

## ▼ Linear Classifier in TensorFlow

Using Low Level API in Eager Execution mode

### ▼ Load tensorflow

```
import tensorflow as tf
```

☞ The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.  
We recommend you [upgrade](#) now or ensure your notebook will continue to use TensorFlow 1.x via the %te

```
#Enable Eager Execution if using tensorflow version < 2.0  
#From tensorflow v2.0 onwards, Eager Execution will be enabled by default
```

```
tf.enable_eager_execution
```

☞ <function tensorflow.python.framework.ops.enable\_eager\_execution>

### ▼ Collect Data

```
from google.colab import drive  
drive.mount('/gdrive')
```

☞ Go to this URL in a browser: [https://accounts.google.com/o/oauth2/auth?client\\_id=9473](https://accounts.google.com/o/oauth2/auth?client_id=9473)

Enter your authorization code:  
.....  
Mounted at /gdrive

```
import pandas as pd  
  
price = pd.read_csv('/gdrive/My Drive/prices.csv')
```

### ▼ Check all columns in the dataset

```
price.describe()
```

☞

	<b>open</b>	<b>close</b>	<b>low</b>	<b>high</b>	<b>volume</b>
<b>count</b>	851264.000000	851264.000000	851264.000000	851264.000000	8.512640e+05
<b>mean</b>	70.836986	70.857109	70.118414	71.543476	5.415113e+06
<b>std</b>	83.695876	83.689686	82.877294	84.465504	1.249468e+07
<b>min</b>	0.850000	0.860000	0.830000	0.880000	0.000000e+00
<b>25%</b>	33.840000	33.849998	33.480000	34.189999	1.221500e+06
<b>50%</b>	52.770000	52.799999	52.230000	53.310001	2.476250e+06
<b>75%</b>	79.879997	79.889999	79.110001	80.610001	5.222500e+06
<b>max</b>	1584.439941	1578.130005	1549.939941	1600.930054	8.596434e+08

```
price.shape
```

```
↳ (851264, 7)
```

```
price.info()
```

```
↳ <class 'pandas.core.frame.DataFrame'>
RangeIndex: 851264 entries, 0 to 851263
Data columns (total 7 columns):
date      851264 non-null object
symbol    851264 non-null object
open       851264 non-null float64
close      851264 non-null float64
low        851264 non-null float64
high       851264 non-null float64
volume     851264 non-null float64
dtypes: float64(5), object(2)
memory usage: 45.5+ MB
```

```
price.columns
```

```
↳ Index(['date', 'symbol', 'open', 'close', 'low', 'high', 'volume'], dtype='object')
```

## ▼ Drop columns date and symbol

```
price.drop(['date', 'symbol'], axis = 1, inplace=True)
```

```
price.head()
```



	open	close	low	high	volume
<b>0</b>	123.430000	125.839996	122.309998	126.250000	2163600.0
<b>1</b>	125.239998	119.980003	119.940002	125.540001	2386400.0
<b>2</b>	116.379997	114.949997	114.930000	119.739998	2489500.0
<b>3</b>	115.480003	116.620003	113.500000	117.440002	2006300.0
<b>4</b>	117.010002	114.970001	114.089996	117.330002	1408600.0

- ▼ Consider only first 1000 rows in the dataset for building feature set and target

Target 'Volume' has very high values. Divide 'Volume' by 1000,000

```
d_price = price.head(1000)
```

```
d_price.tail()
```

	open	close	low	high	volume
<b>995</b>	63.310001	63.590000	63.240002	63.639999	2133200.0
<b>996</b>	27.160000	26.990000	26.680000	27.299999	1982400.0
<b>997</b>	28.320000	28.770000	28.010000	28.809999	37152800.0
<b>998</b>	44.000000	44.799999	43.750000	44.810001	6568600.0
<b>999</b>	36.080002	37.139999	36.009998	37.230000	5604300.0

```
d_price['volume'] = d_price['volume']/1000
```

👤 /usr/local/lib/python3.6/dist-packages/ipykernel\_launcher.py:1: SettingWithCopyWarning  
A value is trying to be set on a copy of a slice from a DataFrame.  
Try using .loc[row\_indexer,col\_indexer] = value instead

See the caveats in the documentation: [http://pandas.pydata.org/pandas-docs/stable/use\\_astype.html](http://pandas.pydata.org/pandas-docs/stable/use_astype.html)  
"""\Entry point for launching an IPython kernel.

```
d_price.head()
```

	open	close	low	high	volume
<b>0</b>	123.430000	125.839996	122.309998	126.250000	2163.6
<b>1</b>	125.239998	119.980003	119.940002	125.540001	2386.4
<b>2</b>	116.379997	114.949997	114.930000	119.739998	2489.5
<b>3</b>	115.480003	116.620003	113.500000	117.440002	2006.3
<b>4</b>	117.010002	114.970001	114.089996	117.330002	1408.6

## ▼ Divide the data into train and test sets

```
from sklearn.model_selection import train_test_split

X = d_price.drop(['volume'], axis = 1)
Y = d_price[['volume']]

X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2,random_state = 100)
```

## ▼ Convert Training and Test Data to numpy float32 arrays

```
import numpy as np

train_x= np.array(X_train)
train_x = train_x.astype('float32')

test_x= np.array(X_test)
test_x = test_x.astype('float32')

train_y= np.array(Y_train)
train_y = train_y.astype('float32')

test_y= np.array(Y_test)
test_y = test_y.astype('float32')
```

```
print(train_x.dtype)
print(test_x.dtype)
print(train_y.dtype)
print(test_y.dtype)
```

👤 float32  
float32  
float32  
float32

## ▼ Normalize the data

You can use Normalizer from sklearn.preprocessing

```
from sklearn.preprocessing import Normalizer
scale = Normalizer()

train_x = scale.fit_transform(train_x)

test_x= scale.fit_transform(X_test)
```

`train_x.shape`

 (800, 4)

`train_x.dtype`

 dtype('float32')

## 1. Define Weights and Bias, use tf.zeros to initialize weights and Bias

```
w = tf.zeros(shape=(4,1))
b = tf.zeros(shape=(1))
```

## 2. Define a function to calculate prediction

```
def prediction(x, w, b):
    xw_matmul = tf.matmul(x, w)
    y = tf.add(xw_matmul, b)

    return y
```

## 3. Loss (Cost) Function [Mean square error]

```
def loss(y_actual, y_predicted):
    diff = y_actual - y_predicted
    sqr = tf.square(diff)
    avg = tf.reduce_mean(sqr)

    return avg
```

## 4. Function to train the Model

1. Record all the mathematical steps to calculate Loss
2. Calculate Gradients of Loss w.r.t weights and bias
3. Update Weights and Bias based on gradients and learning rate to minimize loss

```
def train(x, y_actual, w, b, learning_rate=0.01):
    #Record mathematical operations on 'tape' to calculate loss
    with tf.GradientTape() as t:
        t.watch([w,b])

        current_prediction = prediction(x, w, b)
        current_loss = loss(y_actual, current_prediction)

    #Calculate Gradients for Loss with respect to Weights and Bias
    dw, db = t.gradient(current_loss,[w, b])
```

```
#Update Weights and Bias  
w = w - learning_rate*dw  
b = b - learning_rate*db  
  
return w, b
```

