - accuracy: 0.
Epoch 145/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3863 - accuracy: 0.
Epoch 146/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 147/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 148/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3865 - accuracy: 0.
Epoch 149/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3861 - accuracy: 0.
Epoch 150/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3861 - accuracy: 0.
Epoch 151/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 152/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3862 - accuracy: 0.
Epoch 153/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
```

```
Epoch 154/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 155/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 156/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 157/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3864 - accuracy: 0.
Epoch 158/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 159/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 160/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 161/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3860 - accuracy: 0.
Epoch 162/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3858 - accuracy: 0.
Epoch 163/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 164/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3861 - accuracy: 0.
Epoch 165/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 166/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 167/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 168/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 169/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 170/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 171/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 172/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 173/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3865 - accuracy: 0.
Epoch 174/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 175/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 176/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 177/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3862 - accuracy: 0.
Epoch 178/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 179/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 180/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3858 - accuracy: 0.
Epoch 181/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 182/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 183/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3856 - accuracy: 0.
Epoch 184/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
```

```
Epoch 185/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 186/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3858 - accuracy: 0.
Epoch 187/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 188/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 189/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 190/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3856 - accuracy: 0.
Epoch 191/200
125/125 [==============================] - 0s 2ms/step - loss: 0.3859 - accuracy: 0.
Epoch 192/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 193/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 194/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3861 - accuracy: 0.
Epoch 195/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 196/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3858 - accuracy: 0.
Epoch 197/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
Epoch 198/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3858 - accuracy: 0.
Epoch 199/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3859 - accuracy: 0.
Epoch 200/200
125/125 [==============================] - 0s 1ms/step - loss: 0.3860 - accuracy: 0.
```

```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
print((cm[0][0] + cm[1][1])/2000)
```

```
0.826
```

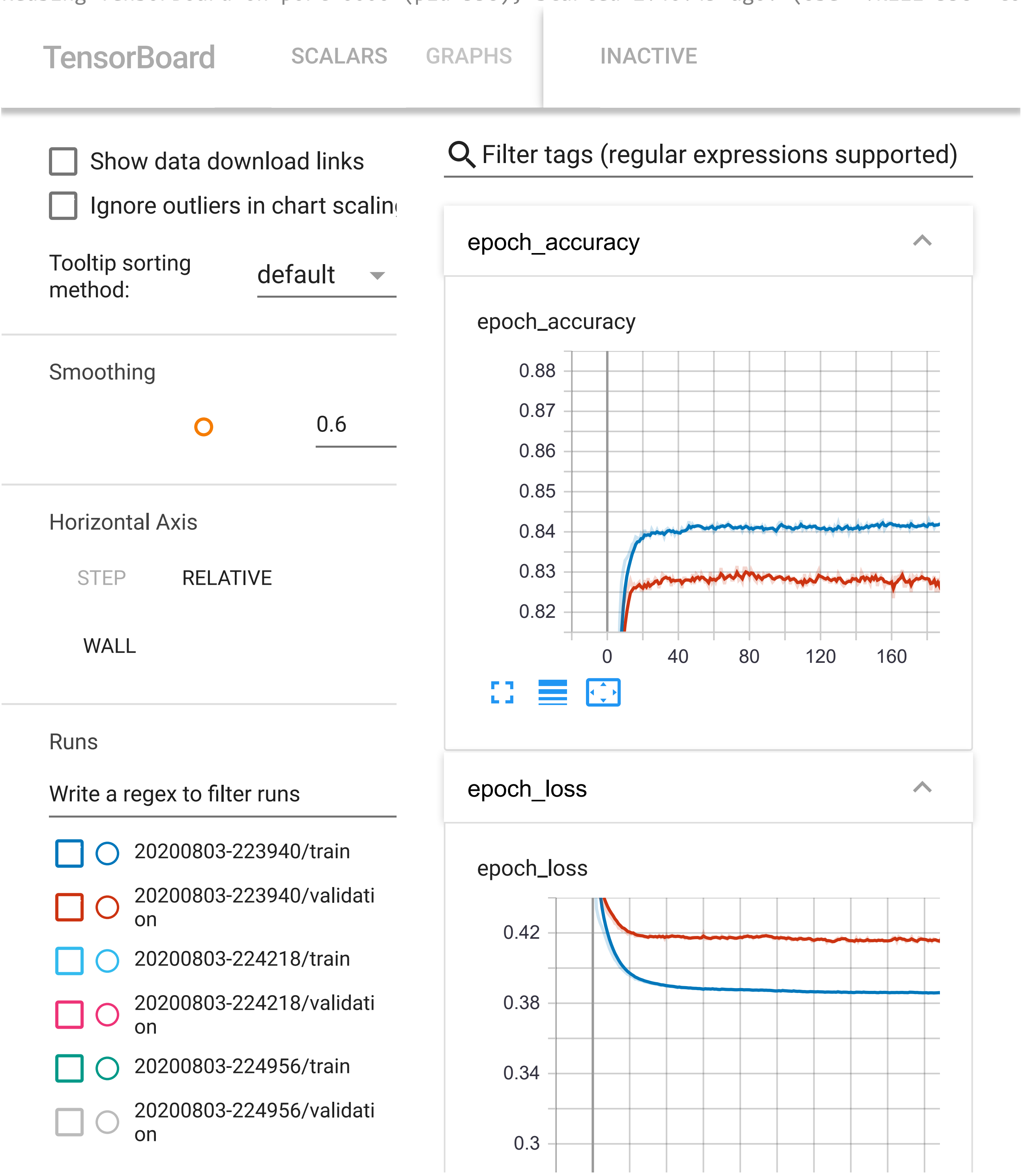
```
%tensorboard --logdir logs
```

one of the most important problem I deal with in this exercise, is overfitting. if the accuracy of he model on the training set is considerably more than the model accuracy on the test set, the it's said that the model overfits. it means that the model learns the training the training set very accurate but fails the learning of the test set in practice. this a common problem in machine learning. one important point I understand is it's better to use fewer mini-batch sizes. this tends to stochastic gradient descent(vs batch gradient descent) if we use mini-batch size = 1. but more sizes is sufficient in most cases.

it's necessary to remember the improvement of the performance of a neural network depends on many hyperparameters such as learning rate, #iterations, regularization parameter,... and techniques such as dropout(to prevent overfitting), optimizer type(such as momentum, adam, RMSprop), regularization(to prevent overfitting), mini-batch gradient descent, #epochs, the complexity of the model, etc. if we select more suitable features and also get more data, it's very useful to improve the neural network performance.

according to said above, to improve the performance of the model considerably, we need to use mose these method in a good way.

