Self_Driving_Car

March 2, 2019

```python
In [23]: import os
         import numpy as np
         import random
         from scipy import pi
         from itertools import islice
         import cv2
         import tensorflow as tf
         import scipy.misc
```

```python
In [24]: DATA_FOLDER = 'G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/
         TRAIN_FILE = os.path.join(DATA_FOLDER, 'data.txt')


         split =0.7
         X = []
         y = []
         with open(TRAIN_FILE) as fp:
             for line in fp:
                 path, angle = line.strip().split()
                 full_path = os.path.join(DATA_FOLDER, path)
                 X.append(full_path)

                 # converting angle from degrees to radians
                 y.append(float(angle) * pi / 180 )


         y = np.array(y)
         print("Completed processing data.txt")

         split_ratio = int(len(X) * 0.7)

         train_x = X[:split_ratio]
         train_y = y[:split_ratio]

         test_x = X[split_ratio:]
         test_y = y[split_ratio:]

         print(len(train_x), len(train_y), len(test_x), len(test_y))
```
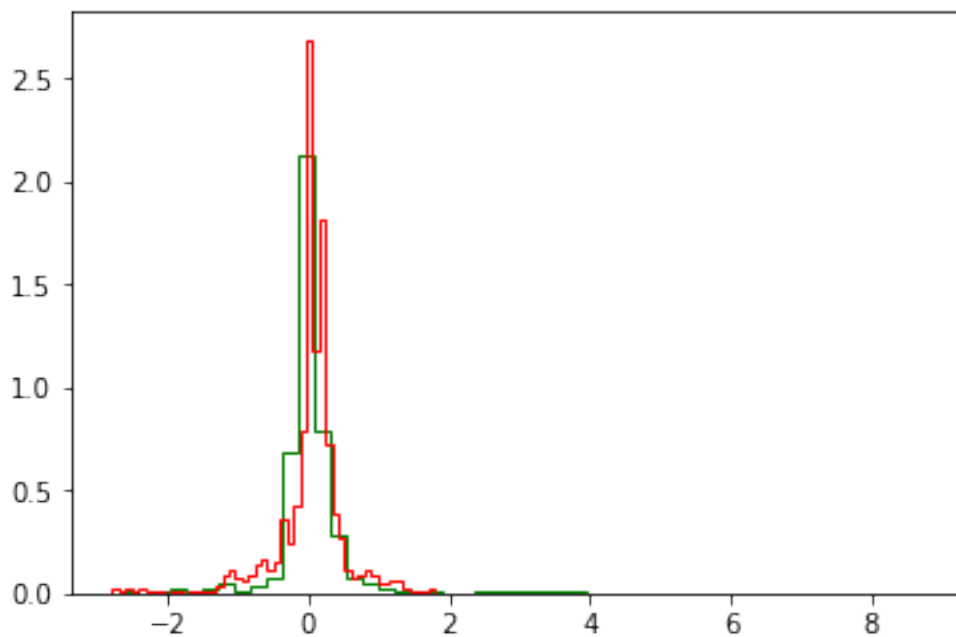
```
Completed processing data.txt
31784 31784 13622 13622
```

In [25]: # PDF of train and test 'y' values.
         import matplotlib.pyplot as plt
         plt.hist(train_y, bins=50, normed=1, color='green', histtype ='step');
         plt.hist(test_y, bins=50, normed=1, color='red', histtype ='step');
         plt.show()

```
C:\Users\abc\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning: The 'norme
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
```

In [26]: #Model 0: Base line Model: y_test_pred = mean(y_train_i)
         train_mean_y = np.mean(train_y)

         print('Test_MSE(MEAN):%f' % np.mean(np.square(test_y-train_mean_y)))

         print('Test_MSE(ZERO):%f' % np.mean(np.square(test_y-0.0)))

```
Test_MSE(MEAN):0.241561
Test_MSE(ZERO):0.241107
```

In [27]: train_batch_pointer = 0
         test_batch_pointer = 0

```python
In [28]: def loadTrainBatch(batch_size):
             global train_batch_pointer
             x_result = []
             y_result = []
             for i in range(batch_size):
                 read_image = cv2.imread(train_x[(train_batch_pointer + i) % len(train_x)])
                 read_image_road = read_image[-150:]
                 read_image_resize = cv2.resize(read_image_road, (200, 66))
                 read_image_final = read_image_resize/255.0
                 x_result.append(read_image_final) #finally appending the image pixel matrix

                 y_result.append(train_y[(train_batch_pointer + i) % len(train_y)]) #appending

             train_batch_pointer += batch_size

             return x_result, y_result

In [29]: def loadTestBatch(batch_size):
             global test_batch_pointer
             x_result = []
             y_result = []
             for i in range(batch_size):
                 read_image = cv2.imread(test_x[(test_batch_pointer + i) % len(test_x)])
                 read_image_road = read_image[-150:]
                 read_image_resize = cv2.resize(read_image_road, (200, 66))
                 read_image_final = read_image_resize/255.0  #here, we are normalizing the ima

                 x_result.append(read_image_final) #finally appending the image pixel matrix

                 y_result.append(test_y[(test_batch_pointer + i) % len(test_y)]) #appending co

             test_batch_pointer += batch_size

             return x_result, y_result

In [30]: def weightVariable(shape):
             initial = tf.truncated_normal(shape = shape, stddev = 0.1)
             return tf.Variable(initial)

         def bias_variable(shape):
             initial = tf.constant(0.1, shape=shape)
             return tf.Variable(initial)

         def conv2D(previous_input, filter_input, strides):
             return tf.nn.conv2d(previous_input, filter_input, strides = [1, strides, strides,

In [31]: x_input = tf.placeholder(tf.float32, shape = [None, 66, 200, 3])
         y_true = tf.placeholder(tf.float32)
```

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```
        input_image = x_input

In [32]: #First convolution layer
        W_Conv1 = weightVariable([5,5,3,24])
        B_Conv1 = bias_variable([24])
        Conv1 = tf.nn.relu(conv2D(input_image, W_Conv1, 2) + B_Conv1)

        #Second convolution layer
        W_Conv2 = weightVariable([5,5,24,36])
        B_Conv2 = bias_variable([36])
        Conv2 = tf.nn.relu(conv2D(Conv1, W_Conv2, 2) + B_Conv2)


        #Third convolution layer
        W_Conv3 = weightVariable([5,5,36,48])
        B_Conv3 = bias_variable([48])
        Conv3 = tf.nn.relu(conv2D(Conv2, W_Conv3, 2) + B_Conv3)