## ▼ Train the model for 100 epochs

1. Observe the training loss at every iteration
2. Observe Train loss at every 5th iteration

```
for i in range(100):
```

```
w, b = train(train_x, train_y, w, b)  
print('Current Loss on iteration', i, loss(train_y, prediction(train_x, w, b)))
```





```
Current Loss on iteration 61 Tensor("Mean_530:0", shape=(), dtype=float32)
Current Loss on iteration 62 Tensor("Mean_532:0", shape=(), dtype=float32)
Current Loss on iteration 63 Tensor("Mean_534:0", shape=(), dtype=float32)
Current Loss on iteration 64 Tensor("Mean_536:0", shape=(), dtype=float32)
Current Loss on iteration 65 Tensor("Mean_538:0", shape=(), dtype=float32)
Current Loss on iteration 66 Tensor("Mean_540:0", shape=(), dtype=float32)
Current Loss on iteration 67 Tensor("Mean_542:0", shape=(), dtype=float32)
Current Loss on iteration 68 Tensor("Mean_544:0", shape=(), dtype=float32)
Current Loss on iteration 69 Tensor("Mean_546:0", shape=(), dtype=float32)
Current Loss on iteration 70 Tensor("Mean_548:0", shape=(), dtype=float32)
Current Loss on iteration 71 Tensor("Mean_550:0", shape=(), dtype=float32)
Current Loss on iteration 72 Tensor("Mean_552:0", shape=(), dtype=float32)
Current Loss on iteration 73 Tensor("Mean_554:0", shape=(), dtype=float32)
Current Loss on iteration 74 Tensor("Mean_556:0", shape=(), dtype=float32)
Current Loss on iteration 75 Tensor("Mean_558:0", shape=(), dtype=float32)
Current Loss on iteration 76 Tensor("Mean_560:0", shape=(), dtype=float32)
Current Loss on iteration 77 Tensor("Mean_562:0", shape=(), dtype=float32)
Current Loss on iteration 78 Tensor("Mean_564:0", shape=(), dtype=float32)
Current Loss on iteration 79 Tensor("Mean_566:0", shape=(), dtype=float32)
Current Loss on iteration 80 Tensor("Mean_568:0", shape=(), dtype=float32)
Current Loss on iteration 81 Tensor("Mean_570:0", shape=(), dtype=float32)
Current Loss on iteration 82 Tensor("Mean_572:0", shape=(), dtype=float32)
Current Loss on iteration 83 Tensor("Mean_574:0", shape=(), dtype=float32)
Current Loss on iteration 84 Tensor("Mean_576:0", shape=(), dtype=float32)
Current Loss on iteration 85 Tensor("Mean_578:0", shape=(), dtype=float32)
Current Loss on iteration 86 Tensor("Mean_580:0", shape=(), dtype=float32)
Current Loss on iteration 87 Tensor("Mean_582:0", shape=(), dtype=float32)
Current Loss on iteration 88 Tensor("Mean_584:0", shape=(), dtype=float32)
Current Loss on iteration 89 Tensor("Mean_586:0", shape=(), dtype=float32)
Current Loss on iteration 90 Tensor("Mean_588:0", shape=(), dtype=float32)
Current Loss on iteration 91 Tensor("Mean_590:0", shape=(), dtype=float32)
Current Loss on iteration 92 Tensor("Mean_592:0", shape=(), dtype=float32)
Current Loss on iteration 93 Tensor("Mean_594:0", shape=(), dtype=float32)
Current Loss on iteration 94 Tensor("Mean_596:0", shape=(), dtype=float32)
Current Loss on iteration 95 Tensor("Mean_598:0", shape=(), dtype=float32)
Current Loss on iteration 96 Tensor("Mean_600:0", shape=(), dtype=float32)
Current Loss on iteration 97 Tensor("Mean_602:0", shape=(), dtype=float32)
Current Loss on iteration 98 Tensor("Mean_604:0", shape=(), dtype=float32)
Current Loss on iteration 99 Tensor("Mean_606:0", shape=(), dtype=float32)
```

## ▼ Get the shapes and values of W and b

```
print('Weights:\n', w)
print('Bias:\n', b)
```



Weights:  
Tensor("sub\_405:0", shape=(4, 1), dtype=float32)  
Bias:  
Tensor("sub\_406:0", shape=(1,), dtype=float32)

## ▼ Model Prediction on 1st Examples in Test Dataset

```
pred = prediction(test_x[0:1],w,b)
```

pred

[https://colab.research.google.com/drive/1PKInR\\_96mGR7OQPiaPTmG7V6w5UZihQY#scrollTo=f9kX6SEqOB6W&printMode=true](https://colab.research.google.com/drive/1PKInR_96mGR7OQPiaPTmG7V6w5UZihQY#scrollTo=f9kX6SEqOB6W&printMode=true)



```
<tf.Tensor 'Add_206:0' shape=(1, 1) dtype=float32>
```

## ▼ Classification using tf.Keras

In this exercise, we will build a Deep Neural Network using tf.Keras. We will use Iris Dataset for this.

## ▼ Load the given Iris data using pandas (Iris.csv)

```
data_iris = pd.read_csv('/content/drive/My Drive/PGAIML/Neural Networks/Iris.csv')
```

## ▼ Target set has different categories. So, Label encode them. And convert into one hot encoding using pandas.

```
from sklearn import preprocessing

# label_encoder object knows how to understand word labels.
label_encoder = preprocessing.LabelEncoder()

# Encode labels in column 'species'.
data_iris['Species']= label_encoder.fit_transform(data_iris['Species'])

data_iris['Species'].unique()

❸ array([0, 1, 2])
```

## ▼ Splitting the data into feature set and target set

```
X1= np.array(data_iris.drop(columns=['Species','Id']))

y1 = np.array(data_iris['Species'])

X1_train,X1_test,y1_train,y1_test = train_test_split(X1,y1,test_size=0.2,random_state=342)

X1_train_z = scale.fit_transform(X1_train)

X1_test_z = scale.fit_transform(X1_test)

y1_train = tf.keras.utils.to_categorical(y1_train, num_classes=3)
y1_test = tf.keras.utils.to_categorical(y1_test, num_classes=3)

X1_train_z = X1_train_z.astype('float32')
X1_test_z = X1_test_z.astype('float32')
v1_test = v1_test.astype('float32')
```

```
y1_train = y1_train.astype('float32')
```

## ▼ Building Model in tf.keras

Build a Linear Classifier model

1. Use Dense Layer with input shape of 4 (according to the feature set) and number of outputs set to 3
2. Apply Softmax on Dense Layer outputs
3. Use SGD as Optimizer
4. Use categorical\_crossentropy as loss function

```
model = tf.keras.models.Sequential()  
  
model.add(tf.keras.layers.BatchNormalization())  
  
model.add(tf.keras.layers.Dense(3, input_shape=(4,), activation='softmax'))
```

## ▼ Model Training

```
model.compile(optimizer='sgd', loss='categorical_crossentropy',  
              metrics=['accuracy'])  
  
model.fit(X1_train_z, y1_train,  
          validation_data=(X1_test_z, y1_test),  
          epochs=500,  
          batch_size=20)
```



Train on 120 samples, validate on 30 samples

Epoch 1/500

120/120 [=====] - 0s 223us/sample - loss: 0.8302 - acc: 0.67  
Epoch 2/500  
120/120 [=====] - 0s 207us/sample - loss: 0.8294 - acc: 0.70  
Epoch 3/500  
120/120 [=====] - 0s 204us/sample - loss: 0.8233 - acc: 0.69  
Epoch 4/500  
120/120 [=====] - 0s 212us/sample - loss: 0.8168 - acc: 0.67  
Epoch 5/500  
120/120 [=====] - 0s 218us/sample - loss: 0.8201 - acc: 0.73  
Epoch 6/500  
120/120 [=====] - 0s 220us/sample - loss: 0.8148 - acc: 0.70  
Epoch 7/500  
120/120 [=====] - 0s 210us/sample - loss: 0.8179 - acc: 0.70  
Epoch 8/500  
120/120 [=====] - 0s 223us/sample - loss: 0.8081 - acc: 0.70  
Epoch 9/500  
120/120 [=====] - 0s 246us/sample - loss: 0.8060 - acc: 0.73  
Epoch 10/500  
120/120 [=====] - 0s 230us/sample - loss: 0.8056 - acc: 0.70  
Epoch 11/500  
120/120 [=====] - 0s 222us/sample - loss: 0.7967 - acc: 0.68  
Epoch 12/500  
120/120 [=====] - 0s 229us/sample - loss: 0.7982 - acc: 0.70  
Epoch 13/500  
120/120 [=====] - 0s 249us/sample - loss: 0.8053 - acc: 0.69  
Epoch 14/500  
120/120 [=====] - 0s 211us/sample - loss: 0.7896 - acc: 0.70  
Epoch 15/500  
120/120 [=====] - 0s 216us/sample - loss: 0.7914 - acc: 0.73  
Epoch 16/500  
120/120 [=====] - 0s 202us/sample - loss: 0.7905 - acc: 0.73  
Epoch 17/500  
120/120 [=====] - 0s 232us/sample - loss: 0.7849 - acc: 0.70  
Epoch 18/500  
120/120 [=====] - 0s 234us/sample - loss: 0.7798 - acc: 0.69  
Epoch 19/500  
120/120 [=====] - 0s 257us/sample - loss: 0.7783 - acc: 0.71  
Epoch 20/500  
120/120 [=====] - 0s 227us/sample - loss: 0.7739 - acc: 0.68  
Epoch 21/500  
120/120 [=====] - 0s 235us/sample - loss: 0.7917 - acc: 0.73  
Epoch 22/500  
120/120 [=====] - 0s 245us/sample - loss: 0.7755 - acc: 0.70  
Epoch 23/500  
120/120 [=====] - 0s 223us/sample - loss: 0.7697 - acc: 0.70  
Epoch 24/500  
120/120 [=====] - 0s 235us/sample - loss: 0.7881 - acc: 0.70  
Epoch 25/500  
120/120 [=====] - 0s 267us/sample - loss: 0.7621 - acc: 0.69  
Epoch 26/500  
120/120 [=====] - 0s 234us/sample - loss: 0.7695 - acc: 0.73  
Epoch 27/500  
120/120 [=====] - 0s 247us/sample - loss: 0.7633 - acc: 0.69  
Epoch 28/500  
120/120 [=====] - 0s 211us/sample - loss: 0.7619 - acc: 0.70  
Epoch 29/500  
120/120 [=====] - 0s 241us/sample - loss: 0.7610 - acc: 0.70  
Epoch 30/500  
120/120 [=====] - 0s 313us/sample - loss: 0.7528 - acc: 0.68