```
Reusing TensorBoard on port 6006 (pid 558), started 2:46:45 ago. (Use '!kill 558' to
```




## Third model(more epoch, fewer bath size, more complex NN)

```
classifier = Sequential()
classifier.add(Dense(input_shape=(11,), units = 16, kernel_initializer = 'random_uniform',
classifier.add(Dense(units = 8, kernel_initializer = 'random_uniform', activation = 'relu'
classifier.add(Dense(units = 1, kernel_initializer = 'random_uniform', activation = 'sigmc
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'


def train_model():

  # model = create_model()
```

```
Epoch 1/200
   2/1000 [..............................] - ETA: 33s - loss: 0.6930 - accuracy: 0.5
1000/1000 [==============================] - 1s 1ms/step - loss: 0.4523 - accuracy:
Epoch 2/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3719 - accuracy:
Epoch 3/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3473 - accuracy:
Epoch 4/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3412 - accuracy:
Epoch 5/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3392 - accuracy:
Epoch 6/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3384 - accuracy:
Epoch 7/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3359 - accuracy:
Epoch 8/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3353 - accuracy:
Epoch 9/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3351 - accuracy:
Epoch 10/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3342 - accuracy:
Epoch 11/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3337 - accuracy:
Epoch 12/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3337 - accuracy:
Epoch 13/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3333 - accuracy:
Epoch 14/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3317 - accuracy:
Epoch 15/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3319 - accuracy:
Epoch 16/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3316 - accuracy:
Epoch 17/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3318 - accuracy:
Epoch 18/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3318 - accuracy:
Epoch 19/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3308 - accuracy:
Epoch 20/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3298 - accuracy:
Epoch 21/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3307 - accuracy:
Epoch 22/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3302 - accuracy:
Epoch 23/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3291 - accuracy:
Epoch 24/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3282 - accuracy:
Epoch 25/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3293 - accuracy:
Epoch 26/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3278 - accuracy:
Epoch 27/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3286 - accuracy:
Epoch 28/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3279 - accuracy:
Epoch 29/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3274 - accuracy:
Epoch 30/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3279 - accuracy:
```

