Analysis Report

The experiments are carried out using TensorFlow and Keras, which are wrappers over scikit.

Keras is a central part of the tightly-connected TensorFlow 2.0 ecosystem, covering every step of the machine learning workflow, from data management to hyperparameter training to deployment solutions.

In the beginning divided the MNIST into pairs of classes and ran it through different MLP models consisting of hidden layers [1,2,3,4]. The accuracy for each hidden layer captured then and using the best model (in our case almost all are good) took 4 hidden layers and experimented on different parameters. Similar tasks were done for Kaggle Data set too.

Processing the model using Node = [12,24,36,48,60] obtained "Accuracy" [0.9995, 0.9995,0.9991, 1.000 and 0.9991] for MNIST Data set and "MSE" for Kaggle Data set[0.1578,0.1578,0.1483,0.1741,0.1381,0.1578]

Processing the model using
Tanh, Relu, and Logistic activation functions.
[Tanh , Relu and Logistic activation Fn] obtained 'Accuracy' [0.9981, 0.9991, 0.9981] and 'MSE" for Kaggle Data set [0.1394,0.1311,0.1338]

Processing the model using

Learning Rate [0.001, 0.010, 0.1, 1]
obtained "Accuracy' [0.9981, 0.9986, 0.9991,0.9986,]
and MSE" for Kaggle Data set [
0.136,0.1640,0.1421,0.1283,0.1316]

Processing the model using
Momentum [0.0, 0.2, 0.4, 0.9] obtained "Accuracy" [
0.9995, 0.9986, 0.9981,0.9986] and "MSE" for Kaggle
Data set [0.1234,0.1282,0.1456,0.1348]

Processing the model using
Early Stopping [min, max,auto] obtained "Accuracy" [
0.9976, 0.9991,0.9986] and "MSE" for Kaggle Data set [
0.1553,0.1673,0,1419]

Overall Accuracy is 100% with different inputs of the above parameters
And MSE is 0.1553.

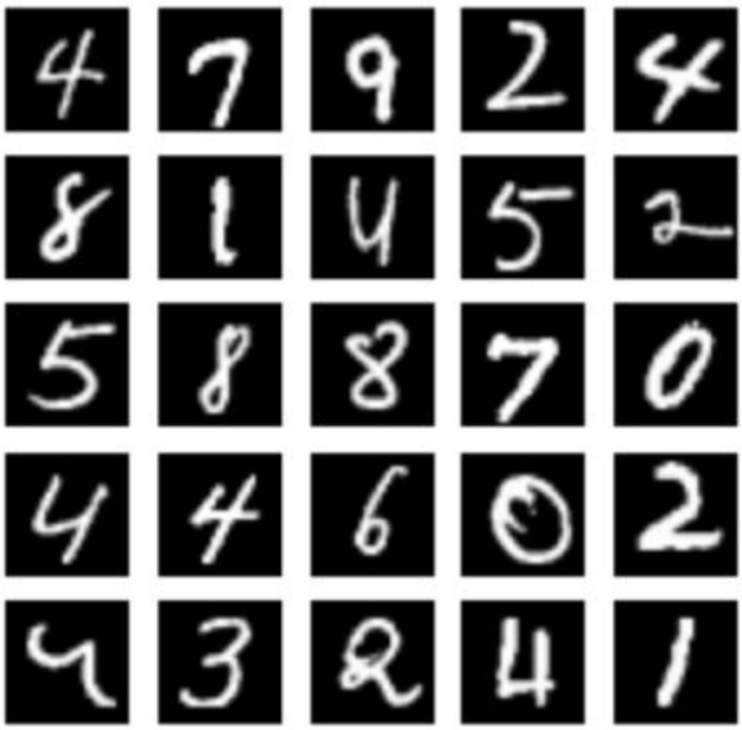
MLP processing for MNIST Analysis

The MNIST database of handwritten digits has a training set of 60,000 examples, and a test set of 10,000 examples. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image.

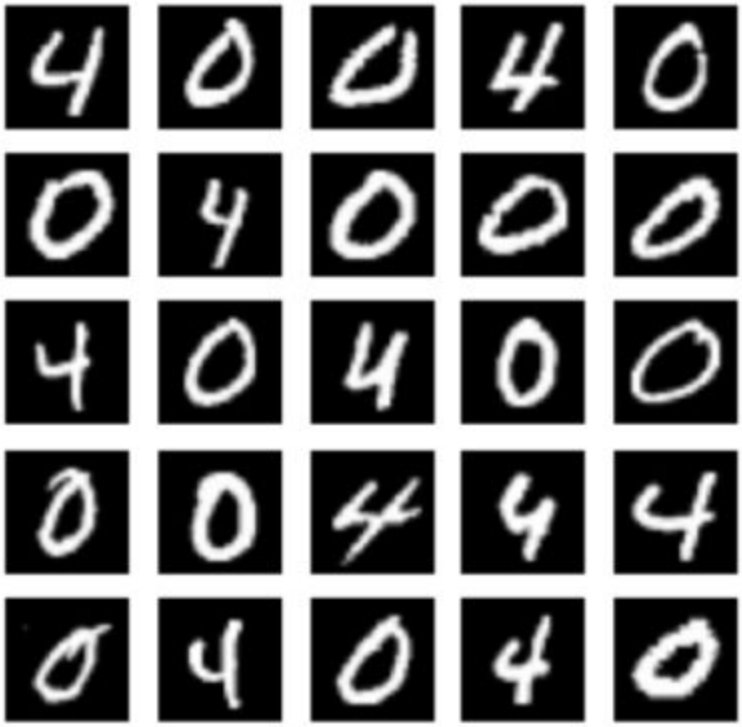
MLP Analytic Results :

Executed MLP on MNIST dataset using different classes using layers 1,2,3 and 4 as shown below

```
plt.figure(figsize=(5,5))
for i in range(len(indexes)):
    plt.subplot(5, 5, i + 1)
    image = images[i]
    plt.imshow(image, cmap='gray')
    plt.axis('off')
```



Selected 2 classes [0,4] as required for experimenting:



Train an MLP each with 1, 2, 3 and 4 hidden layers using Backpropagation.