Epoch 31/500  
120/120 [=====] - 0s 224us/sample - loss: 0.7544 - acc: 0.70  
Epoch 32/500  
120/120 [=====] - 0s 245us/sample - loss: 0.7583 - acc: 0.75  
Epoch 33/500  
120/120 [=====] - 0s 245us/sample - loss: 0.7502 - acc: 0.75  
Epoch 34/500  
120/120 [=====] - 0s 283us/sample - loss: 0.7444 - acc: 0.69  
Epoch 35/500  
120/120 [=====] - 0s 210us/sample - loss: 0.7434 - acc: 0.70  
Epoch 36/500  
120/120 [=====] - 0s 208us/sample - loss: 0.7430 - acc: 0.68  
Epoch 37/500  
120/120 [=====] - 0s 227us/sample - loss: 0.7681 - acc: 0.71  
Epoch 38/500  
120/120 [=====] - 0s 220us/sample - loss: 0.7417 - acc: 0.73  
Epoch 39/500  
120/120 [=====] - 0s 273us/sample - loss: 0.7406 - acc: 0.76  
Epoch 40/500  
120/120 [=====] - 0s 232us/sample - loss: 0.7316 - acc: 0.68  
Epoch 41/500  
120/120 [=====] - 0s 208us/sample - loss: 0.7425 - acc: 0.69  
Epoch 42/500  
120/120 [=====] - 0s 246us/sample - loss: 0.7374 - acc: 0.75  
Epoch 43/500  
120/120 [=====] - 0s 237us/sample - loss: 0.7370 - acc: 0.71  
Epoch 44/500  
120/120 [=====] - 0s 256us/sample - loss: 0.7313 - acc: 0.69  
Epoch 45/500  
120/120 [=====] - 0s 239us/sample - loss: 0.7244 - acc: 0.73  
Epoch 46/500  
120/120 [=====] - 0s 267us/sample - loss: 0.7179 - acc: 0.70  
Epoch 47/500  
120/120 [=====] - 0s 220us/sample - loss: 0.7272 - acc: 0.73  
Epoch 48/500  
120/120 [=====] - 0s 224us/sample - loss: 0.7517 - acc: 0.69  
Epoch 49/500  
120/120 [=====] - 0s 213us/sample - loss: 0.7135 - acc: 0.67  
Epoch 50/500  
120/120 [=====] - 0s 245us/sample - loss: 0.7172 - acc: 0.70  
Epoch 51/500  
120/120 [=====] - 0s 223us/sample - loss: 0.7396 - acc: 0.69  
Epoch 52/500  
120/120 [=====] - 0s 194us/sample - loss: 0.7091 - acc: 0.69  
Epoch 53/500  
120/120 [=====] - 0s 202us/sample - loss: 0.7300 - acc: 0.70  
Epoch 54/500  
120/120 [=====] - 0s 209us/sample - loss: 0.7162 - acc: 0.72  
Epoch 55/500  
120/120 [=====] - 0s 199us/sample - loss: 0.7077 - acc: 0.73  
Epoch 56/500  
120/120 [=====] - 0s 223us/sample - loss: 0.7211 - acc: 0.74  
Epoch 57/500  
120/120 [=====] - 0s 208us/sample - loss: 0.7060 - acc: 0.75  
Epoch 58/500  
120/120 [=====] - 0s 214us/sample - loss: 0.7071 - acc: 0.69  
Epoch 59/500  
120/120 [=====] - 0s 217us/sample - loss: 0.7032 - acc: 0.76  
Epoch 60/500  
120/120 [=====] - 0s 208us/sample - loss: 0.7050 - acc: 0.72  
Epoch 61/500  
120/120 [=====] - 0s 342us/sample - loss: 0.7035 - acc: 0.78

Epoch 62/500  
120/120 [=====] - 0s 208us/sample - loss: 0.6962 - acc: 0.74  
Epoch 63/500  
120/120 [=====] - 0s 210us/sample - loss: 0.6970 - acc: 0.74  
Epoch 64/500  
120/120 [=====] - 0s 207us/sample - loss: 0.7003 - acc: 0.69  
Epoch 65/500  
120/120 [=====] - 0s 203us/sample - loss: 0.6900 - acc: 0.76  
Epoch 66/500  
120/120 [=====] - 0s 240us/sample - loss: 0.6934 - acc: 0.71  
Epoch 67/500  
120/120 [=====] - 0s 233us/sample - loss: 0.6855 - acc: 0.75  
Epoch 68/500  
120/120 [=====] - 0s 214us/sample - loss: 0.6855 - acc: 0.78  
Epoch 69/500  
120/120 [=====] - 0s 224us/sample - loss: 0.6822 - acc: 0.72  
Epoch 70/500  
120/120 [=====] - 0s 209us/sample - loss: 0.7045 - acc: 0.74  
Epoch 71/500  
120/120 [=====] - 0s 205us/sample - loss: 0.6780 - acc: 0.69  
Epoch 72/500  
120/120 [=====] - 0s 213us/sample - loss: 0.6783 - acc: 0.70  
Epoch 73/500  
120/120 [=====] - 0s 214us/sample - loss: 0.6831 - acc: 0.71  
Epoch 74/500  
120/120 [=====] - 0s 220us/sample - loss: 0.6786 - acc: 0.75  
Epoch 75/500  
120/120 [=====] - 0s 243us/sample - loss: 0.6803 - acc: 0.74  
Epoch 76/500  
120/120 [=====] - 0s 263us/sample - loss: 0.6866 - acc: 0.75  
Epoch 77/500  
120/120 [=====] - 0s 253us/sample - loss: 0.6874 - acc: 0.73  
Epoch 78/500  
120/120 [=====] - 0s 240us/sample - loss: 0.6714 - acc: 0.79  
Epoch 79/500  
120/120 [=====] - 0s 218us/sample - loss: 0.6732 - acc: 0.75  
Epoch 80/500  
120/120 [=====] - 0s 221us/sample - loss: 0.6745 - acc: 0.77  
Epoch 81/500  
120/120 [=====] - 0s 217us/sample - loss: 0.6719 - acc: 0.74  
Epoch 82/500  
120/120 [=====] - 0s 242us/sample - loss: 0.6645 - acc: 0.74  
Epoch 83/500  
120/120 [=====] - 0s 230us/sample - loss: 0.6702 - acc: 0.75  
Epoch 84/500  
120/120 [=====] - 0s 208us/sample - loss: 0.6674 - acc: 0.75  
Epoch 85/500  
120/120 [=====] - 0s 203us/sample - loss: 0.6638 - acc: 0.75  
Epoch 86/500  
120/120 [=====] - 0s 210us/sample - loss: 0.6758 - acc: 0.70  
Epoch 87/500  
120/120 [=====] - 0s 209us/sample - loss: 0.6566 - acc: 0.71  
Epoch 88/500  
120/120 [=====] - 0s 237us/sample - loss: 0.6592 - acc: 0.75  
Epoch 89/500  
120/120 [=====] - 0s 248us/sample - loss: 0.6707 - acc: 0.74  
Epoch 90/500  
120/120 [=====] - 0s 218us/sample - loss: 0.6695 - acc: 0.77  
Epoch 91/500  
120/120 [=====] - 0s 217us/sample - loss: 0.6615 - acc: 0.75  
Epoch 92/500