        #Fourth convolution layer
        W_Conv4 = weightVariable([3,3,48,64])
        B_Conv4 = bias_variable([64])
        Conv4 = tf.nn.relu(conv2D(Conv3, W_Conv4, 1) + B_Conv4)

        #Fifth convolution layer
        W_Conv5 = weightVariable([3,3,64,64])
        B_Conv5 = bias_variable([64])
        Conv5 = tf.nn.relu(conv2D(Conv4, W_Conv5, 1) + B_Conv5)

In [33]: keep_prob = tf.placeholder(tf.float32)

        W_FC1 = weightVariable([1152, 1164])
        B_FC1 = bias_variable([1164])
        FC1_Flatten = tf.reshape(Conv5, [-1, 1152])
        Output_FC1 = tf.nn.relu(tf.matmul(FC1_Flatten, W_FC1) + B_FC1)
        Output_FC1_drop = tf.nn.dropout(Output_FC1, keep_prob)


        W_FC2 = weightVariable([1164, 100])
        B_FC2 = bias_variable([100])
        Output_FC2 = tf.nn.relu(tf.matmul(Output_FC1_drop, W_FC2) + B_FC2)
        Output_FC2_drop = tf.nn.dropout(Output_FC2, keep_prob)



        W_FC3 = weightVariable([100, 50])
        B_FC3 = bias_variable([50])
        Output_FC3 = tf.nn.relu(tf.matmul(Output_FC2_drop, W_FC3) + B_FC3)
```

```
         Output_FC3_drop = tf.nn.dropout(Output_FC3, keep_prob)



         W_FC4 = weightVariable([50, 10])

         B_FC4 = bias_variable([10])
         Output_FC4 = tf.nn.relu(tf.matmul(Output_FC3_drop, W_FC4) + B_FC4)
         Output_FC4_drop = tf.nn.dropout(Output_FC4, keep_prob)



         W_FC5 = weightVariable([10, 1])
         B_FC5 = bias_variable([1])

         y_predicted = tf.multiply(tf.atan(tf.matmul(Output_FC4_drop, W_FC5) + B_FC5),2)
```

In [34]:
```
SAVEDIR = "G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/Saver
sess = tf.InteractiveSession()

L2NormConst = 0.001
train_vars = tf.trainable_variables()

loss = tf.reduce_mean(tf.square(tf.subtract(y_true, y_predicted))) + tf.add_n([tf.nn.l

train_step = tf.train.AdamOptimizer(learning_rate = 10**-4).minimize(loss)
sess.run(tf.global_variables_initializer())

saver = tf.train.Saver()

epochs = 10
batch_size = 200
epoch_number, train_loss, test_loss,  = [], [], []

for epoch in range(epochs):
    train_avg_loss = 0
    test_avg_loss = 0
    te_loss_old = 10000

    for i in range(int(len(X)/batch_size)):
        train_batch_x, train_batch_y = loadTrainBatch(batch_size)
        train_step.run(feed_dict = {x_input: train_batch_x, y_true: train_batch_y, kee
        tr_loss = loss.eval(feed_dict = {x_input: train_batch_x, y_true: train_batch_y
        train_avg_loss += tr_loss / batch_size

        test_batch_x, test_batch_y = loadTestBatch(batch_size)
        te_loss_new = loss.eval(feed_dict = {x_input: test_batch_x, y_true: test_batch
        test_avg_loss += te_loss_new / batch_size
```

```python
            if te_loss_new < te_loss_old:
                print("Epoch: {}, Train_Loss: {}, Test_Loss: {} *".format(epoch+1, tr_loss
            else:
                print("Epoch: {}, Train_Loss: {}, Test_Loss: {}".format(epoch+1, tr_loss,
            te_loss_old = te_loss_new

            if (i+1) % batch_size == 0:
                if not os.path.exists(SAVEDIR):
                    os.makedirs(SAVEDIR)
                save_path = os.path.join(SAVEDIR, "model.ckpt")
                saver.save(sess = sess, save_path = save_path)
                print("Model saved at location {} at epoch {}".format(save_path, epoch +

        epoch_number.append(epoch)
        train_loss.append(train_avg_loss)
        test_loss.append(test_avg_loss)
```

C:\Users\abc\Anaconda3\lib\site-packages\tensorflow\python\client\session.py:1702: UserWarning
  warnings.warn('An interactive session is already active. This can '