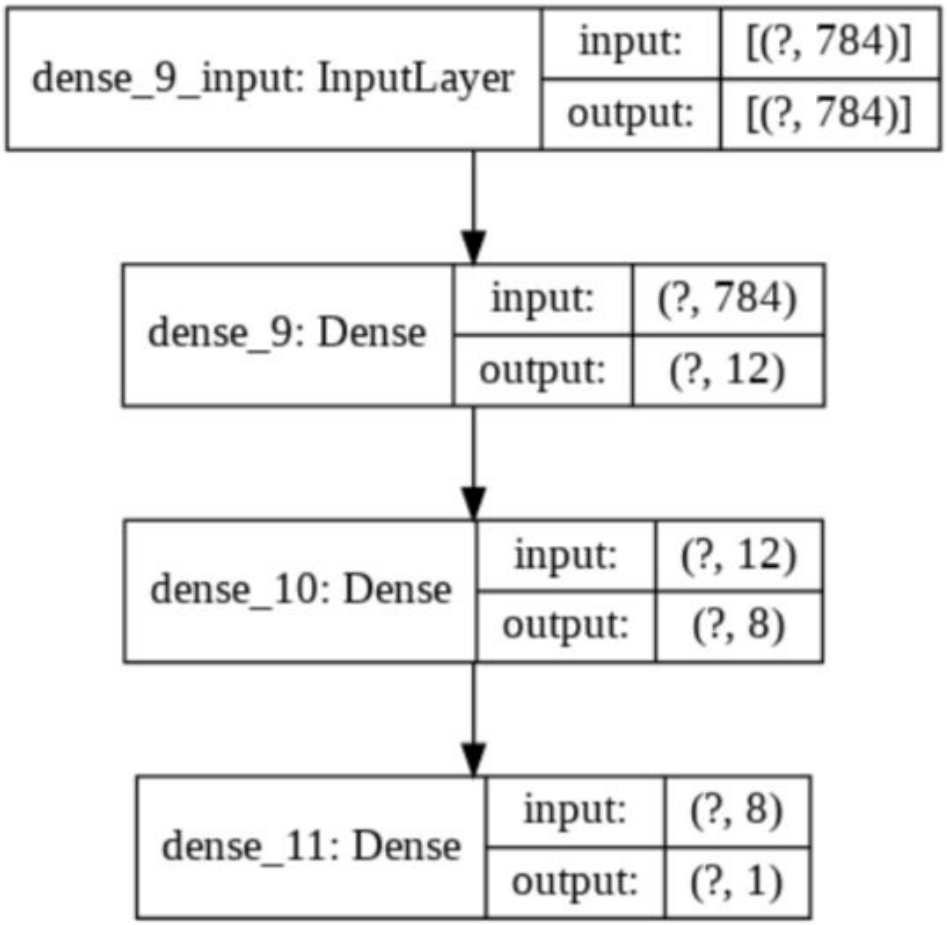
Defined the MLP model Using Two Hidden Layer

```
model = Sequential()
model.add(Dense(12, input_shape=(784,), activation='relu'))
model.add(Dense(8, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
```

Results

```
2.4.0
Model: "sequential_4"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_9 (Dense)              (None, 12)                9420
_________________________________________________________________
dense_10 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_11 (Dense)             (None, 1)                 9
=================================================================
```

Plotted the Layer Diagram showing Input/Output -




```
model.compile(optimizer='sgd', loss='binary_crossentropy',
metrics=['binary_accuracy'])
model.fit(
 x=x_train_final,
 y=y_train_new,
 shuffle=True,
 epochs=5,
 batch_size=16
)
```

Output:

```
Epoch 1/5
```

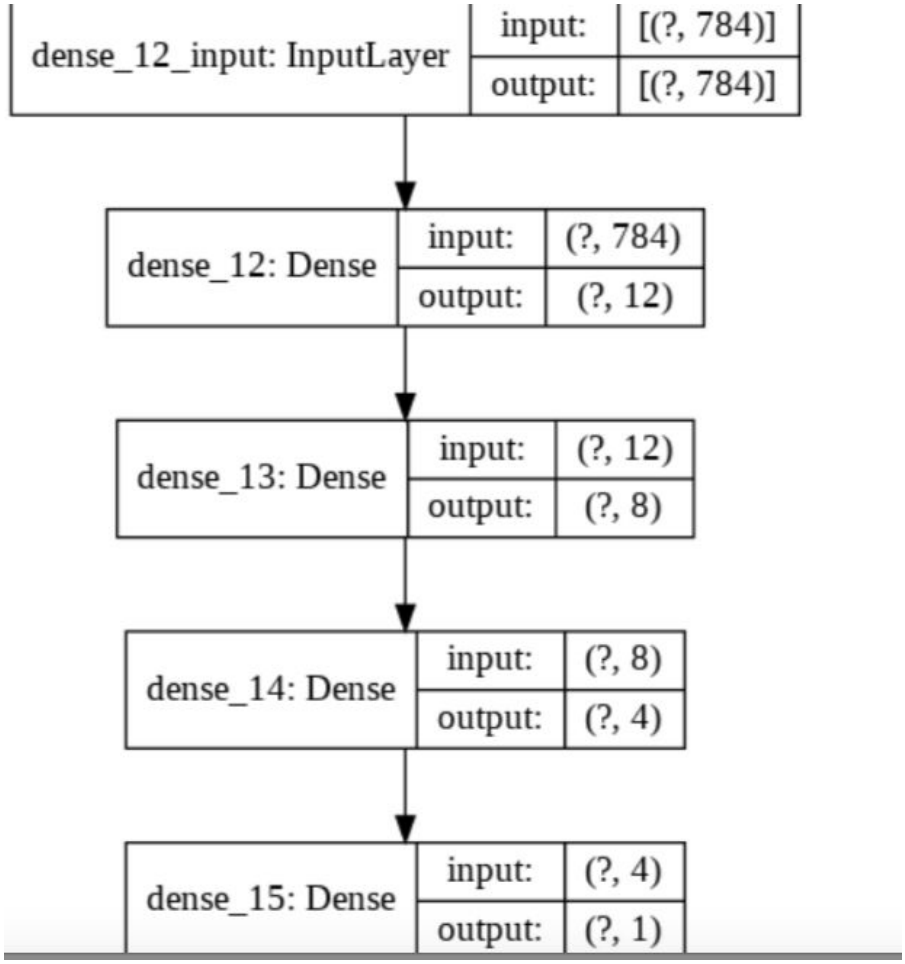
```
792/792 [==============================] - 2s 2ms/step - loss: 0.1036 -
binary_accuracy: 0.9840
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0096 -
binary_accuracy: 0.9979
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0046 -
binary_accuracy: 0.9986
67/67 [==============================] - 0s 2ms/step - loss: 0.0023 -
binary_accuracy: 0.9995
```

Accuracy -------->0.9995

Using Three Hidden Layers

```
model = Sequential()
model.add(Dense(12, input_shape=(784,), activation='relu'))
model.add(Dense(8, activation='relu'))
model.add(Dense(4, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
```

```
2.4.0
Model: "sequential_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_12 (Dense)             (None, 12)                9420
_________________________________________________________________
dense_13 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_14 (Dense)             (None, 4)                 36
_________________________________________________________________
dense_15 (Dense)             (None, 1)                 5
=================================================================
Total params: 9,565
Trainable params: 9,565
Non-trainable params: 0
```




```
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.1052 -
binary_accuracy: 0.9853
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0081 -
binary_accuracy: 0.9979
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0053 -
binary_accuracy: 0.9985
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0042 -
binary_accuracy: 0.9989
Epoch 5/5
```

```
792/792 [==============================] - 2s 2ms/step - loss: 0.0036 -
binary_accuracy: 0.9991
```