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120/120 [=====] - 0s 231us/sample - loss: 0.6554 - acc: 0.72
Epoch 93/500
120/120 [=====] - 0s 310us/sample - loss: 0.6530 - acc: 0.75
Epoch 94/500
120/120 [=====] - 0s 214us/sample - loss: 0.6715 - acc: 0.76
Epoch 95/500
120/120 [=====] - 0s 219us/sample - loss: 0.6577 - acc: 0.74
Epoch 96/500
120/120 [=====] - 0s 234us/sample - loss: 0.6554 - acc: 0.77
Epoch 97/500
120/120 [=====] - 0s 214us/sample - loss: 0.6672 - acc: 0.74
Epoch 98/500
120/120 [=====] - 0s 237us/sample - loss: 0.6615 - acc: 0.71
Epoch 99/500
120/120 [=====] - 0s 219us/sample - loss: 0.6561 - acc: 0.76
Epoch 100/500
120/120 [=====] - 0s 269us/sample - loss: 0.6520 - acc: 0.74
Epoch 101/500
120/120 [=====] - 0s 243us/sample - loss: 0.6438 - acc: 0.73
Epoch 102/500
120/120 [=====] - 0s 210us/sample - loss: 0.6459 - acc: 0.75
Epoch 103/500
120/120 [=====] - 0s 226us/sample - loss: 0.6495 - acc: 0.79
Epoch 104/500
120/120 [=====] - 0s 231us/sample - loss: 0.6400 - acc: 0.77
Epoch 105/500
120/120 [=====] - 0s 229us/sample - loss: 0.6599 - acc: 0.84
Epoch 106/500
120/120 [=====] - 0s 214us/sample - loss: 0.6446 - acc: 0.79
Epoch 107/500
120/120 [=====] - 0s 265us/sample - loss: 0.6444 - acc: 0.72
Epoch 108/500
120/120 [=====] - 0s 252us/sample - loss: 0.6364 - acc: 0.74
Epoch 109/500
120/120 [=====] - 0s 229us/sample - loss: 0.6385 - acc: 0.75
Epoch 110/500
120/120 [=====] - 0s 214us/sample - loss: 0.6332 - acc: 0.75
Epoch 111/500
120/120 [=====] - 0s 246us/sample - loss: 0.6450 - acc: 0.83
Epoch 112/500
120/120 [=====] - 0s 223us/sample - loss: 0.6383 - acc: 0.75
Epoch 113/500
120/120 [=====] - 0s 243us/sample - loss: 0.6416 - acc: 0.74
Epoch 114/500
120/120 [=====] - 0s 238us/sample - loss: 0.6386 - acc: 0.76
Epoch 115/500
120/120 [=====] - 0s 249us/sample - loss: 0.6321 - acc: 0.78
Epoch 116/500
120/120 [=====] - 0s 234us/sample - loss: 0.6432 - acc: 0.85
Epoch 117/500
120/120 [=====] - 0s 214us/sample - loss: 0.6475 - acc: 0.75
Epoch 118/500
120/120 [=====] - 0s 256us/sample - loss: 0.6365 - acc: 0.75
Epoch 119/500
120/120 [=====] - 0s 241us/sample - loss: 0.6324 - acc: 0.76
Epoch 120/500
120/120 [=====] - 0s 237us/sample - loss: 0.6264 - acc: 0.76
Epoch 121/500
120/120 [=====] - 0s 223us/sample - loss: 0.6442 - acc: 0.76
Epoch 122/500
120/120 [=====] - 0s 215us/sample - loss: 0.6346 - acc: 0.80
Epoch 123/500
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120/120 [=====] - 0s 230us/sample - loss: 0.6226 - acc: 0.77  
Epoch 124/500  
120/120 [=====] - 0s 313us/sample - loss: 0.6221 - acc: 0.76  
Epoch 125/500  
120/120 [=====] - 0s 235us/sample - loss: 0.6221 - acc: 0.75  
Epoch 126/500  
120/120 [=====] - 0s 232us/sample - loss: 0.6173 - acc: 0.77  
Epoch 127/500  
120/120 [=====] - 0s 244us/sample - loss: 0.6185 - acc: 0.75  
Epoch 128/500  
120/120 [=====] - 0s 210us/sample - loss: 0.6183 - acc: 0.76  
Epoch 129/500  
120/120 [=====] - 0s 220us/sample - loss: 0.6326 - acc: 0.70  
Epoch 130/500  
120/120 [=====] - 0s 227us/sample - loss: 0.6236 - acc: 0.76  
Epoch 131/500  
120/120 [=====] - 0s 213us/sample - loss: 0.6158 - acc: 0.78  
Epoch 132/500  
120/120 [=====] - 0s 230us/sample - loss: 0.6203 - acc: 0.79  
Epoch 133/500  
120/120 [=====] - 0s 228us/sample - loss: 0.6218 - acc: 0.73  
Epoch 134/500  
120/120 [=====] - 0s 241us/sample - loss: 0.6123 - acc: 0.75  
Epoch 135/500  
120/120 [=====] - 0s 224us/sample - loss: 0.6343 - acc: 0.73  
Epoch 136/500  
120/120 [=====] - 0s 230us/sample - loss: 0.6121 - acc: 0.72  
Epoch 137/500  
120/120 [=====] - 0s 211us/sample - loss: 0.6117 - acc: 0.80  
Epoch 138/500  
120/120 [=====] - 0s 243us/sample - loss: 0.6169 - acc: 0.73  
Epoch 139/500  
120/120 [=====] - 0s 226us/sample - loss: 0.6115 - acc: 0.83  
Epoch 140/500  
120/120 [=====] - 0s 233us/sample - loss: 0.6056 - acc: 0.76  
Epoch 141/500  
120/120 [=====] - 0s 216us/sample - loss: 0.6299 - acc: 0.65  
Epoch 142/500  
120/120 [=====] - 0s 215us/sample - loss: 0.6057 - acc: 0.73  
Epoch 143/500  
120/120 [=====] - 0s 216us/sample - loss: 0.6076 - acc: 0.69  
Epoch 144/500  
120/120 [=====] - 0s 208us/sample - loss: 0.6004 - acc: 0.75  
Epoch 145/500  
120/120 [=====] - 0s 220us/sample - loss: 0.6051 - acc: 0.80  
Epoch 146/500  
120/120 [=====] - 0s 251us/sample - loss: 0.6024 - acc: 0.74  
Epoch 147/500  
120/120 [=====] - 0s 222us/sample - loss: 0.6071 - acc: 0.75  
Epoch 148/500  
120/120 [=====] - 0s 213us/sample - loss: 0.6040 - acc: 0.78  
Epoch 149/500  
120/120 [=====] - 0s 208us/sample - loss: 0.5973 - acc: 0.75  
Epoch 150/500  
120/120 [=====] - 0s 216us/sample - loss: 0.6001 - acc: 0.82  
Epoch 151/500  
120/120 [=====] - 0s 218us/sample - loss: 0.6092 - acc: 0.73  
Epoch 152/500  
120/120 [=====] - 0s 221us/sample - loss: 0.6102 - acc: 0.75  
Epoch 153/500  
120/120 [=====] - 0s 216us/sample - loss: 0.5938 - acc: 0.77
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Epoch 154/500  
120/120 [=====] - 0s 223us/sample - loss: 0.5951 - acc: 0.80  
Epoch 155/500  
120/120 [=====] - 0s 218us/sample - loss: 0.6027 - acc: 0.80  
Epoch 156/500  
120/120 [=====] - 0s 315us/sample - loss: 0.5992 - acc: 0.76  
Epoch 157/500  
120/120 [=====] - 0s 218us/sample - loss: 0.6030 - acc: 0.78  
Epoch 158/500  
120/120 [=====] - 0s 227us/sample - loss: 0.5966 - acc: 0.80  
Epoch 159/500  
120/120 [=====] - 0s 226us/sample - loss: 0.5928 - acc: 0.79  
Epoch 160/500  
120/120 [=====] - 0s 202us/sample - loss: 0.5942 - acc: 0.77  
Epoch 161/500  
120/120 [=====] - 0s 215us/sample - loss: 0.5896 - acc: 0.77  
Epoch 162/500  
120/120 [=====] - 0s 228us/sample - loss: 0.5921 - acc: 0.76  
Epoch 163/500  
120/120 [=====] - 0s 249us/sample - loss: 0.5938 - acc: 0.81  
Epoch 164/500  
120/120 [=====] - 0s 257us/sample - loss: 0.5857 - acc: 0.81  
Epoch 165/500  
120/120 [=====] - 0s 209us/sample - loss: 0.5877 - acc: 0.81  
Epoch 166/500  
120/120 [=====] - 0s 238us/sample - loss: 0.5890 - acc: 0.75  
Epoch 167/500  
120/120 [=====] - 0s 233us/sample - loss: 0.5901 - acc: 0.79  
Epoch 168/500  
120/120 [=====] - 0s 248us/sample - loss: 0.5834 - acc: 0.81  
Epoch 169/500  
120/120 [=====] - 0s 204us/sample - loss: 0.5928 - acc: 0.79  
Epoch 170/500  
120/120 [=====] - 0s 206us/sample - loss: 0.5910 - acc: 0.78  
Epoch 171/500  
120/120 [=====] - 0s 210us/sample - loss: 0.5824 - acc: 0.78  
Epoch 172/500  
120/120 [=====] - 0s 208us/sample - loss: 0.5879 - acc: 0.75  
Epoch 173/500  
120/120 [=====] - 0s 209us/sample - loss: 0.5907 - acc: 0.77  
Epoch 174/500  
120/120 [=====] - 0s 223us/sample - loss: 0.5892 - acc: 0.81  
Epoch 175/500  
120/120 [=====] - 0s 213us/sample - loss: 0.6063 - acc: 0.71  
Epoch 176/500  
120/120 [=====] - 0s 219us/sample - loss: 0.5842 - acc: 0.80  
Epoch 177/500  
120/120 [=====] - 0s 208us/sample - loss: 0.5912 - acc: 0.82  
Epoch 178/500  
120/120 [=====] - 0s 201us/sample - loss: 0.5812 - acc: 0.79  
Epoch 179/500  
120/120 [=====] - 0s 210us/sample - loss: 0.5848 - acc: 0.77  
Epoch 180/500  
120/120 [=====] - 0s 217us/sample - loss: 0.5738 - acc: 0.80  
Epoch 181/500  
120/120 [=====] - 0s 256us/sample - loss: 0.5852 - acc: 0.78  
Epoch 182/500  
120/120 [=====] - 0s 314us/sample - loss: 0.5843 - acc: 0.83  
Epoch 183/500  
120/120 [=====] - 0s 242us/sample - loss: 0.5898 - acc: 0.78  
Epoch 184/500  
120/120 [=====] - 0s 221us/sample - loss: 0.5809 - acc: 0.78