```
Epoch 31/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3274 - accuracy:
Epoch 32/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3269 - accuracy:
Epoch 33/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3274 - accuracy:
Epoch 34/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3275 - accuracy:
Epoch 35/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3265 - accuracy:
Epoch 36/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3265 - accuracy:
Epoch 37/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3264 - accuracy:
Epoch 38/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3258 - accuracy:
Epoch 39/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3267 - accuracy:
Epoch 40/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3258 - accuracy:
Epoch 41/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3256 - accuracy:
Epoch 42/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3242 - accuracy:
Epoch 43/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3256 - accuracy:
Epoch 44/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3245 - accuracy:
Epoch 45/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3244 - accuracy:
Epoch 46/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3249 - accuracy:
Epoch 47/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3249 - accuracy:
Epoch 48/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3239 - accuracy:
Epoch 49/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3239 - accuracy:
Epoch 50/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3240 - accuracy:
Epoch 51/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3231 - accuracy:
Epoch 52/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3240 - accuracy:
Epoch 53/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3236 - accuracy:
Epoch 54/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3234 - accuracy:
Epoch 55/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3231 - accuracy:
Epoch 56/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3232 - accuracy:
Epoch 57/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3230 - accuracy:
Epoch 58/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3223 - accuracy:
Epoch 59/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3225 - accuracy:
Epoch 60/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3227 - accuracy:
Epoch 61/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3222 - accuracy:
```

```
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3222 - accuracy:
Epoch 62/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3228 - accuracy:
Epoch 63/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3217 - accuracy:
Epoch 64/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3221 - accuracy:
Epoch 65/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3219 - accuracy:
Epoch 66/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3219 - accuracy:
Epoch 67/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3217 - accuracy:
Epoch 68/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3214 - accuracy:
Epoch 69/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3212 - accuracy:
Epoch 70/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3207 - accuracy:
Epoch 71/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3212 - accuracy:
Epoch 72/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3202 - accuracy:
Epoch 73/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3206 - accuracy:
Epoch 74/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3204 - accuracy:
Epoch 75/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3195 - accuracy:
Epoch 76/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3200 - accuracy:
Epoch 77/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3195 - accuracy:
Epoch 78/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3200 - accuracy:
Epoch 79/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3187 - accuracy:
Epoch 80/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3187 - accuracy:
Epoch 81/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3198 - accuracy:
Epoch 82/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3192 - accuracy:
Epoch 83/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3193 - accuracy:
Epoch 84/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3186 - accuracy:
Epoch 85/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3191 - accuracy:
Epoch 86/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3197 - accuracy:
Epoch 87/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3188 - accuracy:
Epoch 88/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3190 - accuracy:
Epoch 89/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3188 - accuracy:
Epoch 90/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3175 - accuracy:
Epoch 91/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3174 - accuracy:
Epoch 92/200
```

```
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3176 - accuracy:
Epoch 93/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3178 - accuracy:
Epoch 94/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3176 - accuracy:
Epoch 95/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3168 - accuracy:
Epoch 96/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3168 - accuracy:
Epoch 97/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3174 - accuracy:
Epoch 98/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3174 - accuracy:
Epoch 99/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3175 - accuracy:
Epoch 100/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3171 - accuracy:
Epoch 101/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3166 - accuracy:
Epoch 102/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3159 - accuracy:
Epoch 103/200
1000/1000 [==============================] - 2s 2ms/step - loss: 0.3164 - accuracy:
Epoch 104/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3158 - accuracy:
Epoch 105/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3163 - accuracy:
Epoch 106/200
1000/1000 [==============================] - 2s 2ms/step - loss: 0.3154 - accuracy:
Epoch 107/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3163 - accuracy:
Epoch 108/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3159 - accuracy:
Epoch 109/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3162 - accuracy:
Epoch 110/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3156 - accuracy:
Epoch 111/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3146 - accuracy:
Epoch 112/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3142 - accuracy:
Epoch 113/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3154 - accuracy:
Epoch 114/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3152 - accuracy:
Epoch 115/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3153 - accuracy:
Epoch 116/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3154 - accuracy:
Epoch 117/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3152 - accuracy:
Epoch 118/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3150 - accuracy:
Epoch 119/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3156 - accuracy:
Epoch 120/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3146 - accuracy:
Epoch 121/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3146 - accuracy:
Epoch 122/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3146 - accuracy:
Epoch 123/200
```