67/67 [==============================] - 0s 2ms/step - loss: 0.0020 - binary_accuracy: 0.9999 or 1 or 100

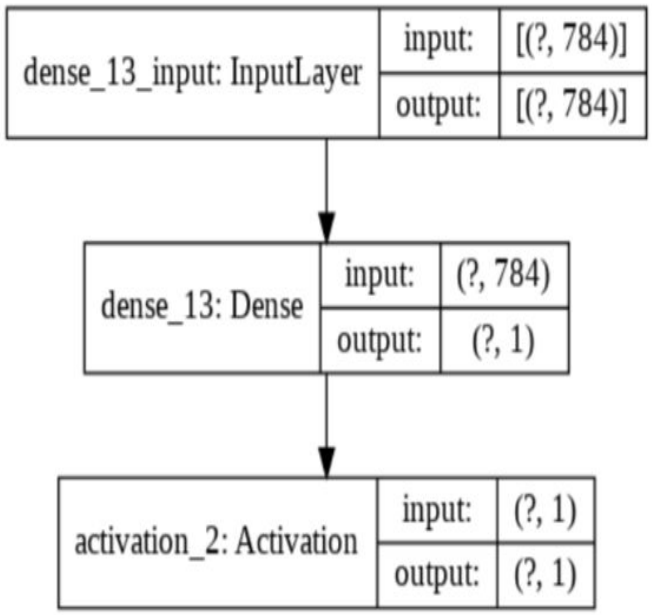
Accuracy ------>0.9999

Using 1 Hidden Layer

```
model = Sequential()

model.add(Dense(1, input_shape=(784,)))

model.summary()
plot_model(model, to_file='mlp-mnist.png', show_shapes=True)
```

```
2.4.0
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_8 (Dense)              (None, 1)                 785
_________________________________________________________________
activation_1 (Activation)    (None, 1)                 0
=================================================================
Total params: 785
Trainable params: 785
Non-trainable params: 0


Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0786 -
binary_accuracy: 0.9897
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0207 -
binary_accuracy: 0.9976
```

```
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0150 -
binary_accuracy: 0.9976
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0124 -
binary_accuracy: 0.9977
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0108 -
binary_accuracy: 0.9979
67/67 [==============================] - 0s 2ms/step - loss: 0.0066 -
binary_accuracy: 0.9995
```



Accuracy ------>0.9995

From the above experiments, all the models [1,2,3,4} have very good Accuracy almost 100.
So for further experiments, 4 hidden layers are considered.

Experimented to determine the Best Batch and Epoch

The batch size is the number of patterns shown to the network before the weights are updated. It is also an optimization in the training of the network, defining how many patterns to read at a time and keep in memory.

The number of epochs is the number of times that the entire training dataset is shown to the network during training

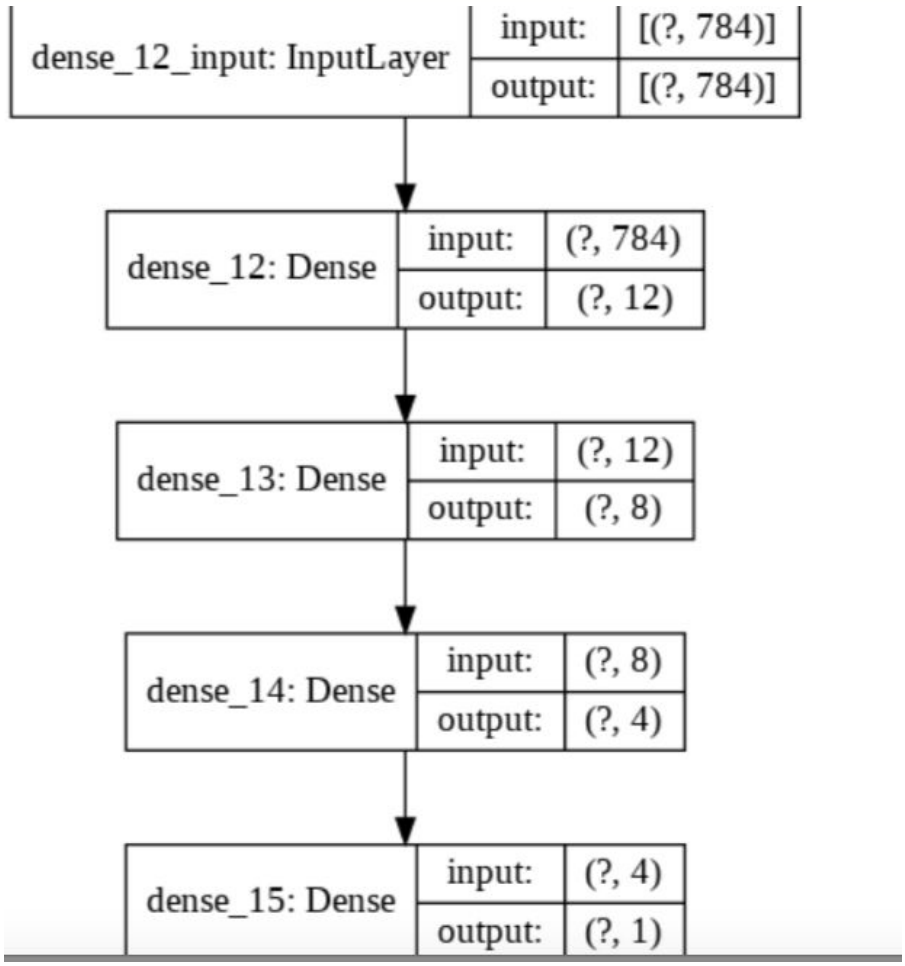
```
Node = 16

model = Sequential()
model.add(Dense(node , input_shape=(784,), activation='relu'))
model.add(Dense(node -4, activation='relu'))
model.add(Dense(node - 8, activation='relu'))
model.add(Dense( 1, activation='sigmoid'))

parameters ={'batch_size':[5,10],
           'Nb_epoch':[10,20,50]}
```

Best: 0.998816 using {'batch_size': 10, 'nb_epoch': 10}
0.998026 (0.000487) with: {'batch_size': 5, 'nb_epoch': 10}
0.997552 (0.000487) with: {'batch_size': 5, 'nb_epoch': 20}

0.998737 (0.000805) with: {'batch_size': 5, 'nb_epoch': 50}
0.998816 (0.000670) with: {'batch_size': 10, 'nb_epoch': 10}
0.997947 (0.001116) with: {'batch_size': 10, 'nb_epoch': 20}
0.998421 (0.000487) with: {'batch_size': 10, 'nb_epoch': 50}

4 Hidden Layer is performed better than other hidden layers however the difference is not very MUCH. It is really close.

For fine tuning experiment considering the 4 Hidden Layer



Experiment with Number of nodes in the hidden layers.

Processing MLP by changing the number of Nodes passed to the Model.