Epoch 185/500  
120/120 [=====] - 0s 222us/sample - loss: 0.6181 - acc: 0.72  
Epoch 186/500  
120/120 [=====] - 0s 231us/sample - loss: 0.5775 - acc: 0.77  
Epoch 187/500  
120/120 [=====] - 0s 241us/sample - loss: 0.5794 - acc: 0.80  
Epoch 188/500  
120/120 [=====] - 0s 243us/sample - loss: 0.5792 - acc: 0.82  
Epoch 189/500  
120/120 [=====] - 0s 235us/sample - loss: 0.5760 - acc: 0.79  
Epoch 190/500  
120/120 [=====] - 0s 264us/sample - loss: 0.5811 - acc: 0.76  
Epoch 191/500  
120/120 [=====] - 0s 234us/sample - loss: 0.5755 - acc: 0.75  
Epoch 192/500  
120/120 [=====] - 0s 218us/sample - loss: 0.5728 - acc: 0.77  
Epoch 193/500  
120/120 [=====] - 0s 223us/sample - loss: 0.5794 - acc: 0.80  
Epoch 194/500  
120/120 [=====] - 0s 237us/sample - loss: 0.5920 - acc: 0.76  
Epoch 195/500  
120/120 [=====] - 0s 263us/sample - loss: 0.5691 - acc: 0.78  
Epoch 196/500  
120/120 [=====] - 0s 236us/sample - loss: 0.5758 - acc: 0.82  
Epoch 197/500  
120/120 [=====] - 0s 244us/sample - loss: 0.5703 - acc: 0.80  
Epoch 198/500  
120/120 [=====] - 0s 213us/sample - loss: 0.5870 - acc: 0.78  
Epoch 199/500  
120/120 [=====] - 0s 220us/sample - loss: 0.5675 - acc: 0.78  
Epoch 200/500  
120/120 [=====] - 0s 219us/sample - loss: 0.5853 - acc: 0.76  
Epoch 201/500  
120/120 [=====] - 0s 251us/sample - loss: 0.5710 - acc: 0.82  
Epoch 202/500  
120/120 [=====] - 0s 239us/sample - loss: 0.5683 - acc: 0.79  
Epoch 203/500  
120/120 [=====] - 0s 241us/sample - loss: 0.5727 - acc: 0.79  
Epoch 204/500  
120/120 [=====] - 0s 227us/sample - loss: 0.5617 - acc: 0.81  
Epoch 205/500  
120/120 [=====] - 0s 258us/sample - loss: 0.5652 - acc: 0.81  
Epoch 206/500  
120/120 [=====] - 0s 215us/sample - loss: 0.6003 - acc: 0.72  
Epoch 207/500  
120/120 [=====] - 0s 213us/sample - loss: 0.5647 - acc: 0.84  
Epoch 208/500  
120/120 [=====] - 0s 237us/sample - loss: 0.5742 - acc: 0.75  
Epoch 209/500  
120/120 [=====] - 0s 215us/sample - loss: 0.5641 - acc: 0.85  
Epoch 210/500  
120/120 [=====] - 0s 255us/sample - loss: 0.5615 - acc: 0.80  
Epoch 211/500  
120/120 [=====] - 0s 259us/sample - loss: 0.5639 - acc: 0.78  
Epoch 212/500  
120/120 [=====] - 0s 242us/sample - loss: 0.5608 - acc: 0.79  
Epoch 213/500  
120/120 [=====] - 0s 212us/sample - loss: 0.5632 - acc: 0.76  
Epoch 214/500  
120/120 [=====] - 0s 240us/sample - loss: 0.5568 - acc: 0.80  
Epoch 215/500