```
Epoch 123/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3149 - accuracy:
Epoch 124/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3145 - accuracy:
Epoch 125/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3143 - accuracy:
Epoch 126/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3149 - accuracy:
Epoch 127/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3145 - accuracy:
Epoch 128/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3146 - accuracy:
Epoch 129/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3132 - accuracy:
Epoch 130/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3147 - accuracy:
Epoch 131/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3139 - accuracy:
Epoch 132/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3145 - accuracy:
Epoch 133/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3136 - accuracy:
Epoch 134/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3140 - accuracy:
Epoch 135/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3128 - accuracy:
Epoch 136/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3133 - accuracy:
Epoch 137/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3134 - accuracy:
Epoch 138/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3131 - accuracy:
Epoch 139/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3137 - accuracy:
Epoch 140/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3131 - accuracy:
Epoch 141/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3138 - accuracy:
Epoch 142/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3124 - accuracy:
Epoch 143/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3130 - accuracy:
Epoch 144/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3127 - accuracy:
Epoch 145/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3128 - accuracy:
Epoch 146/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3124 - accuracy:
Epoch 147/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3122 - accuracy:
Epoch 148/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3122 - accuracy:
Epoch 149/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3121 - accuracy:
Epoch 150/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3122 - accuracy:
Epoch 151/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3125 - accuracy:
Epoch 152/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3117 - accuracy:
Epoch 153/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3117 - accuracy:
```