Considering following no of nodes for experiment

Node = [12,24,36,48,60]

Processing - Node changes 12

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_4 (Dense)              (None, 12)                9420
_________________________________________________________________
dense_5 (Dense)              (None, 8)                 104
_________________________________________________________________
dense_6 (Dense)              (None, 4)                 36
_________________________________________________________________
dense_7 (Dense)              (None, 1)                 5
=================================================================
Total params: 9,565
Trainable params: 9,565
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.1548 -
binary_accuracy: 0.9641
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0086 -
binary_accuracy: 0.9979
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0055 -
binary_accuracy: 0.9985
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0044 -
binary_accuracy: 0.9987
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0038 -
binary_accuracy: 0.9989
```

67/67 [==============================] - 0s 2ms/step - loss: 0.0017 - binary_accuracy: 0.9995

2.4.0

Processing - Node changes 24

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_8 (Dense)              (None, 24)                18840
_________________________________________________________________
dense_9 (Dense)              (None, 20)                500
_________________________________________________________________
dense_10 (Dense)             (None, 16)                336
_________________________________________________________________
dense_11 (Dense)             (None, 1)                 17
=================================================================
Total params: 19,693
Trainable params: 19,693
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0605 -
binary_accuracy: 0.9957
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0070 -
binary_accuracy: 0.9984
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0050 -
binary_accuracy: 0.9985
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0041 -
binary_accuracy: 0.9987
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0035 -
binary_accuracy: 0.9990
67/67 [==============================] - 0s 2ms/step - loss: 0.0019 -
binary_accuracy: 0.9995
2.4.0
```

Processing - Node changes 36

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_12 (Dense)             (None, 36)                28260
_________________________________________________________________
dense_13 (Dense)             (None, 32)                1184
_________________________________________________________________
dense_14 (Dense)             (None, 28)                924
_________________________________________________________________
dense_15 (Dense)             (None, 1)                 29
=================================================================
Total params: 30,397
Trainable params: 30,397
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0988 -
binary_accuracy: 0.9849
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0091 -
binary_accuracy: 0.9982
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0064 -
binary_accuracy: 0.9985
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0052 -
binary_accuracy: 0.9987
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0045 -
binary_accuracy: 0.9988
67/67 [==============================] - 0s 2ms/step - loss: 0.0026 -
binary_accuracy: 0.9991
2.4.0
```

Processing - Node changes 48

```
Model: "sequential_4"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_16 (Dense)             (None, 48)                37680
_________________________________________________________________
dense_17 (Dense)             (None, 44)                2156
_________________________________________________________________
dense_18 (Dense)             (None, 40)                1800
```

```
_________________________________________________________________
dense_19 (Dense)             (None, 1)                 41
=================================================================
Total params: 41,677
Trainable params: 41,677
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.1060 -
binary_accuracy: 0.9701
Epoch 2/5
792/792 [==============================] - 2s 3ms/step - loss: 0.0079 -
binary_accuracy: 0.9983
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0057 -
binary_accuracy: 0.9985
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0047 -
binary_accuracy: 0.9988
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0040 -
binary_accuracy: 0.9988
```

67/67 [==============================] - 0s 2ms/step - loss: 0.0018 - binary_accuracy: 1.0000

```
2.4.0
```

Processing - Node changes 60

```
Model: "sequential_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_20 (Dense)             (None, 60)                47100
_________________________________________________________________
dense_21 (Dense)             (None, 56)                3416
_________________________________________________________________
dense_22 (Dense)             (None, 52)                2964
_________________________________________________________________
dense_23 (Dense)             (None, 1)                 53
=================================================================
Total params: 53,533
Trainable params: 53,533
Non-trainable params: 0
```

```
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0650 -
binary_accuracy: 0.9925
Epoch 2/5
792/792 [==============================] - 2s 3ms/step - loss: 0.0075 -
binary_accuracy: 0.9979
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0052 -
binary_accuracy: 0.9987
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0043 -
binary_accuracy: 0.9989
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0037 -
binary_accuracy: 0.9991
67/67 [==============================] - 0s 2ms/step - loss: 0.0028 -
binary_accuracy: 0.9991
```

==========

Processing the model using Tanh, Relu, and Logistic activation functions.

The activation function controls the non-linearity of individual neurons and when to fire.

fn_list = ["tanh", "relu","sigmoid"]

Processing - activation function changes ----> "tanh"

```
Model: "sequential_6"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_24 (Dense)             (None, 16)                12560
_________________________________________________________________
```

```
dense_25 (Dense)             (None, 12)                204
_________________________________________________________________
dense_26 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_27 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0238 -
binary_accuracy: 0.9962
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0102 -
binary_accuracy: 0.9990
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0094 -
binary_accuracy: 0.9987
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0088 -
binary_accuracy: 0.9990
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0079 -
binary_accuracy: 0.9992
67/67 [==============================] - 0s 2ms/step - loss: 0.0103 -
binary_accuracy: 0.9981
2.4.0
```

Processing - activation function changes 'relu'

```
Model: "sequential_7"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_28 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_29 (Dense)             (None, 12)                204
_________________________________________________________________
dense_30 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_31 (Dense)             (None, 1)                 9
=================================================================
```

```
Total params: 12,877


Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0297 -
binary_accuracy: 0.9931
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0116 -
binary_accuracy: 0.9987
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0060 -
binary_accuracy: 0.9984
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0056 -
binary_accuracy: 0.9991
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0047 -
binary_accuracy: 0.9988
67/67 [==============================] - 0s 2ms/step - loss: 0.0100 -
binary_accuracy: 0.9991
2.4.0
```

Processing - activation function changes 'sigmoid'

```
Model: "sequential_8"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_32 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_33 (Dense)             (None, 12)                204
_________________________________________________________________
dense_34 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_35 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
Epoch 1/5
```

```
792/792 [==============================] - 2s 2ms/step - loss: 0.6870 -
binary_accuracy: 0.5229
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.6662 -
binary_accuracy: 0.5552
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.6206 -
binary_accuracy: 0.7484
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.4882 -
binary_accuracy: 0.9843
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.2668 -
binary_accuracy: 0.9958
67/67 [==============================] - 0s 2ms/step - loss: 0.1709 -
binary_accuracy: 0.9981
```

Activation function achieved the best results with an accuracy of about 99.9 [almost 100%]

Processing Hyperparameters -

```
#Hyperparameters: Momentum term, Early stopping, and Learning Rate
```

Learning rate controls how much to update the weight at the end of each batch and the momentum controls how much to let the previous update influence the current weight update.

Will try a suite of small standard learning rates as given below with fixed batch size and epochs.