```
Epoch: 1, Train_Loss: 19.420602798461914, Test_Loss: 19.830364227294922 *
Epoch: 1, Train_Loss: 27.89381980895996, Test_Loss: 19.873416900634766
Epoch: 1, Train_Loss: 22.030961990356445, Test_Loss: 19.785560607910156 *
Epoch: 1, Train_Loss: 19.37044334411621, Test_Loss: 19.628219604492188 *
Epoch: 1, Train_Loss: 25.271411895751953, Test_Loss: 19.401042938232422 *
Epoch: 1, Train_Loss: 19.471393585205078, Test_Loss: 18.92800521850586 *
Epoch: 1, Train_Loss: 21.915739059448242, Test_Loss: 19.299386978149414
Epoch: 1, Train_Loss: 18.860393524169922, Test_Loss: 19.60858917236328
Epoch: 1, Train_Loss: 18.838003158569336, Test_Loss: 19.16059112548828 *
Epoch: 1, Train_Loss: 18.832393646240234, Test_Loss: 19.57221031188965
Epoch: 1, Train_Loss: 18.70285987854004, Test_Loss: 18.71562385559082 *
Epoch: 1, Train_Loss: 18.646743774414062, Test_Loss: 18.565217971801758 *
Epoch: 1, Train_Loss: 18.61345863342285, Test_Loss: 19.325063705444336
Epoch: 1, Train_Loss: 18.610361099243164, Test_Loss: 19.70792007446289
Epoch: 1, Train_Loss: 18.435014724731445, Test_Loss: 19.08921241760254 *
Epoch: 1, Train_Loss: 18.363229751586914, Test_Loss: 18.39752197265625 *
Epoch: 1, Train_Loss: 18.287731170654297, Test_Loss: 19.076282501220703
Epoch: 1, Train_Loss: 18.24899673461914, Test_Loss: 18.37957000732422 *
Epoch: 1, Train_Loss: 18.13007354736328, Test_Loss: 18.414688110351562
Epoch: 1, Train_Loss: 18.086069107055664, Test_Loss: 19.02676010131836
Epoch: 1, Train_Loss: 18.092222213745117, Test_Loss: 18.446372985839844 *
Epoch: 1, Train_Loss: 18.045249938964844, Test_Loss: 18.094234466552734 *
Epoch: 1, Train_Loss: 22.619016647338867, Test_Loss: 18.010560989379883 *
Epoch: 1, Train_Loss: 17.931947708129883, Test_Loss: 18.328269958496094
Epoch: 1, Train_Loss: 17.92731285095215, Test_Loss: 17.9345645904541 *
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Epoch: 1, Train_Loss: 17.88017463684082, Test_Loss: 17.936397552490234
Epoch: 1, Train_Loss: 18.020341873168945, Test_Loss: 19.025970458984375
Epoch: 1, Train_Loss: 17.903114318847656, Test_Loss: 18.258588790893555 *
Epoch: 1, Train_Loss: 17.926668167114258, Test_Loss: 17.831571578979492 *
Epoch: 1, Train_Loss: 17.960668563842773, Test_Loss: 17.780838012695312 *
Epoch: 1, Train_Loss: 17.777820587158203, Test_Loss: 17.79485511779785
Epoch: 1, Train_Loss: 17.737491607666016, Test_Loss: 17.717844009399414 *
Epoch: 1, Train_Loss: 17.692468643188477, Test_Loss: 17.897151947021484
Epoch: 1, Train_Loss: 17.61901092529297, Test_Loss: 17.743928909301758 *
Epoch: 1, Train_Loss: 20.512027740478516, Test_Loss: 17.620389938354492 *
Epoch: 1, Train_Loss: 17.571475982666016, Test_Loss: 17.589473724365234 *
Epoch: 1, Train_Loss: 17.55953598022461, Test_Loss: 20.502037048339844
Epoch: 1, Train_Loss: 17.51742172241211, Test_Loss: 17.50925064086914 *
Epoch: 1, Train_Loss: 17.50290298461914, Test_Loss: 17.482837677001953 *
Epoch: 1, Train_Loss: 17.46778678894043, Test_Loss: 17.441370010375977 *
Epoch: 1, Train_Loss: 17.43007469177246, Test_Loss: 17.430089950561523 *
Epoch: 1, Train_Loss: 17.39609718322754, Test_Loss: 17.409589767456055 *
Epoch: 1, Train_Loss: 17.40639305114746, Test_Loss: 17.383169174194336 *
Epoch: 1, Train_Loss: 17.3836727142334, Test_Loss: 17.35584259033203 *
Epoch: 1, Train_Loss: 17.29904556274414, Test_Loss: 17.327045440673828 *
Epoch: 1, Train_Loss: 17.33378028869629, Test_Loss: 17.28707504272461 *
Epoch: 1, Train_Loss: 17.28871726989746, Test_Loss: 17.275026321411133 *
Epoch: 1, Train_Loss: 17.2994327545166, Test_Loss: 17.229576110839844 *
Epoch: 1, Train_Loss: 17.258602142333984, Test_Loss: 17.212194442749023 *
Epoch: 1, Train_Loss: 17.24372673034668, Test_Loss: 17.180091857910156 *
Epoch: 1, Train_Loss: 17.149145126342773, Test_Loss: 17.157522201538086 *
Epoch: 1, Train_Loss: 17.136362075805664, Test_Loss: 17.17836570739746
Epoch: 1, Train_Loss: 17.182817459106445, Test_Loss: 19.98103141784668
Epoch: 1, Train_Loss: 19.53806495666504, Test_Loss: 17.07717514038086 *
Epoch: 1, Train_Loss: 17.06702423095703, Test_Loss: 17.07261848449707 *
Epoch: 1, Train_Loss: 17.007381439208984, Test_Loss: 17.06983757019043 *
Epoch: 1, Train_Loss: 16.982004165649414, Test_Loss: 17.048370361328125 *
Epoch: 1, Train_Loss: 16.952173233032227, Test_Loss: 16.986631393432617 *
Epoch: 1, Train_Loss: 17.048954010009766, Test_Loss: 16.93899154663086 *
Epoch: 1, Train_Loss: 17.022075653076172, Test_Loss: 16.96556282043457
Epoch: 1, Train_Loss: 16.92729949951172, Test_Loss: 17.003461837768555
Epoch: 1, Train_Loss: 17.041648864746094, Test_Loss: 16.885334014892578 *
Epoch: 1, Train_Loss: 16.894254684448242, Test_Loss: 16.858963012695312 *
Epoch: 1, Train_Loss: 16.79082679748535, Test_Loss: 16.819129943847656 *
Epoch: 1, Train_Loss: 16.76641845703125, Test_Loss: 16.794706344604492 *
Epoch: 1, Train_Loss: 16.748233795166016, Test_Loss: 16.76532745361328 *
Epoch: 1, Train_Loss: 16.719804763793945, Test_Loss: 16.71714210510254 *
Epoch: 1, Train_Loss: 16.75227165222168, Test_Loss: 16.717239379882812
Epoch: 1, Train_Loss: 16.801862716674805, Test_Loss: 16.861581802368164
Epoch: 1, Train_Loss: 16.747112274169922, Test_Loss: 16.69133758544922 *
Epoch: 1, Train_Loss: 16.724828720092773, Test_Loss: 16.82612419128418
Epoch: 1, Train_Loss: 16.83371925354004, Test_Loss: 16.778783798217773 *
Epoch: 1, Train_Loss: 16.589696884155273, Test_Loss: 16.72907257080078 *
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Epoch: 1, Train_Loss: 18.273902893066406, Test_Loss: 16.57227325439453 *