```
Epoch 154/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3120 - accuracy:
Epoch 155/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3112 - accuracy:
Epoch 156/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3115 - accuracy:
Epoch 157/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3119 - accuracy:
Epoch 158/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3111 - accuracy:
Epoch 159/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3112 - accuracy:
Epoch 160/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3110 - accuracy:
Epoch 161/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3112 - accuracy:
Epoch 162/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3110 - accuracy:
Epoch 163/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3110 - accuracy:
Epoch 164/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3110 - accuracy:
Epoch 165/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3107 - accuracy:
Epoch 166/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3105 - accuracy:
Epoch 167/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3112 - accuracy:
Epoch 168/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3102 - accuracy:
Epoch 169/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3104 - accuracy:
Epoch 170/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3097 - accuracy:
Epoch 171/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3097 - accuracy:
Epoch 172/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3106 - accuracy:
Epoch 173/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3099 - accuracy:
Epoch 174/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3107 - accuracy:
Epoch 175/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3100 - accuracy:
Epoch 176/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3104 - accuracy:
Epoch 177/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3099 - accuracy:
Epoch 178/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3093 - accuracy:
Epoch 179/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3098 - accuracy:
Epoch 180/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3101 - accuracy:
Epoch 181/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3101 - accuracy:
Epoch 182/200
1000/1000 [==============================] - 1s 1ms/step - loss: 0.3099 - accuracy:
```

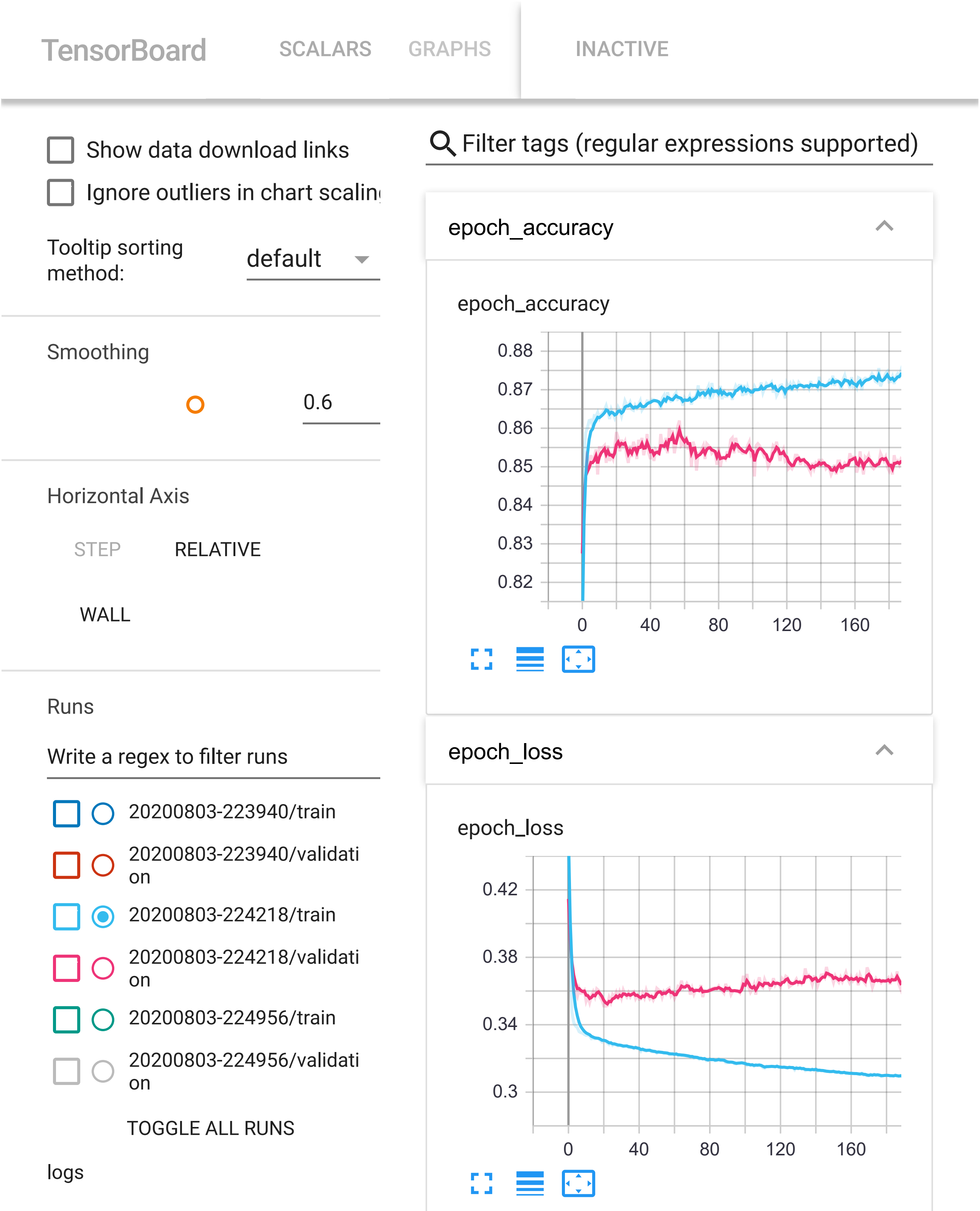
```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
print((cm[0][0] + cm[1][1])/2000)
```

```
0.851
Epoch 189/200
```

```
%tensorboard --logdir logs
```

```
Reusing TensorBoard on port 6006 (pid 558), started 2:45:18 ago. (Use '!kill 558' to
```



```
Epoch 1/200
   2/4000 [..............................] - ETA: 2:31 - loss: 0.6929 - accuracy: 0.
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4379 - accuracy:
Epoch 2/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4144 - accuracy:
Epoch 3/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4101 - accuracy:
Epoch 4/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4081 - accuracy:
Epoch 5/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4055 - accuracy:
Epoch 6/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4040 - accuracy:
Epoch 7/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4039 - accuracy:
Epoch 8/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4024 - accuracy:
Epoch 9/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4020 - accuracy:
Epoch 10/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4012 - accuracy:
Epoch 11/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4004 - accuracy:
Epoch 12/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4005 - accuracy:
Epoch 13/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4001 - accuracy:
Epoch 14/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.4004 - accuracy:
Epoch 15/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3994 - accuracy:
Epoch 16/200
4000/4000 [==============================] - 6s 1ms/step - loss: 0.3990 - accuracy:
Epoch 17/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3989 - accuracy:
Epoch 18/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3977 - accuracy:
Epoch 19/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3979 - accuracy:
Epoch 20/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3974 - accuracy:
Epoch 21/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3976 - accuracy:
Epoch 22/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3963 - accuracy:
Epoch 23/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3955 - accuracy:
Epoch 24/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3951 - accuracy:
Epoch 25/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3934 - accuracy:
Epoch 26/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3942 - accuracy:
Epoch 27/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3936 - accuracy:
Epoch 28/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3939 - accuracy:
Epoch 29/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3931 - accuracy:
Epoch 30/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3933 - accuracy:
```