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120/120 [=====] - 0s 238us/sample - loss: 0.5576 - acc: 0.83
Epoch 216/500
120/120 [=====] - 0s 248us/sample - loss: 0.5729 - acc: 0.83
Epoch 217/500
120/120 [=====] - 0s 220us/sample - loss: 0.5558 - acc: 0.81
Epoch 218/500
120/120 [=====] - 0s 337us/sample - loss: 0.5650 - acc: 0.79
Epoch 219/500
120/120 [=====] - 0s 210us/sample - loss: 0.5643 - acc: 0.80
Epoch 220/500
120/120 [=====] - 0s 208us/sample - loss: 0.5603 - acc: 0.82
Epoch 221/500
120/120 [=====] - 0s 223us/sample - loss: 0.5773 - acc: 0.75
Epoch 222/500
120/120 [=====] - 0s 225us/sample - loss: 0.5963 - acc: 0.72
Epoch 223/500
120/120 [=====] - 0s 225us/sample - loss: 0.5781 - acc: 0.75
Epoch 224/500
120/120 [=====] - 0s 225us/sample - loss: 0.5662 - acc: 0.80
Epoch 225/500
120/120 [=====] - 0s 252us/sample - loss: 0.5534 - acc: 0.83
Epoch 226/500
120/120 [=====] - 0s 226us/sample - loss: 0.5548 - acc: 0.79
Epoch 227/500
120/120 [=====] - 0s 250us/sample - loss: 0.5591 - acc: 0.80
Epoch 228/500
120/120 [=====] - 0s 247us/sample - loss: 0.5535 - acc: 0.83
Epoch 229/500
120/120 [=====] - 0s 234us/sample - loss: 0.5535 - acc: 0.79
Epoch 230/500
120/120 [=====] - 0s 218us/sample - loss: 0.5634 - acc: 0.77
Epoch 231/500
120/120 [=====] - 0s 231us/sample - loss: 0.5560 - acc: 0.80
Epoch 232/500
120/120 [=====] - 0s 201us/sample - loss: 0.5539 - acc: 0.78
Epoch 233/500
120/120 [=====] - 0s 221us/sample - loss: 0.5595 - acc: 0.80
Epoch 234/500
120/120 [=====] - 0s 280us/sample - loss: 0.5536 - acc: 0.82
Epoch 235/500
120/120 [=====] - 0s 259us/sample - loss: 0.5625 - acc: 0.80
Epoch 236/500
120/120 [=====] - 0s 262us/sample - loss: 0.5472 - acc: 0.83
Epoch 237/500
120/120 [=====] - 0s 262us/sample - loss: 0.5467 - acc: 0.84
Epoch 238/500
120/120 [=====] - 0s 219us/sample - loss: 0.5718 - acc: 0.79
Epoch 239/500
120/120 [=====] - 0s 222us/sample - loss: 0.5613 - acc: 0.81
Epoch 240/500
120/120 [=====] - 0s 222us/sample - loss: 0.5692 - acc: 0.72
Epoch 241/500
120/120 [=====] - 0s 245us/sample - loss: 0.5453 - acc: 0.82
Epoch 242/500
120/120 [=====] - 0s 227us/sample - loss: 0.5537 - acc: 0.78
Epoch 243/500
120/120 [=====] - 0s 238us/sample - loss: 0.5495 - acc: 0.86
Epoch 244/500
120/120 [=====] - 0s 231us/sample - loss: 0.5655 - acc: 0.80
Epoch 245/500
120/120 [=====] - 0s 208us/sample - loss: 0.5462 - acc: 0.84
Epoch 246/500
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120/120 [=====] - 0s 224us/sample - loss: 0.5544 - acc: 0.79
Epoch 247/500
120/120 [=====] - 0s 216us/sample - loss: 0.5533 - acc: 0.80
Epoch 248/500
120/120 [=====] - 0s 219us/sample - loss: 0.5495 - acc: 0.78
Epoch 249/500
120/120 [=====] - 0s 221us/sample - loss: 0.5455 - acc: 0.82
Epoch 250/500
120/120 [=====] - 0s 278us/sample - loss: 0.5452 - acc: 0.82
Epoch 251/500
120/120 [=====] - 0s 214us/sample - loss: 0.5621 - acc: 0.76
Epoch 252/500
120/120 [=====] - 0s 230us/sample - loss: 0.5399 - acc: 0.81
Epoch 253/500
120/120 [=====] - 0s 240us/sample - loss: 0.5585 - acc: 0.78
Epoch 254/500
120/120 [=====] - 0s 233us/sample - loss: 0.5393 - acc: 0.83
Epoch 255/500
120/120 [=====] - 0s 216us/sample - loss: 0.5865 - acc: 0.73
Epoch 256/500
120/120 [=====] - 0s 217us/sample - loss: 0.5612 - acc: 0.76
Epoch 257/500
120/120 [=====] - 0s 281us/sample - loss: 0.5397 - acc: 0.85
Epoch 258/500
120/120 [=====] - 0s 240us/sample - loss: 0.5599 - acc: 0.71
Epoch 259/500
120/120 [=====] - 0s 219us/sample - loss: 0.5387 - acc: 0.82
Epoch 260/500
120/120 [=====] - 0s 243us/sample - loss: 0.5440 - acc: 0.82
Epoch 261/500
120/120 [=====] - 0s 232us/sample - loss: 0.5367 - acc: 0.80
Epoch 262/500
120/120 [=====] - 0s 207us/sample - loss: 0.5392 - acc: 0.84
Epoch 263/500
120/120 [=====] - 0s 239us/sample - loss: 0.5393 - acc: 0.80
Epoch 264/500
120/120 [=====] - 0s 232us/sample - loss: 0.5368 - acc: 0.81
Epoch 265/500
120/120 [=====] - 0s 281us/sample - loss: 0.5401 - acc: 0.80
Epoch 266/500
120/120 [=====] - 0s 228us/sample - loss: 0.5343 - acc: 0.82
Epoch 267/500
120/120 [=====] - 0s 215us/sample - loss: 0.5510 - acc: 0.76
Epoch 268/500
120/120 [=====] - 0s 206us/sample - loss: 0.5385 - acc: 0.80
Epoch 269/500
120/120 [=====] - 0s 238us/sample - loss: 0.5387 - acc: 0.85
Epoch 270/500
120/120 [=====] - 0s 231us/sample - loss: 0.5341 - acc: 0.81
Epoch 271/500
120/120 [=====] - 0s 253us/sample - loss: 0.5366 - acc: 0.82
Epoch 272/500
120/120 [=====] - 0s 238us/sample - loss: 0.5370 - acc: 0.81
Epoch 273/500
120/120 [=====] - 0s 252us/sample - loss: 0.5337 - acc: 0.83
Epoch 274/500
120/120 [=====] - 0s 225us/sample - loss: 0.5438 - acc: 0.79
Epoch 275/500
120/120 [=====] - 0s 256us/sample - loss: 0.5375 - acc: 0.82
Epoch 276/500
120/120 [=====] - 0s 242us/sample - loss: 0.5337 - acc: 0.84
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Epoch 277/500
120/120 [=====] - 0s 228us/sample - loss: 0.5228 - acc: 0.85
Epoch 278/500
120/120 [=====] - 0s 227us/sample - loss: 0.5245 - acc: 0.88
Epoch 279/500
120/120 [=====] - 0s 226us/sample - loss: 0.5426 - acc: 0.85
Epoch 280/500
120/120 [=====] - 0s 306us/sample - loss: 0.5367 - acc: 0.80
Epoch 281/500
120/120 [=====] - 0s 223us/sample - loss: 0.5431 - acc: 0.80
Epoch 282/500
120/120 [=====] - 0s 219us/sample - loss: 0.5469 - acc: 0.78
Epoch 283/500
120/120 [=====] - 0s 228us/sample - loss: 0.5679 - acc: 0.72
Epoch 284/500
120/120 [=====] - 0s 211us/sample - loss: 0.5288 - acc: 0.84
Epoch 285/500
120/120 [=====] - 0s 230us/sample - loss: 0.5732 - acc: 0.67
Epoch 286/500
120/120 [=====] - 0s 245us/sample - loss: 0.5270 - acc: 0.83
Epoch 287/500
120/120 [=====] - 0s 242us/sample - loss: 0.5391 - acc: 0.79
Epoch 288/500
120/120 [=====] - 0s 241us/sample - loss: 0.5246 - acc: 0.87
Epoch 289/500
120/120 [=====] - 0s 297us/sample - loss: 0.5282 - acc: 0.85
Epoch 290/500
120/120 [=====] - 0s 208us/sample - loss: 0.5296 - acc: 0.81
Epoch 291/500
120/120 [=====] - 0s 223us/sample - loss: 0.5267 - acc: 0.84
Epoch 292/500
120/120 [=====] - 0s 251us/sample - loss: 0.5279 - acc: 0.81
Epoch 293/500
120/120 [=====] - 0s 243us/sample - loss: 0.5359 - acc: 0.84
Epoch 294/500
120/120 [=====] - 0s 217us/sample - loss: 0.5237 - acc: 0.82
Epoch 295/500
120/120 [=====] - 0s 265us/sample - loss: 0.5319 - acc: 0.80
Epoch 296/500
120/120 [=====] - 0s 204us/sample - loss: 0.5214 - acc: 0.85
Epoch 297/500
120/120 [=====] - 0s 232us/sample - loss: 0.5235 - acc: 0.82
Epoch 298/500
120/120 [=====] - 0s 315us/sample - loss: 0.5232 - acc: 0.87
Epoch 299/500
120/120 [=====] - 0s 230us/sample - loss: 0.5358 - acc: 0.81
Epoch 300/500
120/120 [=====] - 0s 248us/sample - loss: 0.5235 - acc: 0.84
Epoch 301/500
120/120 [=====] - 0s 217us/sample - loss: 0.5313 - acc: 0.82
Epoch 302/500
120/120 [=====] - 0s 223us/sample - loss: 0.5303 - acc: 0.85
Epoch 303/500
120/120 [=====] - 0s 247us/sample - loss: 0.5200 - acc: 0.83
Epoch 304/500
120/120 [=====] - 0s 212us/sample - loss: 0.5239 - acc: 0.86
Epoch 305/500
120/120 [=====] - 0s 227us/sample - loss: 0.5245 - acc: 0.88
Epoch 306/500
120/120 [=====] - 0s 243us/sample - loss: 0.5228 - acc: 0.85
Epoch 307/500
120/120 [=====] - 0s 228us/sample - loss: 0.5244 - acc: 0.83
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Epoch 308/500  
120/120 [=====] - 0s 232us/sample - loss: 0.5192 - acc: 0.84  
Epoch 309/500  
120/120 [=====] - 0s 238us/sample - loss: 0.5238 - acc: 0.82  
Epoch 310/500  
120/120 [=====] - 0s 331us/sample - loss: 0.5329 - acc: 0.80  
Epoch 311/500  
120/120 [=====] - 0s 203us/sample - loss: 0.5218 - acc: 0.83  
Epoch 312/500  
120/120 [=====] - 0s 262us/sample - loss: 0.5190 - acc: 0.85  
Epoch 313/500  
120/120 [=====] - 0s 229us/sample - loss: 0.5216 - acc: 0.85  
Epoch 314/500  
120/120 [=====] - 0s 209us/sample - loss: 0.5277 - acc: 0.80  
Epoch 315/500  
120/120 [=====] - 0s 201us/sample - loss: 0.5150 - acc: 0.86  
Epoch 316/500  
120/120 [=====] - 0s 204us/sample - loss: 0.5170 - acc: 0.84  
Epoch 317/500  
120/120 [=====] - 0s 218us/sample - loss: 0.5201 - acc: 0.84  
Epoch 318/500  
120/120 [=====] - 0s 207us/sample - loss: 0.5251 - acc: 0.80  
Epoch 319/500  
120/120 [=====] - 0s 211us/sample - loss: 0.5144 - acc: 0.89  
Epoch 320/500  
120/120 [=====] - 0s 215us/sample - loss: 0.5451 - acc: 0.76  
Epoch 321/500  
120/120 [=====] - 0s 225us/sample - loss: 0.5142 - acc: 0.85  
Epoch 322/500  
120/120 [=====] - 0s 284us/sample - loss: 0.5113 - acc: 0.87  
Epoch 323/500  
120/120 [=====] - 0s 234us/sample - loss: 0.5324 - acc: 0.85  
Epoch 324/500  
120/120 [=====] - 0s 275us/sample - loss: 0.5155 - acc: 0.84  
Epoch 325/500  
120/120 [=====] - 0s 225us/sample - loss: 0.5342 - acc: 0.81  
Epoch 326/500  
120/120 [=====] - 0s 210us/sample - loss: 0.5112 - acc: 0.85  
Epoch 327/500  
120/120 [=====] - 0s 215us/sample - loss: 0.5098 - acc: 0.86  
Epoch 328/500  
120/120 [=====] - 0s 200us/sample - loss: 0.5145 - acc: 0.86  
Epoch 329/500  
120/120 [=====] - 0s 234us/sample - loss: 0.5194 - acc: 0.86  
Epoch 330/500  
120/120 [=====] - 0s 229us/sample - loss: 0.5369 - acc: 0.75  
Epoch 331/500  
120/120 [=====] - 0s 217us/sample - loss: 0.5203 - acc: 0.82  
Epoch 332/500  
120/120 [=====] - 0s 212us/sample - loss: 0.5065 - acc: 0.84  
Epoch 333/500  
120/120 [=====] - 0s 213us/sample - loss: 0.5115 - acc: 0.85  
Epoch 334/500  
120/120 [=====] - 0s 212us/sample - loss: 0.5183 - acc: 0.82  
Epoch 335/500  
120/120 [=====] - 0s 241us/sample - loss: 0.5451 - acc: 0.75  
Epoch 336/500  
120/120 [=====] - 0s 212us/sample - loss: 0.5116 - acc: 0.85  
Epoch 337/500  
120/120 [=====] - 0s 217us/sample - loss: 0.5244 - acc: 0.81  
Epoch 338/500  
120/120 [=====] - 0s 215us/sample - loss: 0.5100 - acc: 0.82