Epoch: 1, Train_Loss: 16.538799285888672, Test_Loss: 16.568099975585938 *
Epoch: 1, Train_Loss: 16.5189266204834, Test_Loss: 17.04533576965332
Epoch: 1, Train_Loss: 16.48398208618164, Test_Loss: 17.138870239257812
Epoch: 1, Train_Loss: 16.589035034179688, Test_Loss: 16.903289794921875 *
Epoch: 1, Train_Loss: 16.52687644958496, Test_Loss: 16.42686653137207 *
Epoch: 1, Train_Loss: 16.43589973449707, Test_Loss: 16.488540649414062
Epoch: 1, Train_Loss: 16.37740135192871, Test_Loss: 16.949146270751953
Epoch: 1, Train_Loss: 16.344154357910156, Test_Loss: 17.601802825927734
Epoch: 1, Train_Loss: 16.35163116455078, Test_Loss: 17.019338607788086 *
Epoch: 1, Train_Loss: 16.330001831054688, Test_Loss: 16.337793350219727 *
Epoch: 1, Train_Loss: 16.26517677307129, Test_Loss: 17.319721221923828
Epoch: 1, Train_Loss: 16.233182907104492, Test_Loss: 16.30231475830078 *
Epoch: 1, Train_Loss: 16.2093505859375, Test_Loss: 16.46358299255371
Epoch: 1, Train_Loss: 16.19192886352539, Test_Loss: 16.755491256713867
Epoch: 1, Train_Loss: 16.164077758789062, Test_Loss: 16.685224533081055 *
Epoch: 1, Train_Loss: 16.1356258392334, Test_Loss: 16.153827667236328 *
Epoch: 1, Train_Loss: 16.113676071166992, Test_Loss: 16.145671844482422 *
Epoch: 1, Train_Loss: 16.086997985839844, Test_Loss: 16.64405059814453
Epoch: 1, Train_Loss: 16.0687313079834, Test_Loss: 16.154178619384766 *
Epoch: 1, Train_Loss: 16.04193687438965, Test_Loss: 16.062868118286133 *
Epoch: 1, Train_Loss: 16.013891220092773, Test_Loss: 16.819116592407227
Epoch: 1, Train_Loss: 16.047693252563477, Test_Loss: 16.589506149291992 *
Epoch: 1, Train_Loss: 15.989753723144531, Test_Loss: 16.005569458007812 *
Epoch: 1, Train_Loss: 15.95724105834961, Test_Loss: 15.944746971130371 *
Epoch: 1, Train_Loss: 15.929946899414062, Test_Loss: 15.966784477233887
Epoch: 1, Train_Loss: 15.915369033813477, Test_Loss: 15.901910781860352 *
Epoch: 1, Train_Loss: 16.006481170654297, Test_Loss: 16.11851692199707
Epoch: 1, Train_Loss: 15.883719444274902, Test_Loss: 15.95173454284668 *
Epoch: 1, Train_Loss: 15.84075927734375, Test_Loss: 15.824163436889648 *
Epoch: 1, Train_Loss: 15.793965339660645, Test_Loss: 15.808595657348633 *
Epoch: 1, Train_Loss: 15.780895233154297, Test_Loss: 18.598363876342773
Epoch: 1, Train_Loss: 15.794682502746582, Test_Loss: 15.771214485168457 *
Epoch: 1, Train_Loss: 15.772692680358887, Test_Loss: 15.719042778015137 *
Epoch: 1, Train_Loss: 15.762308120727539, Test_Loss: 15.694682121276855 *
Epoch: 1, Train_Loss: 15.772735595703125, Test_Loss: 15.674128532409668 *
Epoch: 1, Train_Loss: 15.660333633422852, Test_Loss: 15.649164199829102 *
Epoch: 1, Train_Loss: 15.624672889709473, Test_Loss: 15.629722595214844 *
Epoch: 1, Train_Loss: 15.616621971130371, Test_Loss: 15.611886024475098 *
Epoch: 1, Train_Loss: 15.605215072631836, Test_Loss: 15.577878952026367 *
Epoch: 1, Train_Loss: 15.593194007873535, Test_Loss: 15.552091598510742 *
Epoch: 1, Train_Loss: 15.537323951721191, Test_Loss: 15.527772903442383 *
Epoch: 1, Train_Loss: 15.510581970214844, Test_Loss: 15.50261402130127 *
Epoch: 1, Train_Loss: 15.488000869750977, Test_Loss: 15.481365203857422 *
Epoch: 1, Train_Loss: 15.508981704711914, Test_Loss: 15.463021278381348 *
Epoch: 1, Train_Loss: 15.500788688659668, Test_Loss: 15.435944557189941 *
Epoch: 1, Train_Loss: 15.413887977600098, Test_Loss: 15.450529098510742
Epoch: 1, Train_Loss: 15.401970863342285, Test_Loss: 18.19193458557129
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Epoch: 1, Train_Loss: 15.373991966247559, Test_Loss: 15.364572525024414 *
Epoch: 1, Train_Loss: 17.984312057495117, Test_Loss: 15.364299774169922 *
Epoch: 1, Train_Loss: 15.418365478515625, Test_Loss: 15.361225128173828 *
Epoch: 1, Train_Loss: 15.412849426269531, Test_Loss: 15.3639554977417
Epoch: 1, Train_Loss: 15.311050415039062, Test_Loss: 15.298650741577148 *
Epoch: 1, Train_Loss: 15.290034294128418, Test_Loss: 15.253080368041992 *
Epoch: 1, Train_Loss: 15.244149208068848, Test_Loss: 15.288630485534668
Epoch: 1, Train_Loss: 16.22797393798828, Test_Loss: 15.339764595031738
Epoch: 1, Train_Loss: 15.842823028564453, Test_Loss: 15.19202709197998 *
Epoch: 1, Train_Loss: 16.385961532592773, Test_Loss: 15.16649341583252 *
Epoch: 1, Train_Loss: 15.625798225402832, Test_Loss: 15.146469116210938 *
Epoch: 1, Train_Loss: 15.589073181152344, Test_Loss: 15.114509582519531 *
Epoch: 1, Train_Loss: 16.382925033569336, Test_Loss: 15.101216316223145 *
Epoch: 1, Train_Loss: 15.085576057434082, Test_Loss: 15.061087608337402 *
Epoch: 1, Train_Loss: 15.399415016174316, Test_Loss: 15.082058906555176
Epoch: 1, Train_Loss: 15.03942584991455, Test_Loss: 15.193181037902832
Epoch: 1, Train_Loss: 15.11637020111084, Test_Loss: 15.068500518798828 *
Epoch: 1, Train_Loss: 15.242928504943848, Test_Loss: 15.218046188354492
Epoch: 1, Train_Loss: 15.0551118850708, Test_Loss: 15.093406677246094 *
Epoch: 1, Train_Loss: 15.229904174804688, Test_Loss: 15.099610328674316
Epoch: 1, Train_Loss: 15.214910507202148, Test_Loss: 14.929935455322266 *
Epoch: 1, Train_Loss: 14.997705459594727, Test_Loss: 14.909943580627441 *
Epoch: 1, Train_Loss: 14.906182289123535, Test_Loss: 15.392723083496094
Epoch: 1, Train_Loss: 14.831436157226562, Test_Loss: 15.631429672241211
Epoch: 1, Train_Loss: 14.810041427612305, Test_Loss: 15.227581024169922 *
Epoch: 1, Train_Loss: 14.85889720916748, Test_Loss: 14.829428672790527 *