```
Epoch 31/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3931 - accuracy:
Epoch 32/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3934 - accuracy:
Epoch 33/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3932 - accuracy:
Epoch 34/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3930 - accuracy:
Epoch 35/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3925 - accuracy:
Epoch 36/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3918 - accuracy:
Epoch 37/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3924 - accuracy:
Epoch 38/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3920 - accuracy:
Epoch 39/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3923 - accuracy:
Epoch 40/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3924 - accuracy:
Epoch 41/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3914 - accuracy:
Epoch 42/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3911 - accuracy:
Epoch 43/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3919 - accuracy:
Epoch 44/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3905 - accuracy:
Epoch 45/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3919 - accuracy:
Epoch 46/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3914 - accuracy:
Epoch 47/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3909 - accuracy:
Epoch 48/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3912 - accuracy:
Epoch 49/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3909 - accuracy:
Epoch 50/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3910 - accuracy:
Epoch 51/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3905 - accuracy:
Epoch 52/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3907 - accuracy:
Epoch 53/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3900 - accuracy:
Epoch 54/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3907 - accuracy:
Epoch 55/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3899 - accuracy:
Epoch 56/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3901 - accuracy:
Epoch 57/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3906 - accuracy:
Epoch 58/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3914 - accuracy:
Epoch 59/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3900 - accuracy:
Epoch 60/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3902 - accuracy:
Epoch 61/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3908 - accuracy:
```

```
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3908 - accuracy:
Epoch 62/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3901 - accuracy:
Epoch 63/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3896 - accuracy:
Epoch 64/200
4000/4000 [==============================] - 6s 1ms/step - loss: 0.3904 - accuracy:
Epoch 65/200
4000/4000 [==============================] - 6s 1ms/step - loss: 0.3907 - accuracy:
Epoch 66/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3897 - accuracy:
Epoch 67/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3914 - accuracy:
Epoch 68/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3900 - accuracy:
Epoch 69/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3904 - accuracy:
Epoch 70/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3896 - accuracy:
Epoch 71/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3903 - accuracy:
Epoch 72/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3900 - accuracy:
Epoch 73/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3899 - accuracy:
Epoch 74/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3892 - accuracy:
Epoch 75/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3903 - accuracy:
Epoch 76/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3892 - accuracy:
Epoch 77/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3895 - accuracy:
Epoch 78/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3888 - accuracy:
Epoch 79/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3863 - accuracy:
Epoch 80/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3759 - accuracy:
Epoch 81/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3554 - accuracy:
Epoch 82/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3404 - accuracy:
Epoch 83/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3356 - accuracy:
Epoch 84/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3343 - accuracy:
Epoch 85/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3330 - accuracy:
Epoch 86/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3317 - accuracy:
Epoch 87/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3326 - accuracy:
Epoch 88/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3308 - accuracy:
Epoch 89/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3301 - accuracy:
Epoch 90/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3296 - accuracy:
Epoch 91/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3275 - accuracy:
Epoch 92/200
```