120/120 [=====] - 0s 210us/sample - loss: 0.5101 - acc: 0.85  
Epoch 339/500  
120/120 [=====] - 0s 221us/sample - loss: 0.5135 - acc: 0.82  
Epoch 340/500  
120/120 [=====] - 0s 205us/sample - loss: 0.5083 - acc: 0.87  
Epoch 341/500  
120/120 [=====] - 0s 247us/sample - loss: 0.5114 - acc: 0.86  
Epoch 342/500  
120/120 [=====] - 0s 250us/sample - loss: 0.5037 - acc: 0.85  
Epoch 344/500  
120/120 [=====] - 0s 244us/sample - loss: 0.5109 - acc: 0.83  
Epoch 345/500  
120/120 [=====] - 0s 224us/sample - loss: 0.5387 - acc: 0.80  
Epoch 346/500  
120/120 [=====] - 0s 229us/sample - loss: 0.5143 - acc: 0.82  
Epoch 347/500  
120/120 [=====] - 0s 240us/sample - loss: 0.5044 - acc: 0.85  
Epoch 348/500  
120/120 [=====] - 0s 232us/sample - loss: 0.5035 - acc: 0.86  
Epoch 349/500  
120/120 [=====] - 0s 240us/sample - loss: 0.5114 - acc: 0.85  
Epoch 350/500  
120/120 [=====] - 0s 225us/sample - loss: 0.5073 - acc: 0.85  
Epoch 351/500  
120/120 [=====] - 0s 247us/sample - loss: 0.5000 - acc: 0.87  
Epoch 352/500  
120/120 [=====] - 0s 233us/sample - loss: 0.5072 - acc: 0.88  
Epoch 353/500  
120/120 [=====] - 0s 223us/sample - loss: 0.5182 - acc: 0.83  
Epoch 354/500  
120/120 [=====] - 0s 239us/sample - loss: 0.5076 - acc: 0.81  
Epoch 355/500  
120/120 [=====] - 0s 233us/sample - loss: 0.4990 - acc: 0.87  
Epoch 356/500  
120/120 [=====] - 0s 250us/sample - loss: 0.5172 - acc: 0.80  
Epoch 357/500  
120/120 [=====] - 0s 209us/sample - loss: 0.5090 - acc: 0.80  
Epoch 358/500  
120/120 [=====] - 0s 254us/sample - loss: 0.4987 - acc: 0.86  
Epoch 359/500  
120/120 [=====] - 0s 220us/sample - loss: 0.5068 - acc: 0.86  
Epoch 360/500  
120/120 [=====] - 0s 239us/sample - loss: 0.4976 - acc: 0.87  
Epoch 361/500  
120/120 [=====] - 0s 233us/sample - loss: 0.5106 - acc: 0.81  
Epoch 362/500  
120/120 [=====] - 0s 235us/sample - loss: 0.5053 - acc: 0.86  
Epoch 363/500  
120/120 [=====] - 0s 211us/sample - loss: 0.4990 - acc: 0.88  
Epoch 364/500  
120/120 [=====] - 0s 228us/sample - loss: 0.5011 - acc: 0.85  
Epoch 365/500  
120/120 [=====] - 0s 228us/sample - loss: 0.4937 - acc: 0.88  
Epoch 366/500  
120/120 [=====] - 0s 209us/sample - loss: 0.5087 - acc: 0.87  
Epoch 367/500  
120/120 [=====] - 0s 213us/sample - loss: 0.5230 - acc: 0.78  
Epoch 368/500  
120/120 [=====] - 0s 230us/sample - loss: 0.5417 - acc: 0.76  
Epoch 369/500

120/120 [=====] - 0s 208us/sample - loss: 0.4999 - acc: 0.85  
Epoch 370/500  
120/120 [=====] - 0s 217us/sample - loss: 0.5184 - acc: 0.80  
Epoch 371/500  
120/120 [=====] - 0s 212us/sample - loss: 0.4929 - acc: 0.88  
Epoch 372/500  
120/120 [=====] - 0s 258us/sample - loss: 0.4954 - acc: 0.86  
Epoch 373/500  
120/120 [=====] - 0s 248us/sample - loss: 0.4979 - acc: 0.85  
Epoch 374/500  
120/120 [=====] - 0s 295us/sample - loss: 0.5021 - acc: 0.82  
Epoch 375/500  
120/120 [=====] - 0s 220us/sample - loss: 0.5089 - acc: 0.85  
Epoch 376/500  
120/120 [=====] - 0s 226us/sample - loss: 0.4942 - acc: 0.86  
Epoch 377/500  
120/120 [=====] - 0s 238us/sample - loss: 0.5202 - acc: 0.78  
Epoch 378/500  
120/120 [=====] - 0s 223us/sample - loss: 0.5128 - acc: 0.81  
Epoch 379/500  
120/120 [=====] - 0s 217us/sample - loss: 0.4951 - acc: 0.85  
Epoch 380/500  
120/120 [=====] - 0s 230us/sample - loss: 0.5065 - acc: 0.85  
Epoch 381/500  
120/120 [=====] - 0s 219us/sample - loss: 0.5012 - acc: 0.85  
Epoch 382/500  
120/120 [=====] - 0s 225us/sample - loss: 0.4946 - acc: 0.86  
Epoch 383/500  
120/120 [=====] - 0s 214us/sample - loss: 0.4897 - acc: 0.88  
Epoch 384/500  
120/120 [=====] - 0s 217us/sample - loss: 0.4890 - acc: 0.88  
Epoch 385/500  
120/120 [=====] - 0s 222us/sample - loss: 0.4858 - acc: 0.88  
Epoch 386/500  
120/120 [=====] - 0s 234us/sample - loss: 0.4933 - acc: 0.85  
Epoch 387/500  
120/120 [=====] - 0s 234us/sample - loss: 0.4894 - acc: 0.89  
Epoch 388/500  
120/120 [=====] - 0s 226us/sample - loss: 0.5004 - acc: 0.85  
Epoch 389/500  
120/120 [=====] - 0s 225us/sample - loss: 0.4857 - acc: 0.86  
Epoch 390/500  
120/120 [=====] - 0s 212us/sample - loss: 0.4907 - acc: 0.89  
Epoch 391/500  
120/120 [=====] - 0s 207us/sample - loss: 0.4841 - acc: 0.88  
Epoch 392/500  
120/120 [=====] - 0s 218us/sample - loss: 0.4951 - acc: 0.85  
Epoch 393/500  
120/120 [=====] - 0s 223us/sample - loss: 0.4929 - acc: 0.85  
Epoch 394/500  
120/120 [=====] - 0s 213us/sample - loss: 0.4916 - acc: 0.88  
Epoch 395/500  
120/120 [=====] - 0s 233us/sample - loss: 0.4787 - acc: 0.90  
Epoch 396/500  
120/120 [=====] - 0s 209us/sample - loss: 0.4925 - acc: 0.87  
Epoch 397/500  
120/120 [=====] - 0s 213us/sample - loss: 0.4969 - acc: 0.85  
Epoch 398/500  
120/120 [=====] - 0s 218us/sample - loss: 0.4849 - acc: 0.86  
Epoch 399/500  
120/120 [=====] - 0s 204us/sample - loss: 0.5076 - acc: 0.80  
Epoch 400/500

Epoch 400/500  
120/120 [=====] - 0s 207us/sample - loss: 0.4902 - acc: 0.86  
Epoch 401/500  
120/120 [=====] - 0s 209us/sample - loss: 0.4840 - acc: 0.88  
Epoch 402/500  
120/120 [=====] - 0s 304us/sample - loss: 0.4840 - acc: 0.90  
Epoch 403/500  
120/120 [=====] - 0s 237us/sample - loss: 0.4795 - acc: 0.89  
Epoch 404/500  
120/120 [=====] - 0s 232us/sample - loss: 0.4885 - acc: 0.86  
Epoch 405/500  
120/120 [=====] - 0s 287us/sample - loss: 0.4764 - acc: 0.91  
Epoch 406/500  
120/120 [=====] - 0s 261us/sample - loss: 0.4754 - acc: 0.90  
Epoch 407/500  
120/120 [=====] - 0s 236us/sample - loss: 0.4777 - acc: 0.90  
Epoch 408/500  
120/120 [=====] - 0s 259us/sample - loss: 0.5071 - acc: 0.82  
Epoch 409/500  
120/120 [=====] - 0s 241us/sample - loss: 0.4946 - acc: 0.84  
Epoch 410/500  
120/120 [=====] - 0s 235us/sample - loss: 0.4738 - acc: 0.89  
Epoch 411/500  
120/120 [=====] - 0s 212us/sample - loss: 0.5039 - acc: 0.82  
Epoch 412/500  
120/120 [=====] - 0s 223us/sample - loss: 0.4780 - acc: 0.92  
Epoch 413/500  
120/120 [=====] - 0s 223us/sample - loss: 0.4813 - acc: 0.87  
Epoch 414/500  
120/120 [=====] - 0s 239us/sample - loss: 0.4947 - acc: 0.83  
Epoch 415/500  
120/120 [=====] - 0s 214us/sample - loss: 0.4717 - acc: 0.90  
Epoch 416/500  
120/120 [=====] - 0s 228us/sample - loss: 0.4712 - acc: 0.91  
Epoch 417/500  
120/120 [=====] - 0s 215us/sample - loss: 0.4780 - acc: 0.88  
Epoch 418/500  
120/120 [=====] - 0s 219us/sample - loss: 0.4838 - acc: 0.85  
Epoch 419/500  
120/120 [=====] - 0s 216us/sample - loss: 0.4735 - acc: 0.92  
Epoch 420/500  
120/120 [=====] - 0s 219us/sample - loss: 0.5135 - acc: 0.85  
Epoch 421/500  
120/120 [=====] - 0s 253us/sample - loss: 0.4791 - acc: 0.90  
Epoch 422/500  
120/120 [=====] - 0s 264us/sample - loss: 0.4812 - acc: 0.86  
Epoch 423/500  
120/120 [=====] - 0s 271us/sample - loss: 0.4898 - acc: 0.84  
Epoch 424/500  
120/120 [=====] - 0s 251us/sample - loss: 0.4845 - acc: 0.89  
Epoch 425/500  
120/120 [=====] - 0s 225us/sample - loss: 0.4662 - acc: 0.93  
Epoch 426/500  
120/120 [=====] - 0s 227us/sample - loss: 0.4841 - acc: 0.85  
Epoch 427/500  
120/120 [=====] - 0s 241us/sample - loss: 0.4708 - acc: 0.92  
Epoch 428/500  
120/120 [=====] - 0s 252us/sample - loss: 0.4674 - acc: 0.90  
Epoch 429/500  
120/120 [=====] - 0s 240us/sample - loss: 0.5024 - acc: 0.81  
Epoch 430/500  
120/120 [=====] - 0s 227us/sample - loss: 0.4643 - acc: 0.90