Epoch: 1, Train_Loss: 14.873616218566895, Test_Loss: 14.847249984741211
Epoch: 1, Train_Loss: 15.046661376953125, Test_Loss: 15.298104286193848
Epoch: 1, Train_Loss: 14.785943984985352, Test_Loss: 15.952414512634277
Epoch: 1, Train_Loss: 15.185075759887695, Test_Loss: 15.439441680908203 *
Epoch: 1, Train_Loss: 14.685406684875488, Test_Loss: 14.693887710571289 *
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/
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Epoch: 3, Train_Loss: 7.127880096435547, Test_Loss: 7.135000228881836 *
Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/S
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/S
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/S
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/S
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Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/S
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Epoch: 10, Train_Loss: 1.7653203010559082, Test_Loss: 1.5456976890563965 *
Epoch: 10, Train_Loss: 1.5854276418685913, Test_Loss: 1.5574076175689697
Epoch: 10, Train_Loss: 1.548959493637085, Test_Loss: 2.0010111331939697
Epoch: 10, Train_Loss: 10.37198257446289, Test_Loss: 1.7549071311950684 *
Epoch: 10, Train_Loss: 3.553250551223755, Test_Loss: 1.5694594383239746 *
Epoch: 10, Train_Loss: 1.5702474117279053, Test_Loss: 1.9244797229766846
Epoch: 10, Train_Loss: 7.525750637054443, Test_Loss: 2.2963550090789795
Epoch: 10, Train_Loss: 1.706836462020874, Test_Loss: 1.597103476524353 *
Epoch: 10, Train_Loss: 4.722131729125977, Test_Loss: 1.5371707677841187 *
Epoch: 10, Train_Loss: 1.5411616563796997, Test_Loss: 1.5606235265731812
Epoch: 10, Train_Loss: 1.5295541286468506, Test_Loss: 1.5537304878234863 *
Epoch: 10, Train_Loss: 1.5252221822738647, Test_Loss: 1.7582790851593018
Epoch: 10, Train_Loss: 1.523697853088379, Test_Loss: 1.631728172302246 *
Epoch: 10, Train_Loss: 1.5310497283935547, Test_Loss: 1.520877480506897 *
Epoch: 10, Train_Loss: 1.5410971641540527, Test_Loss: 1.5194153785705566 *
Epoch: 10, Train_Loss: 1.5706017017364502, Test_Loss: 3.9409987926483154
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Epoch: 10, Train_Loss: 1.5243935585021973, Test_Loss: 2.000837802886963 *
Epoch: 10, Train_Loss: 1.5179462432861328, Test_Loss: 1.5182859897613525 *
Epoch: 10, Train_Loss: 1.5168125629425049, Test_Loss: 1.5182217359542847 *
Epoch: 10, Train_Loss: 1.518842101097107, Test_Loss: 1.5290858745574951
Epoch: 10, Train_Loss: 1.51394784450531, Test_Loss: 1.5323960781097412
Epoch: 10, Train_Loss: 1.5165886878967285, Test_Loss: 1.5261878967285156 *
Epoch: 10, Train_Loss: 1.5283788442611694, Test_Loss: 1.5210394859313965 *
Epoch: 10, Train_Loss: 1.5422228574752808, Test_Loss: 1.5204765796661377 *
Epoch: 10, Train_Loss: 6.064241886138916, Test_Loss: 1.5192230939865112 *
Epoch: 10, Train_Loss: 1.5167758464813232, Test_Loss: 1.5232934951782227
Epoch: 10, Train_Loss: 1.528152585029602, Test_Loss: 1.5195505619049072 *
Epoch: 10, Train_Loss: 1.5246976613998413, Test_Loss: 1.5213302373886108
Epoch: 10, Train_Loss: 1.7005279064178467, Test_Loss: 1.518246054649353 *
Epoch: 10, Train_Loss: 1.5860059261322021, Test_Loss: 1.516664981842041 *
Epoch: 10, Train_Loss: 1.6226569414138794, Test_Loss: 1.5506623983383179
Epoch: 10, Train_Loss: 1.6513885259628296, Test_Loss: 4.45428466796875
Epoch: 10, Train_Loss: 1.5739271640777588, Test_Loss: 1.5148221254348755 *
Epoch: 10, Train_Loss: 1.5418293476104736, Test_Loss: 1.530594825744629
Epoch: 10, Train_Loss: 1.5140527486801147, Test_Loss: 1.5191413164138794 *
Epoch: 10, Train_Loss: 1.505011796951294, Test_Loss: 1.6032705307006836
Epoch: 10, Train_Loss: 4.2981343269348145, Test_Loss: 1.52300226688385 *
Epoch: 10, Train_Loss: 1.5202559232711792, Test_Loss: 1.5083630084991455 *
Epoch: 10, Train_Loss: 1.5198183059692383, Test_Loss: 1.557769775390625
Epoch: 10, Train_Loss: 1.5023539066314697, Test_Loss: 1.6041288375854492
Epoch: 10, Train_Loss: 1.5108224153518677, Test_Loss: 1.531807541847229 *
Epoch: 10, Train_Loss: 1.505569577217102, Test_Loss: 1.4940367937088013 *
Epoch: 10, Train_Loss: 1.4973540306091309, Test_Loss: 1.4963881969451904
Epoch: 10, Train_Loss: 1.502079963684082, Test_Loss: 1.4964853525161743
Epoch: 10, Train_Loss: 1.5088205337524414, Test_Loss: 1.4959322214126587 *
Epoch: 10, Train_Loss: 1.527479887008667, Test_Loss: 1.492600440979004 *
Epoch: 10, Train_Loss: 1.4918694496154785, Test_Loss: 1.5051926374435425
Epoch: 10, Train_Loss: 1.551020622253418, Test_Loss: 1.6886069774627686
Epoch: 10, Train_Loss: 1.5420668125152588, Test_Loss: 1.5196436643600464 *
Epoch: 10, Train_Loss: 1.5359532833099365, Test_Loss: 1.6808741092681885
Epoch: 10, Train_Loss: 1.524040937423706, Test_Loss: 1.5964853763580322 *
Epoch: 10, Train_Loss: 1.5443534851074219, Test_Loss: 1.7038064002990723
Epoch: 10, Train_Loss: 1.4827114343643188, Test_Loss: 1.5166593790054321 *
Epoch: 10, Train_Loss: 1.4813810586929321, Test_Loss: 1.4892939329147339 *
Epoch: 10, Train_Loss: 1.6665517091751099, Test_Loss: 1.9969639778137207
Epoch: 10, Train_Loss: 3.760695457458496, Test_Loss: 2.0871362686157227
Epoch: 10, Train_Loss: 1.4863958358764648, Test_Loss: 1.881818175315857 *
Epoch: 10, Train_Loss: 1.473376750946045, Test_Loss: 1.59916353225708 *
Epoch: 10, Train_Loss: 1.4722930192947388, Test_Loss: 1.5100302696228027 *
Epoch: 10, Train_Loss: 1.4711400270462036, Test_Loss: 2.058427333831787
Epoch: 10, Train_Loss: 1.5574579238891602, Test_Loss: 2.6687424182891846