```
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3279 - accuracy:
Epoch 93/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3279 - accuracy:
Epoch 94/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3282 - accuracy:
Epoch 95/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3280 - accuracy:
Epoch 96/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3263 - accuracy:
Epoch 97/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3270 - accuracy:
Epoch 98/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3275 - accuracy:
Epoch 99/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3257 - accuracy:
Epoch 100/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3261 - accuracy:
Epoch 101/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3258 - accuracy:
Epoch 102/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3264 - accuracy:
Epoch 103/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3260 - accuracy:
Epoch 104/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3264 - accuracy:
Epoch 105/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3252 - accuracy:
Epoch 106/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3246 - accuracy:
Epoch 107/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3253 - accuracy:
Epoch 108/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3255 - accuracy:
Epoch 109/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3264 - accuracy:
Epoch 110/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3246 - accuracy:
Epoch 111/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3261 - accuracy:
Epoch 112/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3244 - accuracy:
Epoch 113/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3231 - accuracy:
Epoch 114/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3253 - accuracy:
Epoch 115/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3243 - accuracy:
Epoch 116/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3255 - accuracy:
Epoch 117/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3238 - accuracy:
Epoch 118/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3237 - accuracy:
Epoch 119/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3248 - accuracy:
Epoch 120/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3244 - accuracy:
Epoch 121/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3234 - accuracy:
Epoch 122/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3239 - accuracy:
Epoch 123/200
```

```
Epoch 123/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3246 - accuracy:
Epoch 124/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3219 - accuracy:
Epoch 125/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3237 - accuracy:
Epoch 126/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3242 - accuracy:
Epoch 127/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3246 - accuracy:
Epoch 128/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3225 - accuracy:
Epoch 129/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3239 - accuracy:
Epoch 130/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3234 - accuracy:
Epoch 131/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3231 - accuracy:
Epoch 132/200
4000/4000 [==============================] - 6s 1ms/step - loss: 0.3227 - accuracy:
Epoch 133/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3221 - accuracy:
Epoch 134/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3226 - accuracy:
Epoch 135/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3219 - accuracy:
Epoch 136/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3221 - accuracy:
Epoch 137/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3211 - accuracy:
Epoch 138/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3234 - accuracy:
Epoch 139/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3215 - accuracy:
Epoch 140/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3212 - accuracy:
Epoch 141/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3219 - accuracy:
Epoch 142/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3216 - accuracy:
Epoch 143/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3212 - accuracy:
Epoch 144/200
4000/4000 [==============================] - 6s 1ms/step - loss: 0.3219 - accuracy:
Epoch 145/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3212 - accuracy:
Epoch 146/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3209 - accuracy:
Epoch 147/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3213 - accuracy:
Epoch 148/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3212 - accuracy:
Epoch 149/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3209 - accuracy:
Epoch 150/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3215 - accuracy:
Epoch 151/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3205 - accuracy:
Epoch 152/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3212 - accuracy:
Epoch 153/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3209 - accuracy:
```

```
Epoch 154/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3216 - accuracy:
Epoch 155/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3216 - accuracy:
Epoch 156/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3208 - accuracy:
Epoch 157/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3197 - accuracy:
Epoch 158/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3196 - accuracy:
Epoch 159/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3205 - accuracy:
Epoch 160/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3205 - accuracy:
Epoch 161/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3199 - accuracy:
Epoch 162/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3207 - accuracy:
Epoch 163/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3206 - accuracy:
Epoch 164/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3194 - accuracy:
Epoch 165/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3201 - accuracy:
Epoch 166/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3206 - accuracy:
Epoch 167/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3204 - accuracy:
Epoch 168/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3194 - accuracy:
Epoch 169/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3188 - accuracy:
Epoch 170/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3208 - accuracy:
Epoch 171/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3190 - accuracy:
Epoch 172/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3197 - accuracy:
Epoch 173/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3189 - accuracy:
Epoch 174/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3189 - accuracy:
Epoch 175/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3182 - accuracy:
Epoch 176/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3191 - accuracy:
Epoch 177/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3184 - accuracy:
Epoch 178/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3180 - accuracy:
Epoch 179/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3197 - accuracy:
Epoch 180/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3193 - accuracy:
Epoch 181/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3191 - accuracy:
Epoch 182/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3187 - accuracy:
Epoch 183/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3189 - accuracy:
Epoch 184/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3192 - accuracy:
```