```
learning_rate_list = [ 0.001, 0.010, 0.1, 1]
```

```
Processing - learning rate  changes 0.001
Model: "sequential_19"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_76 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_77 (Dense)             (None, 12)                204
_________________________________________________________________
dense_78 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_79 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f0853d88c18>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.2732 -
binary_accuracy: 0.9558
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0356 -
binary_accuracy: 0.9987
Epoch 3/5
792/792 [==============================] - 2s 3ms/step - loss: 0.0154 -
binary_accuracy: 0.9993
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0093 -
binary_accuracy: 0.9994
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0063 -
binary_accuracy: 0.9995
67/67 [==============================] - 0s 2ms/step - loss: 0.0095 -
binary_accuracy: 0.9981
2.4.0
 Processing - learning rate  changes 0.01
Model: "sequential_20"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
```

```
=================================================================
dense_80 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_81 (Dense)             (None, 12)                204
_________________________________________________________________
dense_82 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_83 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f085c22bdd8>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.2650 -
binary_accuracy: 0.9582
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0347 -
binary_accuracy: 0.9988
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0148 -
binary_accuracy: 0.9995
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0090 -
binary_accuracy: 0.9994
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0063 -
binary_accuracy: 0.9993
67/67 [==============================] - 0s 2ms/step - loss: 0.0083 -
binary_accuracy: 0.9986
2.4.0
 Processing - learning rate  changes 0.1
Model: "sequential_21"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_84 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_85 (Dense)             (None, 12)                204
_________________________________________________________________
dense_86 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_87 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
```

```
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f0851a3dac8>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.2745 -
binary_accuracy: 0.9721
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0388 -
binary_accuracy: 0.9988
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0166 -
binary_accuracy: 0.9992
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0096 -
binary_accuracy: 0.9994
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0070 -
binary_accuracy: 0.9993
67/67 [==============================] - 0s 2ms/step - loss: 0.0070 -
binary_accuracy: 0.9991
2.4.0
 Processing - learning rate  changes 1
Model: "sequential_22"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_88 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_89 (Dense)             (None, 12)                204
_________________________________________________________________
dense_90 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_91 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f0852b86d30>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.2457 -
binary_accuracy: 0.9464
Epoch 2/5
```

```
792/792 [==============================] - 2s 2ms/step - loss: 0.0348 -
binary_accuracy: 0.9987
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0152 -
binary_accuracy: 0.9991
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0088 -
binary_accuracy: 0.9995
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0068 -
binary_accuracy: 0.9993
67/67 [==============================] - 0s 2ms/step -
loss: 0.0077 - binary_accuracy: 0.9986
```

Processing momentum:

Experiment with different momentum values [0.0,0.2,0.4,0.9], keeping others parameters fixed.

```
momentum_list = [ 0.0, 0.2, 0.4, 0.9]
```

```
2.4.0
 Processing - momentum  changes 0.0
Model: "sequential_42"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_168 (Dense)            (None, 16)                12560
_________________________________________________________________
dense_169 (Dense)            (None, 12)                204
_________________________________________________________________
dense_170 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_171 (Dense)            (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f086e0a75c0>
Epoch 1/5
```

```
792/792 [==============================] - 2s 2ms/step - loss: 0.0428 -
binary_accuracy: 0.9799
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0052 -
binary_accuracy: 0.9987
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0032 -
binary_accuracy: 0.9991
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0019 -
binary_accuracy: 0.9996
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0031 -
binary_accuracy: 0.9990
67/67 [==============================] - 0s 2ms/step - loss: 0.0028 -
binary_accuracy: 0.9995
2.4.0


 Processing - momentum  changes 0.2

Model: "sequential_43"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_172 (Dense)            (None, 16)                12560
_________________________________________________________________
dense_173 (Dense)            (None, 12)                204
_________________________________________________________________
dense_174 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_175 (Dense)            (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f0854f74a20>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0351 -
binary_accuracy: 0.9868
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0046 -
binary_accuracy: 0.9988
Epoch 3/5
```

```
792/792 [==============================] - 2s 2ms/step - loss: 0.0043 -
binary_accuracy: 0.9991
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0030 -
binary_accuracy: 0.9989
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0016 -
binary_accuracy: 0.9994
67/67 [==============================] - 0s 2ms/step - loss: 0.0031 -
binary_accuracy: 0.9986
2.4.0
```

Processing - momentum changes 0.4

```
Model: "sequential_44"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_176 (Dense)            (None, 16)                12560
_________________________________________________________________
dense_177 (Dense)            (None, 12)                204
_________________________________________________________________
dense_178 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_179 (Dense)            (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f08fdda52b0>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0465 -
binary_accuracy: 0.9758
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0068 -
binary_accuracy: 0.9983
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0024 -
binary_accuracy: 0.9994
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0027 -
binary_accuracy: 0.9993
```

```
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0037 -
binary_accuracy: 0.9989
67/67 [==============================] - 0s 2ms/step - loss: 0.0054 -
binary_accuracy: 0.9981
2.4.0
```

Processing - momentum changes 0.9

```
Model: "sequential_45"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_180 (Dense)            (None, 16)                12560
_________________________________________________________________
dense_181 (Dense)            (None, 12)                204
_________________________________________________________________
dense_182 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_183 (Dense)            (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f0852c22d68>
Epoch 1/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0374 -
binary_accuracy: 0.9848
Epoch 2/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0120 -
binary_accuracy: 0.9968
Epoch 3/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0110 -
binary_accuracy: 0.9969
Epoch 4/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0054 -
binary_accuracy: 0.9981
Epoch 5/5
792/792 [==============================] - 2s 2ms/step - loss: 0.0042 -
binary_accuracy: 0.9986
```

```
67/67 [==============================] - 0s 2ms/step - loss: 0.0072 -
binary_accuracy: 0.9986
```

Accuracy is almost [100% for different values of momentum]

Experimentation with early_stopping_list..

==========

Early Stopping is used to Halt the Training of Neural Networks At the Right Time..

A problem with training neural networks is in the choice of the number of training epochs to use.

Too many epochs can lead to overfitting of the training dataset, whereas too few may result in an underfit model. Early stopping is a method that allows you to specify an arbitrary large number of training epochs and stop training once the model performance stops improving on a hold out validation dataset.

```
early_stopping_list = [ 'min','max','auto']

for e_s in  early_stopping_list:


     callback = k.callbacks.EarlyStopping(monitor='accuracy',
min_delta=0.0001,patience=1)


2.4.0
 Processing - early stopping  changes min
Model: "sequential_8"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
```

```
=================================================================
dense_32 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_33 (Dense)             (None, 12)                204
_________________________________________________________________
dense_34 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_35 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f284e291ac8>
Epoch 1/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0620 -
accuracy: 0.9756 - val_loss: 0.0048 - val_accuracy: 0.9987
Epoch 2/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0099 -
accuracy: 0.9973 - val_loss: 0.0035 - val_accuracy: 0.9989
Epoch 3/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0055 -
accuracy: 0.9982 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 4/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0062 -
accuracy: 0.9982 - val_loss: 0.0128 - val_accuracy: 0.9955
 No of epochs ran 4
67/67 [==============================] - 0s 2ms/step - loss: 0.0106 -
accuracy: 0.9976
2.4.0
 Processing - early stopping  changes max
Model: "sequential_9"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_36 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_37 (Dense)             (None, 12)                204
_________________________________________________________________
```