Epoch: 10, Train_Loss: 1.5533342361450195, Test_Loss: 2.1821634769439697 *
Epoch: 10, Train_Loss: 1.527769684791565, Test_Loss: 1.4844962358474731 *
Epoch: 10, Train_Loss: 1.6606565713882446, Test_Loss: 2.4062576293945312
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Epoch: 10, Train_Loss: 1.5423325300216675, Test_Loss: 1.6701468229293823 *
Epoch: 10, Train_Loss: 1.4646344184875488, Test_Loss: 1.5422030687332153 *
Epoch: 10, Train_Loss: 1.4714961051940918, Test_Loss: 1.807770013809204
Epoch: 10, Train_Loss: 1.4666119813919067, Test_Loss: 2.3545055389404297
Epoch: 10, Train_Loss: 1.4619485139846802, Test_Loss: 1.4711098670959473 *
Epoch: 10, Train_Loss: 1.543243408203125, Test_Loss: 1.491678237915039
Epoch: 10, Train_Loss: 1.6237375736236572, Test_Loss: 1.8168308734893799
Epoch: 10, Train_Loss: 1.5593221187591553, Test_Loss: 1.7095725536346436 *
Epoch: 10, Train_Loss: 1.5559934377670288, Test_Loss: 1.482944369316101 *
Epoch: 10, Train_Loss: 1.6846191883087158, Test_Loss: 1.7749754190444946
Epoch: 10, Train_Loss: 1.4675331115722656, Test_Loss: 2.3920655250549316
Epoch: 10, Train_Loss: 3.0547282695770264, Test_Loss: 1.5104711055755615 *
Epoch: 10, Train_Loss: 1.486025094985962, Test_Loss: 1.4583427906036377 *
Epoch: 10, Train_Loss: 1.4843848943710327, Test_Loss: 1.4761602878570557
Epoch: 10, Train_Loss: 1.4758834838867188, Test_Loss: 1.475056767463684 *
Epoch: 10, Train_Loss: 1.554771900177002, Test_Loss: 1.6228203773498535
Epoch: 10, Train_Loss: 1.5224679708480835, Test_Loss: 1.6583648920059204
Epoch: 10, Train_Loss: 1.4814198017120361, Test_Loss: 1.4532533884048462 *
Epoch: 10, Train_Loss: 1.4691071510314941, Test_Loss: 1.4511168003082275 *
Epoch: 10, Train_Loss: 1.4600903987884521, Test_Loss: 2.9185733795166016
Epoch: 10, Train_Loss: 1.4707988500595093, Test_Loss: 2.721360445022583 *
Epoch: 10, Train_Loss: 1.4660155773162842, Test_Loss: 1.4444458484649658 *
Epoch: 10, Train_Loss: 1.4444659948349, Test_Loss: 1.446305751800537
Epoch: 10, Train_Loss: 1.4420298337936401, Test_Loss: 1.4449800252914429 *
Epoch: 10, Train_Loss: 1.4446141719818115, Test_Loss: 1.4471099376678467
Epoch: 10, Train_Loss: 1.4432430267333984, Test_Loss: 1.4457108974456787 *
Epoch: 10, Train_Loss: 1.4434670209884644, Test_Loss: 1.456817388534546
Epoch: 10, Train_Loss: 1.4511088132858276, Test_Loss: 1.4386374950408936 *
Epoch: 10, Train_Loss: 1.453517198562622, Test_Loss: 1.4373962879180908 *
Epoch: 10, Train_Loss: 1.4419949054718018, Test_Loss: 1.4368315935134888 *
Epoch: 10, Train_Loss: 1.4423739910125732, Test_Loss: 1.4343289136886597 *
Epoch: 10, Train_Loss: 1.4492323398590088, Test_Loss: 1.4349209070205688
Epoch: 10, Train_Loss: 1.4385572671890259, Test_Loss: 1.4336438179016113 *
Epoch: 10, Train_Loss: 1.4764615297317505, Test_Loss: 1.4329348802566528 *
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Epoch: 10, Train_Loss: 1.4612535238265991, Test_Loss: 4.012517929077148
Epoch: 10, Train_Loss: 1.438828706741333, Test_Loss: 1.628190517425537 *
Epoch: 10, Train_Loss: 1.4499527215957642, Test_Loss: 1.470568299293518 *
Epoch: 10, Train_Loss: 1.5230692625045776, Test_Loss: 1.4542092084884644 *
Epoch: 10, Train_Loss: 1.4533518552780151, Test_Loss: 1.507943034172058
Epoch: 10, Train_Loss: 1.4394152164459229, Test_Loss: 1.446503758430481 *
Epoch: 10, Train_Loss: 1.4289449453353882, Test_Loss: 1.4366706609725952 *
Epoch: 10, Train_Loss: 1.4348831176757812, Test_Loss: 1.4965451955795288
Epoch: 10, Train_Loss: 1.4758553504943848, Test_Loss: 1.5084832906723022
Epoch: 10, Train_Loss: 1.4674979448318481, Test_Loss: 1.472411870956421 *
Epoch: 10, Train_Loss: 1.4826470613479614, Test_Loss: 1.4284173250198364 *
Epoch: 10, Train_Loss: 1.525731086730957, Test_Loss: 1.4339131116867065
Epoch: 10, Train_Loss: 1.4330164194107056, Test_Loss: 1.4394193887710571
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Epoch: 10, Train_Loss: 1.415440320968628, Test_Loss: 1.429616093635559 *
Epoch: 10, Train_Loss: 1.4207872152328491, Test_Loss: 1.420528531074524 *
Epoch: 10, Train_Loss: 1.4306482076644897, Test_Loss: 1.4351837635040283
Epoch: 10, Train_Loss: 1.428062915802002, Test_Loss: 1.6022777557373047
Epoch: 10, Train_Loss: 1.4157447814941406, Test_Loss: 1.4477784633636475 *
Epoch: 10, Train_Loss: 1.4190467596054077, Test_Loss: 1.637847661972046
Epoch: 10, Train_Loss: 1.4301809072494507, Test_Loss: 1.49732506275177 *
Epoch: 10, Train_Loss: 1.438644289970398, Test_Loss: 1.6221885681152344
Epoch: 10, Train_Loss: 1.4447654485702515, Test_Loss: 1.4374207258224487 *
Epoch: 10, Train_Loss: 1.4225801229476929, Test_Loss: 1.4235892295837402 *
Epoch: 10, Train_Loss: 1.4129388332366943, Test_Loss: 1.896763801574707
Epoch: 10, Train_Loss: 1.425873041152954, Test_Loss: 1.9569034576416016
Epoch: 10, Train_Loss: 4.1276679039001465, Test_Loss: 1.8502380847930908 *
Epoch: 10, Train_Loss: 1.4279857873916626, Test_Loss: 1.5788713693618774 *
Epoch: 10, Train_Loss: 1.5118579864501953, Test_Loss: 1.4252245426177979 *
Epoch: 10, Train_Loss: 1.4312635660171509, Test_Loss: 1.9569571018218994
Epoch: 10, Train_Loss: 1.4370758533477783, Test_Loss: 2.5114054679870605
Epoch: 10, Train_Loss: 1.4126765727996826, Test_Loss: 2.2214527130126953 *
Epoch: 10, Train_Loss: 2.406754493713379, Test_Loss: 1.4507884979248047 *
Epoch: 10, Train_Loss: 1.9709006547927856, Test_Loss: 2.1493592262268066
Epoch: 10, Train_Loss: 2.6724371910095215, Test_Loss: 1.7876652479171753 *