```
Epoch 185/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3195 - accuracy:
Epoch 186/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3188 - accuracy:
Epoch 187/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3187 - accuracy:
Epoch 188/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3186 - accuracy:
Epoch 189/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3187 - accuracy:
Epoch 190/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3177 - accuracy:
Epoch 191/200
4000/4000 [==============================] - 5s 1ms/step - loss: 0.3185 - accuracy:
```

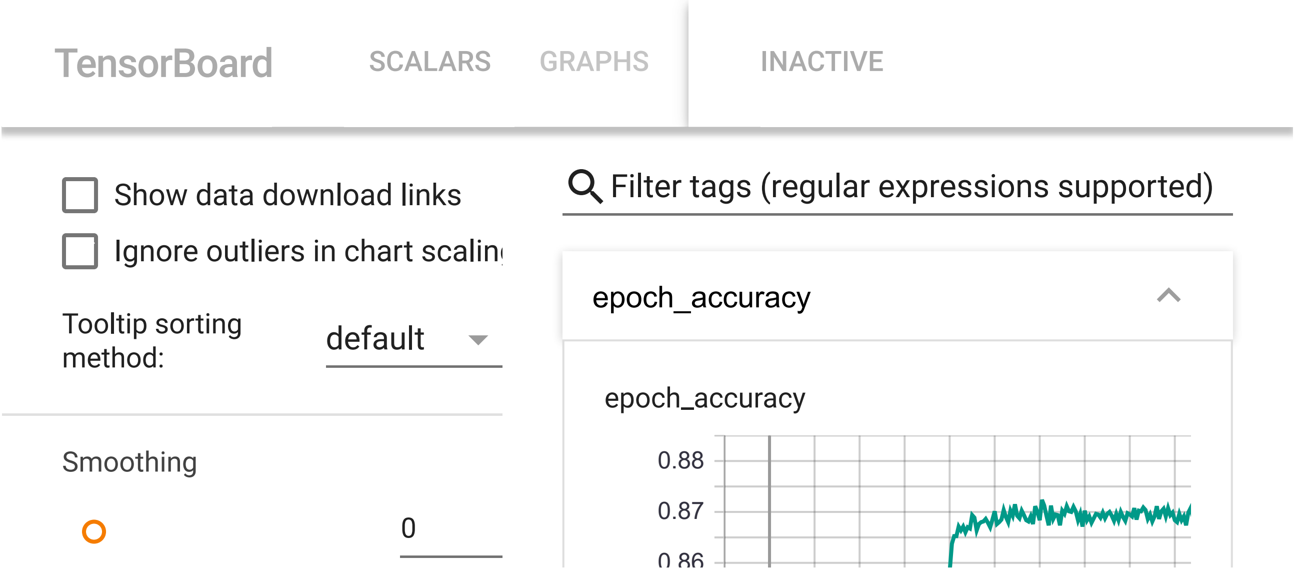
```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
print((cm[0][0] + cm[1][1])/2000)
```

```
0.85
Epoch 198/200
```

```
%tensorboard --logdir logs
```

```
Reusing TensorBoard on port 6006 (pid 558), started 2:43:48 ago. (Use '!kill 558' to
```




```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
```

```
array([[1535,   75],
       [ 208,  182]])
```

In the first model, we have a neural network with 3 layers: layer 1 has 6 neuron units, layer 2 has 10 neuron units, and layer 3 or output layer has 1 neuron unit. the model is trained with mini-batch size 10, and epochs = 100. our model is relatively simple. however, it work well in general.

In the second model, we have a neural network with 3 layers: layer 1 has 6 neuron units, layer 2 has 10 neuron units, and layer 3 or output layer has 1 neuron unit. the model is trained with mini-batch size 64, and epochs = 200. in this model, we see a little bit increasement in trainig set accuracy but the test set accuracy got decreased a bit. this means that the increasement of the bacth size was not a good idea.

In the third model, we have a neural network with 3 layers: layer 1 has 16 neuron units, layer 2 has 8 neuron units, and layer 3 or output layer has 1 neuron unit. the model is trained with mini-batch size 8, and epochs = 200. in this model, we have changed the num of hidden units in the hidden layers, and also decrease the batch size to 8. we see an increasement in both test set accuracy and training set accuracy.

In the fourth model, we have a neural network with 4 layers: layer 1 has 16 neuron units, layer 2 has 8 neuron units, and layer 3 has 8 neuron units, and layer 4 or output layer has 1 neuron unit. the model is trained with mini-batch size 2, and epochs = 200. in this model, we did our model more complex and add a hidden layer to it. and alse decrease the batch size. we see the training set accuracy increases but the test set accuracy is the same.