```
dense_38 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_39 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f284e0d60b8>
Epoch 1/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0568 -
accuracy: 0.9748 - val_loss: 0.0048 - val_accuracy: 0.9987
Epoch 2/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0074 -
accuracy: 0.9984 - val_loss: 0.0045 - val_accuracy: 0.9992
Epoch 3/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0044 -
accuracy: 0.9990 - val_loss: 0.0029 - val_accuracy: 0.9995
Epoch 4/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0066 -
accuracy: 0.9984 - val_loss: 0.0029 - val_accuracy: 0.9995
 No of epochs ran 4
67/67 [==============================] - 0s 2ms/step - loss: 0.0025 -
accuracy: 0.9991
2.4.0
 Processing - early stopping  changes auto
Model: "sequential_10"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_40 (Dense)             (None, 16)                12560
_________________________________________________________________
dense_41 (Dense)             (None, 12)                204
_________________________________________________________________
dense_42 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_43 (Dense)             (None, 1)                 9
=================================================================
Total params: 12,877
```

```
Trainable params: 12,877
Non-trainable params: 0
_________________________________________________________________
model <tensorflow.python.keras.engine.sequential.Sequential object at
0x7f2842742e10>
Epoch 1/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0683 -
accuracy: 0.9649 - val_loss: 0.0044 - val_accuracy: 0.9984
Epoch 2/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0113 -
accuracy: 0.9966 - val_loss: 0.0040 - val_accuracy: 0.9987
Epoch 3/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0052 -
accuracy: 0.9984 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 4/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0047 -
accuracy: 0.9992 - val_loss: 0.0035 - val_accuracy: 0.9992
Epoch 5/100
278/278 [==============================] - 1s 3ms/step - loss: 0.0044 -
accuracy: 0.9985 - val_loss: 0.0028 - val_accuracy: 0.9997
```

No of epochs ran 5

67/67 [==============================] - 0s 2ms/step - loss:0.0046 - accuracy: 0.9986

Kaggle Analysis Report

Kaggle Analysis:

For IBM Dataset to determine the Attrition in the company using MLP

The Features consists of both Numerical and Categorical Data as shown below:
Also attached the HR.CSV sheet for reference.

['Age', 'DailyRate', 'DistanceFromHome', 'Education', 'EmployeeCount',
'EmployeeNumber', 'EnvironmentSatisfaction', 'HourlyRate',
'JobInvolvement', 'JobLevel', 'JobSatisfaction', 'MonthlyIncome',
'MonthlyRate', 'NumCompaniesWorked', 'PercentSalaryHike',
'PerformanceRating', 'RelationshipSatisfaction', 'StandardHours',
'StockOptionLevel', 'TotalWorkingYears', 'TrainingTimesLastYear',
'WorkLifeBalance', 'YearsAtCompany', 'YearsInCurrentRole',
'YearsSinceLastPromotion', 'YearsWithCurrManager', 'n_Gender',
'n_JobRole', 'n_BusinessTravel', 'n_Department', 'n_EducationField'],
dtype='object')

In [11]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	Env
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	

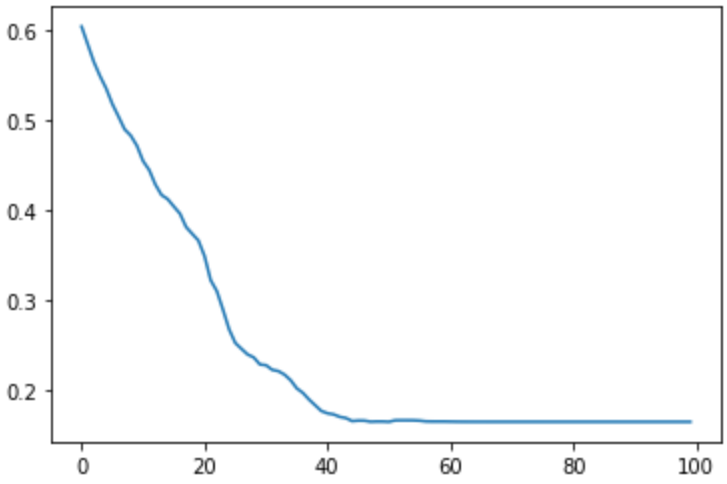
Identified best model among layer [1,2,3,4] hidden layer

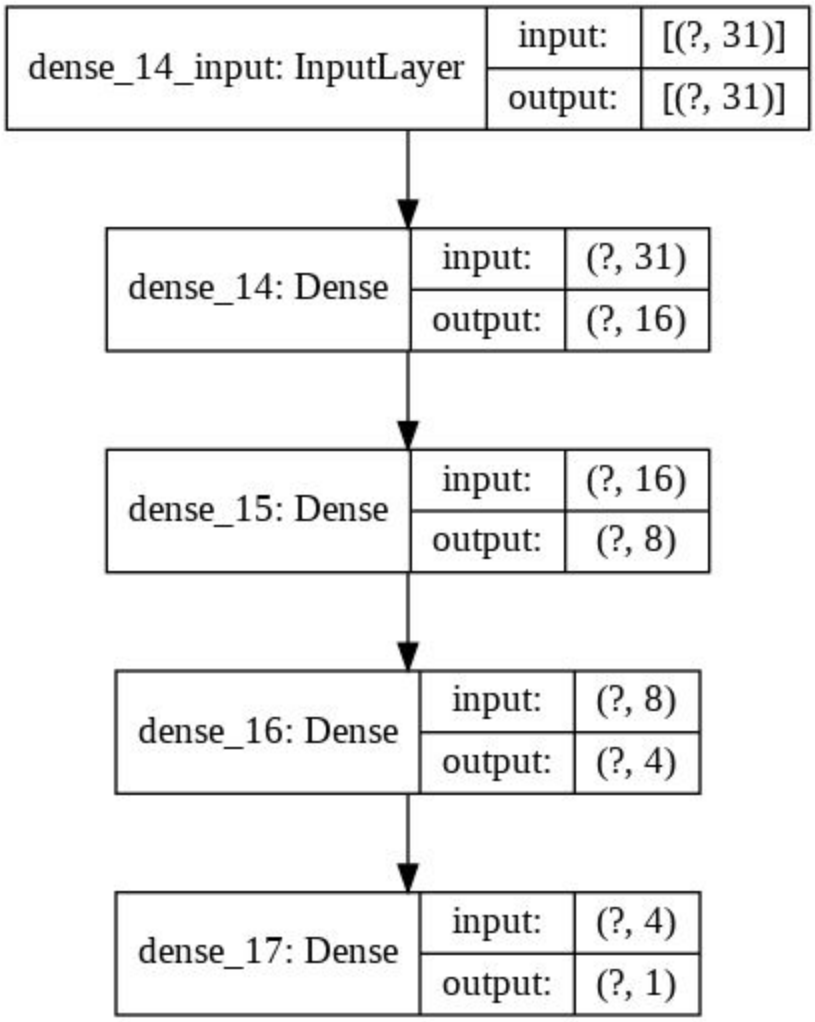
Experimented - Using 3 hidden layers