Epoch: 10, Train_Loss: 1.7593241930007935, Test_Loss: 1.4557135105133057 *
Epoch: 10, Train_Loss: 1.9593658447265625, Test_Loss: 1.7014713287353516
Epoch: 10, Train_Loss: 2.5238895416259766, Test_Loss: 2.281069755554199
Epoch: 10, Train_Loss: 1.419579267501831, Test_Loss: 1.4162744283676147 *
Epoch: 10, Train_Loss: 1.7343807220458984, Test_Loss: 1.4060412645339966 *
Epoch: 10, Train_Loss: 1.4144731760025024, Test_Loss: 1.715458869934082
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Epoch: 10, Train_Loss: 1.6344349384307861, Test_Loss: 1.4215787649154663 *
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Epoch: 10, Train_Loss: 1.6643006801605225, Test_Loss: 2.349294900894165
Epoch: 10, Train_Loss: 1.6999953985214233, Test_Loss: 1.445992350578308 *
Epoch: 10, Train_Loss: 1.478774905204773, Test_Loss: 1.3869342803955078 *
Epoch: 10, Train_Loss: 1.4154964685440063, Test_Loss: 1.4054739475250244
Epoch: 10, Train_Loss: 1.3819580078125, Test_Loss: 1.404589056968689 *
Epoch: 10, Train_Loss: 1.3846992254257202, Test_Loss: 1.469433069229126
Epoch: 10, Train_Loss: 1.4254337549209595, Test_Loss: 1.7088936567306519
Epoch: 10, Train_Loss: 1.4527256488800049, Test_Loss: 1.3852936029434204 *
Epoch: 10, Train_Loss: 1.662259578704834, Test_Loss: 1.3815009593963623 *
Epoch: 10, Train_Loss: 1.445363998413086, Test_Loss: 2.065962314605713
Epoch: 10, Train_Loss: 1.7733391523361206, Test_Loss: 3.4556896686553955
Epoch: 10, Train_Loss: 1.3780467510223389, Test_Loss: 1.3754433393478394 *
Epoch: 10, Train_Loss: 2.0054028034210205, Test_Loss: 1.3762558698654175
Epoch: 10, Train_Loss: 1.4549720287322998, Test_Loss: 1.3770874738693237
Epoch: 10, Train_Loss: 1.7853398323059082, Test_Loss: 1.379390001296997
Epoch: 10, Train_Loss: 2.114380359649658, Test_Loss: 1.3755924701690674 *
Epoch: 10, Train_Loss: 1.3830796480178833, Test_Loss: 1.3820877075195312
Epoch: 10, Train_Loss: 1.6011296510696411, Test_Loss: 1.3731273412704468 *
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Epoch: 10, Train_Loss: 1.4003431797027588, Test_Loss: 1.3695628643035889 *
Epoch: 10, Train_Loss: 1.3781510591506958, Test_Loss: 1.3670071363449097 *
Epoch: 10, Train_Loss: 10.241740226745605, Test_Loss: 1.3680168390274048
Epoch: 10, Train_Loss: 3.3905396461486816, Test_Loss: 1.3668490648269653 *
Epoch: 10, Train_Loss: 1.4024689197540283, Test_Loss: 1.365604043006897 *
Epoch: 10, Train_Loss: 7.359947204589844, Test_Loss: 1.3660109043121338
Epoch: 10, Train_Loss: 1.4230350255966187, Test_Loss: 1.383838415145874
Epoch: 10, Train_Loss: 4.552467346191406, Test_Loss: 3.211841106414795
Epoch: 10, Train_Loss: 1.3699040412902832, Test_Loss: 2.2982726097106934 *
Epoch: 10, Train_Loss: 1.3610132932662964, Test_Loss: 1.3945844173431396 *
Epoch: 10, Train_Loss: 1.3578723669052124, Test_Loss: 1.381287932395935 *
Epoch: 10, Train_Loss: 1.3561971187591553, Test_Loss: 1.4580086469650269
Epoch: 10, Train_Loss: 1.3622822761535645, Test_Loss: 1.3738460540771484 *
Epoch: 10, Train_Loss: 1.375222086906433, Test_Loss: 1.3734030723571777 *
Epoch: 10, Train_Loss: 1.397720217704773, Test_Loss: 1.407914161682129
Epoch: 10, Train_Loss: 1.3573836088180542, Test_Loss: 1.4563987255096436
Epoch: 10, Train_Loss: 1.3524158000946045, Test_Loss: 1.4133896827697754 *
Epoch: 10, Train_Loss: 1.349301815032959, Test_Loss: 1.3536691665649414 *
Epoch: 10, Train_Loss: 1.350117802619934, Test_Loss: 1.3509917259216309 *
Model saved at location G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-master/:
Epoch: 10, Train_Loss: 1.3470081090927124, Test_Loss: 1.354528546333313
Epoch: 10, Train_Loss: 1.3516985177993774, Test_Loss: 1.351413607597351 *
Epoch: 10, Train_Loss: 1.3678137063980103, Test_Loss: 1.348519206047058 *
Epoch: 10, Train_Loss: 1.686882734298706, Test_Loss: 1.3593372106552124
Epoch: 10, Train_Loss: 5.451210975646973, Test_Loss: 1.5765680074691772
Epoch: 10, Train_Loss: 1.3619590997695923, Test_Loss: 1.3792296648025513 *
Epoch: 10, Train_Loss: 1.3632252216339111, Test_Loss: 1.4990710020065308
Epoch: 10, Train_Loss: 1.376456618309021, Test_Loss: 1.4283339977264404 *
Epoch: 10, Train_Loss: 1.5463416576385498, Test_Loss: 1.6372472047805786
Epoch: 10, Train_Loss: 1.4095227718353271, Test_Loss: 1.4052056074142456 *
Epoch: 10, Train_Loss: 1.468538761138916, Test_Loss: 1.3499339818954468 *
Epoch: 10, Train_Loss: 1.4682215452194214, Test_Loss: 1.8502321243286133
Epoch: 10, Train_Loss: 1.3989248275756836, Test_Loss: 1.747441291809082 *
Epoch: 10, Train_Loss: 1.388765573501587, Test_Loss: 1.8373072147369385
Epoch: 10, Train_Loss: 1.3561463356018066, Test_Loss: 1.6086056232452393 *
Epoch: 10, Train_Loss: 1.3466203212738037, Test_Loss: 1.3427788019180298 *
Epoch: 10, Train_Loss: 4.0592474937438965, Test_Loss: 1.7948052883148193
Epoch: 10, Train_Loss: 1.3603485822677612, Test_Loss: 2.381831407546997
Epoch: 10, Train_Loss: 1.35545814037323, Test_Loss: 2.290292263031006 *
Epoch: 10, Train_Loss: 1.3384864330291748, Test_Loss: 1.4891043901443481 *
Epoch: 10, Train_Loss: 1.3496568202972412, Test_Loss: 1.856292963027954
Epoch: 10, Train_Loss: 1.342421054840088, Test_Loss: 1.8335912227630615 *
Epoch: 10, Train_Loss: 1.3329846858978271, Test_Loss: 1.3826406002044678 *
Epoch: 10, Train_Loss: 1.3389649391174316, Test_Loss: 1.5916924476623535
Epoch: 10, Train_Loss: 1.350704312324524, Test_Loss: 2.275322437286377
Epoch: 10, Train_Loss: 1.3621588945388794, Test_Loss: 1.430985927581787 *
Epoch: 10, Train_Loss: 1.3335916996002197, Test_Loss: 1.3536771535873413 *
```