Epoch 431/500  
120/120 [=====] - 0s 251us/sample - loss: 0.4834 - acc: 0.85  
Epoch 432/500  
120/120 [=====] - 0s 249us/sample - loss: 0.4670 - acc: 0.88  
Epoch 433/500  
120/120 [=====] - 0s 244us/sample - loss: 0.4651 - acc: 0.91  
Epoch 434/500  
120/120 [=====] - 0s 223us/sample - loss: 0.4761 - acc: 0.90  
Epoch 435/500  
120/120 [=====] - 0s 220us/sample - loss: 0.4783 - acc: 0.86  
Epoch 436/500  
120/120 [=====] - 0s 307us/sample - loss: 0.4668 - acc: 0.88  
Epoch 437/500  
120/120 [=====] - 0s 217us/sample - loss: 0.4930 - acc: 0.80  
Epoch 438/500  
120/120 [=====] - 0s 231us/sample - loss: 0.4705 - acc: 0.90  
Epoch 439/500  
120/120 [=====] - 0s 224us/sample - loss: 0.4603 - acc: 0.92  
Epoch 440/500  
120/120 [=====] - 0s 211us/sample - loss: 0.4830 - acc: 0.84  
Epoch 441/500  
120/120 [=====] - 0s 222us/sample - loss: 0.4697 - acc: 0.87  
Epoch 442/500  
120/120 [=====] - 0s 224us/sample - loss: 0.4668 - acc: 0.90  
Epoch 443/500  
120/120 [=====] - 0s 228us/sample - loss: 0.4917 - acc: 0.81  
Epoch 444/500  
120/120 [=====] - 0s 235us/sample - loss: 0.4692 - acc: 0.86  
Epoch 445/500  
120/120 [=====] - 0s 242us/sample - loss: 0.4613 - acc: 0.90  
Epoch 446/500  
120/120 [=====] - 0s 250us/sample - loss: 0.4747 - acc: 0.90  
Epoch 447/500  
120/120 [=====] - 0s 238us/sample - loss: 0.4565 - acc: 0.93  
Epoch 448/500  
120/120 [=====] - 0s 240us/sample - loss: 0.4953 - acc: 0.79  
Epoch 449/500  
120/120 [=====] - 0s 217us/sample - loss: 0.4613 - acc: 0.90  
Epoch 450/500  
120/120 [=====] - 0s 277us/sample - loss: 0.4803 - acc: 0.84  
Epoch 451/500  
120/120 [=====] - 0s 227us/sample - loss: 0.4709 - acc: 0.89  
Epoch 452/500  
120/120 [=====] - 0s 213us/sample - loss: 0.4565 - acc: 0.90  
Epoch 453/500  
120/120 [=====] - 0s 247us/sample - loss: 0.4716 - acc: 0.89  
Epoch 454/500  
120/120 [=====] - 0s 219us/sample - loss: 0.4591 - acc: 0.90  
Epoch 455/500  
120/120 [=====] - 0s 211us/sample - loss: 0.4541 - acc: 0.90  
Epoch 456/500  
120/120 [=====] - 0s 230us/sample - loss: 0.4884 - acc: 0.85  
Epoch 457/500  
120/120 [=====] - 0s 238us/sample - loss: 0.4714 - acc: 0.86  
Epoch 458/500  
120/120 [=====] - 0s 234us/sample - loss: 0.4577 - acc: 0.90  
Epoch 459/500  
120/120 [=====] - 0s 236us/sample - loss: 0.4736 - acc: 0.88  
Epoch 460/500  
120/120 [=====] - 0s 217us/sample - loss: 0.4665 - acc: 0.86  
Epoch 461/500  
120/120 [=====] - 0s 216us/sample - loss: 0.4511 - acc: 0.91

120/120 [=====] - 0s 240us/sample - loss: 0.4511 - acc: 0.91  
Epoch 462/500  
120/120 [=====] - 0s 230us/sample - loss: 0.4569 - acc: 0.91  
Epoch 463/500  
120/120 [=====] - 0s 267us/sample - loss: 0.4597 - acc: 0.88  
Epoch 464/500  
120/120 [=====] - 0s 233us/sample - loss: 0.4662 - acc: 0.89  
Epoch 465/500  
120/120 [=====] - 0s 223us/sample - loss: 0.4672 - acc: 0.85  
Epoch 466/500  
120/120 [=====] - 0s 228us/sample - loss: 0.4526 - acc: 0.90  
Epoch 467/500  
120/120 [=====] - 0s 318us/sample - loss: 0.4464 - acc: 0.92  
Epoch 468/500  
120/120 [=====] - 0s 204us/sample - loss: 0.4534 - acc: 0.90  
Epoch 469/500  
120/120 [=====] - 0s 210us/sample - loss: 0.4515 - acc: 0.92  
Epoch 470/500  
120/120 [=====] - 0s 214us/sample - loss: 0.4565 - acc: 0.87  
Epoch 471/500  
120/120 [=====] - 0s 204us/sample - loss: 0.4615 - acc: 0.86  
Epoch 472/500  
120/120 [=====] - 0s 230us/sample - loss: 0.4632 - acc: 0.88  
Epoch 473/500  
120/120 [=====] - 0s 240us/sample - loss: 0.4543 - acc: 0.90  
Epoch 474/500  
120/120 [=====] - 0s 220us/sample - loss: 0.4448 - acc: 0.92  
Epoch 475/500  
120/120 [=====] - 0s 264us/sample - loss: 0.4552 - acc: 0.87  
Epoch 476/500  
120/120 [=====] - 0s 219us/sample - loss: 0.4739 - acc: 0.84  
Epoch 477/500  
120/120 [=====] - 0s 246us/sample - loss: 0.4513 - acc: 0.91  
Epoch 478/500  
120/120 [=====] - 0s 247us/sample - loss: 0.4416 - acc: 0.88  
Epoch 479/500  
120/120 [=====] - 0s 237us/sample - loss: 0.4627 - acc: 0.86  
Epoch 480/500  
120/120 [=====] - 0s 242us/sample - loss: 0.4474 - acc: 0.90  
Epoch 481/500  
120/120 [=====] - 0s 213us/sample - loss: 0.4385 - acc: 0.93  
Epoch 482/500  
120/120 [=====] - 0s 237us/sample - loss: 0.4434 - acc: 0.89  
Epoch 483/500  
120/120 [=====] - 0s 239us/sample - loss: 0.4406 - acc: 0.92  
Epoch 484/500  
120/120 [=====] - 0s 235us/sample - loss: 0.4471 - acc: 0.88  
Epoch 485/500  
120/120 [=====] - 0s 241us/sample - loss: 0.4532 - acc: 0.87  
Epoch 486/500  
120/120 [=====] - 0s 232us/sample - loss: 0.4559 - acc: 0.84  
Epoch 487/500  
120/120 [=====] - 0s 238us/sample - loss: 0.4588 - acc: 0.85  
Epoch 488/500  
120/120 [=====] - 0s 272us/sample - loss: 0.4485 - acc: 0.87  
Epoch 489/500  
120/120 [=====] - 0s 250us/sample - loss: 0.4406 - acc: 0.89  
Epoch 490/500  
120/120 [=====] - 0s 203us/sample - loss: 0.4526 - acc: 0.88  
Epoch 491/500  
120/120 [=====] - 0s 239us/sample - loss: 0.4667 - acc: 0.88  
Epoch 492/500

```
120/120 [=====] - 0s 214us/sample - loss: 0.4342 - acc: 0.92
Epoch 493/500
120/120 [=====] - 0s 221us/sample - loss: 0.4318 - acc: 0.93
Epoch 494/500
120/120 [=====] - 0s 279us/sample - loss: 0.4594 - acc: 0.85
Epoch 495/500
120/120 [=====] - 0s 238us/sample - loss: 0.4372 - acc: 0.91
Epoch 496/500
120/120 [=====] - 0s 296us/sample - loss: 0.4531 - acc: 0.86
Epoch 497/500
120/120 [=====] - 0s 342us/sample - loss: 0.4285 - acc: 0.92
Epoch 498/500
120/120 [=====] - 0s 227us/sample - loss: 0.4311 - acc: 0.94
Epoch 499/500
120/120 [=====] - 0s 209us/sample - loss: 0.4433 - acc: 0.90
Epoch 500/500
120/120 [=====] - 0s 209us/sample - loss: 0.4293 - acc: 0.90
<tensorflow.python.keras.callbacks.History at 0x7fc38b860e10>
```

## ▼ Model Prediction

```
model.summary()
```



Model: "sequential\_1"

Layer (type)	Output Shape	Param #
<hr/>		
batch_normalization (BatchNo multiple)		16
dense (Dense)	multiple	15
dense_1 (Dense)	multiple	12
<hr/>		
Total params: 43		
Trainable params: 35		
Non-trainable params: 8		

---

## ▼ Save the Model

```
model.save('test.h5')
```

## ▼ Build and Train a Deep Neural network with 2 hidden layer - Optional - For Practice

Does it perform better than Linear Classifier? What could be the reason for difference in performance?