```
model = Sequential()
```

```
    model.add(Dense(16, input_shape=(31,), activation='relu'))
    model.add(Dense(8, activation='relu'))
    model.add(Dense(4, activation='relu'))
    model.add(Dense(1, activation='sigmoid'))
    #---
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_28 (Dense)             (None, 12)                384
_________________________________________________________________
dense_29 (Dense)             (None, 8)                 104
_________________________________________________________________
dense_30 (Dense)             (None, 4)                 36
_________________________________________________________________
dense_31 (Dense)             (None, 1)                 5
=================================================================
Total params: 529
Trainable params: 529
Non-trainable params: 0
_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.1578 - mse: 0.1578 - mae: 0.1578 - mape: 15.7823
Epoch 2/100
2/2 - 0s - loss: 0.1578 - mse: 0.1578 - mae: 0.1578 - mape: 15.7823
Epoch 3/100
2/2 - 0s - loss: 0.1578 - mse: 0.1578 - mae: 0.1578 - mape: 15.7823
Epoch 4/100
```


0.6
0.5
0.4
0.3
0.2
0
20
40
60
80
100



MSE 0.1578

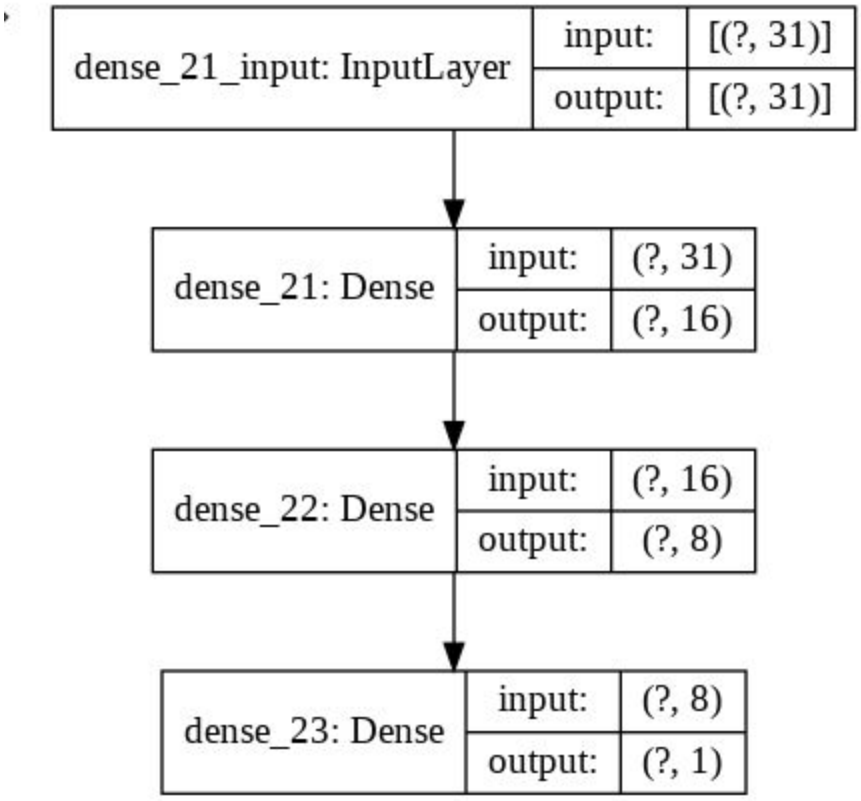
Experimenting with 2 Hidden Layers

```
model = Sequential()
model.add(Dense(16, input_shape=(31,), activation='relu'))
model.add(Dense(8, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
```

```
#---
```

```
Epoch 88/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 89/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 90/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 91/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 92/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 93/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 94/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 95/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 96/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8711
Epoch 97/100
```

MSE : 0.1687

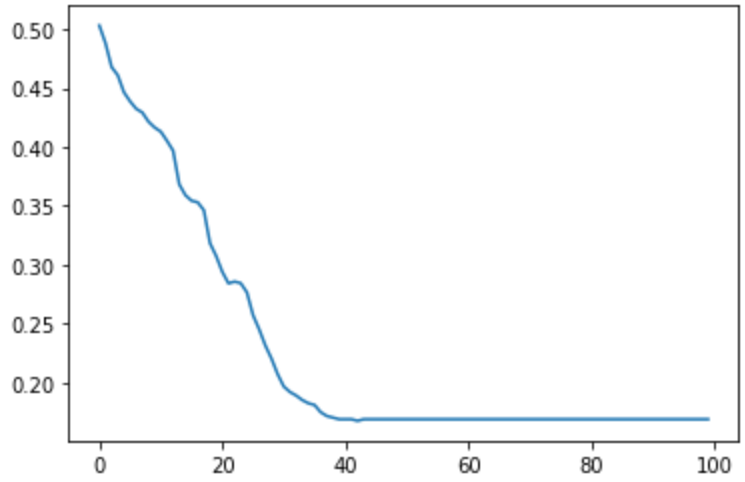


Experimenting with 1 Hidden Layer

```
model = Sequential()
model.add(Dense(16, input_shape=(31,), activation='relu'))
model.add(Dense(1, activation='sigmoid'))
#---
```

```
Epoch 29/100
1/1 - 0s - loss: 0.2202 - mse: 0.2202 - mae: 0.2211 - mape: 89027704.0000
Epoch 30/100
1/1 - 0s - loss: 0.2070 - mse: 0.2070 - mae: 0.2073 - mape: 74012832.0000
Epoch 31/100
1/1 - 0s - loss: 0.1965 - mse: 0.1965 - mae: 0.1971 - mape: 56738072.0000
Epoch 32/100
1/1 - 0s - loss: 0.1919 - mse: 0.1919 - mae: 0.1921 - mape: 42445088.0000
Epoch 33/100
```

```
1/1 - 0s - loss: 0.1889 - mse: 0.1889 - mae: 0.1891 - mape: 35438988.0000
Epoch 34/100
1/1 - 0s - loss: 0.1850 - mse: 0.1850 - mae: 0.1850 - mape: 28571500.0000
Epoch 35/100
1/1 - 0s - loss: 0.1823 - mse: 0.1823 - mae: 0.1823 - mape: 23129268.0000
Epoch 36/100
1/1 - 0s - loss: 0.1808 - mse: 0.1808 - mae: 0.1809 - mape: 17664676.0000
Epoch 37/100
1/1 - 0s - loss: 0.1747 - mse: 0.1747 - mae: 0.1750 - mape: 10402883.0000
Epoch 38/100
1/1 - 0s - loss: 0.1714 - mse: 0.1714 - mae: 0.1714 - mape: 5442194.0000
Epoch 39/100
1/1 - 0s - loss: 0.1701 - mse: 0.1701 - mae: 0.1701 - mape: 2721105.2500
Epoch 40/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 1360741.1250
Epoch 41/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 1360560.8750
Epoch 42/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 1360560.3750
Epoch 43/100
1/1 - 0s - loss: 0.1673 - mse: 0.1673 - mae: 0.1674 - mape: 16.7600
Epoch 44/100
1/1 - 0s - loss: 0.1687 - mse: 0.1687 - mae: 0.1687 - mape: 16.8707
Epoch 45/100