```
In [17]: import pandas as pd
         record = pd.DataFrame(columns = ["Epoch Number","Test Loss"])
         record["Epoch Number"] = epoch_number
         record["Test Loss"] = test_loss
         record.to_csv("result.csv")

In [36]: sess = tf.InteractiveSession()
         saver = tf.train.Saver()
         saver.restore(sess, "G:/Applied AI case study/Self driving car/Autopilot-TensorFlow-ma

         img = cv2.imread('steering_wheel_image.jpg', 0)
         rows, cols = img.shape
         smoothed_angle = 0

         i = 0
         while(cv2.waitKey(60) != ord("q")):
             full_image = scipy.misc.imread(test_x[i], mode="RGB")

             image = ((cv2.resize(full_image[-150:], (200, 66)) / 255.0).reshape((1, 66, 200,
             #degrees = model.y.eval(feed_dict={model.x: [image], model.keep_prob: 1.0})[0][0]
             degrees = sess.run(y_predicted, feed_dict = {x_input: image, keep_prob: 0.5})[0][
             cv2.imshow("frame", cv2.cvtColor(full_image, cv2.COLOR_RGB2BGR))
             smoothed_angle += 0.2 * pow(abs((degrees - smoothed_angle)), 2.0 / 3.0) * (degrees
             #full_image = cv2.imread(test_x[i])
             #cv2.imshow('Frame Window', full_image)
             #image = ((cv2.resize(full_image[-150:], (200, 66)) / 255.0).reshape((1, 66, 200,
             #degrees = sess.run(y_predicted, feed_dict = {x_input: image, keep_prob: 0.5})[0]
             M = cv2.getRotationMatrix2D((cols/2,rows/2), -smoothed_angle, 1)
             dst = cv2.warpAffine(src = img, M = M, dsize = (cols, rows))
             cv2.imshow("Steering Wheel", dst)
             i += 1

         cv2.destroyAllWindows()

C:\Users\abc\Anaconda3\lib\site-packages\tensorflow\python\client\session.py:1702: UserWarning
  warnings.warn('An interactive session is already active. This can '


INFO:tensorflow:Restoring parameters from G:/Applied AI case study/Self driving car/Autopilot-T


C:\Users\abc\Anaconda3\lib\site-packages\ipykernel_launcher.py:11: DeprecationWarning: `imread
`imread` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``imageio.imread`` instead.
  # This is added back by InteractiveShellApp.init_path()
```

0.1 Procedure

- Read all the image along with steering andle from data.txt file

- Split the data into train and text by 70:30
- Then create a convnet model using 5 convulation layer with different kernel alon with 5 fully connected dense layer
- Then train the model using a training dataset and store the loss at each epoch
- At the end we visualize the result.

0.2 Conclusion

```python
In [1]: import pandas as pd
        res=pd.read_csv("result.csv")
```

```python
In [2]: print(res[["Epoch Number","Test Loss"]])
```

```
   Epoch Number  Test Loss
0             0  18.109542
1             1  12.926361
2             2   9.416918
3             3   7.008951
4             4   5.298237
5             5   4.094995
6             6   3.270577
7             7   2.656271
8             8   2.210532
9             9   1.912212
```