MSE 0.1687
```



From the experiment above, the MSE error is almost same for all model based on Hidden Layer 1,2,3 so choosing 3 layer for experimenting with parameters:

#MLP Processing by changing the NODEs in the Model

```
Choosed following Model for processing - 3 Hidden Layer
    Node = 16
     model = Sequential()
     model.add(Dense(node, input_shape=(31,), activation='relu'))
     model.add(Dense(node-4, activation='relu'))
     model.add(Dense(node-8, activation='relu'))
     model.add(Dense(1, activation='sigmoid'))

Model: "sequential_67"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_308 (Dense)            (None, 12)                384
_________________________________________________________________
dense_309 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_310 (Dense)            (None, 4)                 36
_________________________________________________________________
dense_311 (Dense)            (None, 1)                 5
=================================================================
Total params: 529
Trainable params: 529
Non-trainable params: 0
_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.5510 - mse: 0.5510 - mae: 0.5510 - mape: 459883104.0000
Epoch 2/100
2/2 - 0s - loss: 0.5428 - mse: 0.5428 - mae: 0.5429 - mape: 447681984.0000
Epoch 3/100
2/2 - 0s - loss: 0.5417 - mse: 0.5417 - mae: 0.5422 - mape: 448318752.0000
Epoch 4/100
2/2 - 0s - loss: 0.5294 - mse: 0.5294 - mae: 0.5298 - mape: 433188416.0000
```

```
Epoch 5/100
2/2 - 0s - loss: 0.5245 - mse: 0.5245 - mae: 0.5248 - mape: 425491552.0000
Epoch 6/100
2/2 - 0s - loss: 0.5235 - mse: 0.5235 - mae: 0.5237 - mape: 418908256.0000
Epoch 7/100
2/2 - 0s - loss: 0.5131 - mse: 0.5131 - mae: 0.5135 - mape: 407387104.0000
```
Epoch 96/100
2/2 - 0s - loss: 0.2122 - mse: 0.2122 - mae: 0.2122 - mape: 54421992.0000
Epoch 97/100
2/2 - 0s - loss: 0.2063 - mse: 0.2063 - mae: 0.2066 - mape: 48770628.0000
Epoch 98/100
2/2 - 0s - loss: 0.2041 - mse: 0.2041 - mae: 0.2041 - mape: 46258520.0000
Epoch 99/100
2/2 - 0s - loss: 0.2041 - mse: 0.2041 - mae: 0.2041 - mape: 44897164.0000
Epoch 100/100

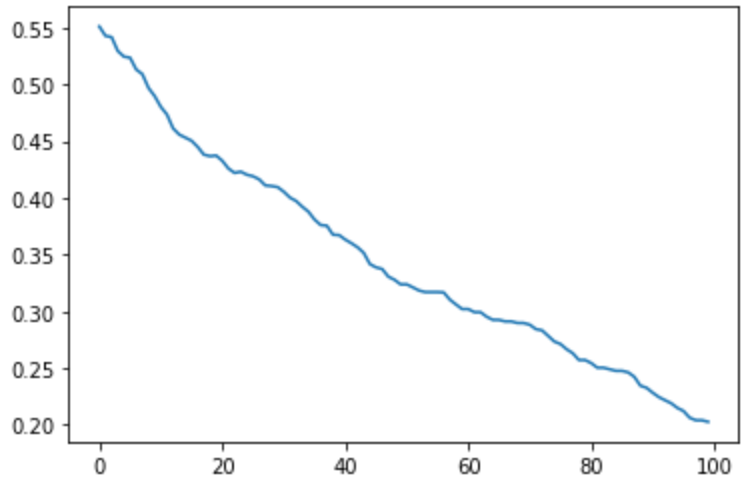
MSE : 0.2041

Processing - Node changes 60

Model: "sequential_74"

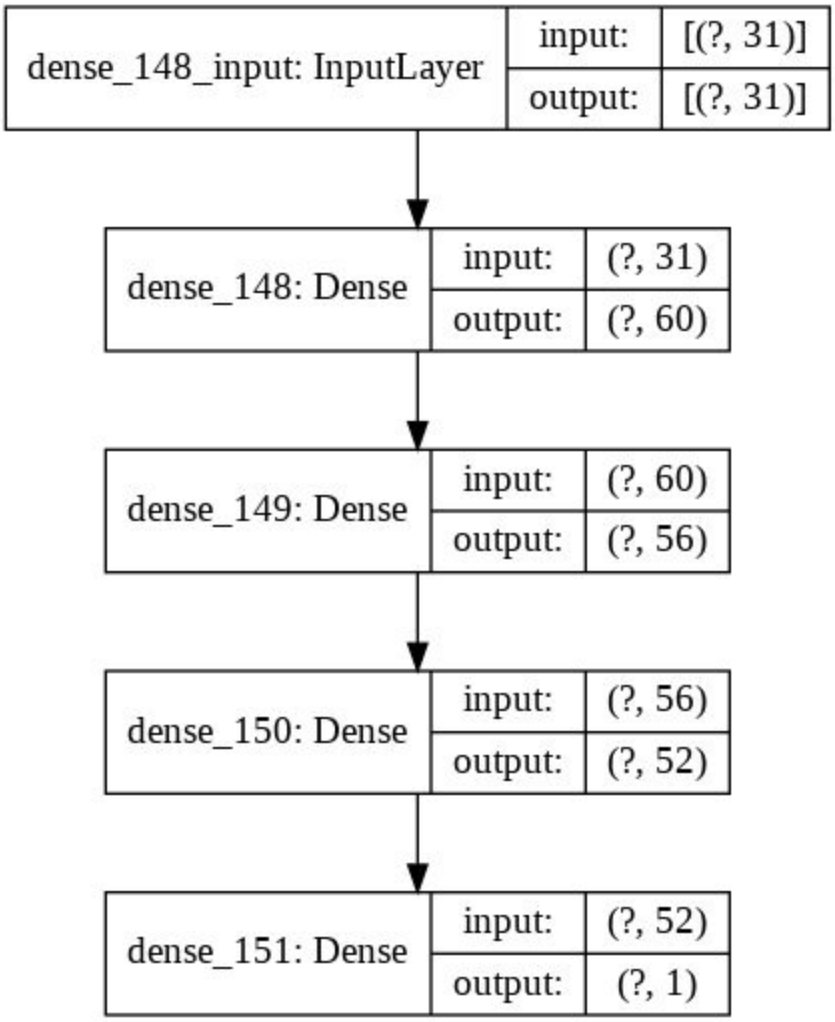
Layer (type)	Output Shape	Param #
dense_336 (Dense)	(None, 60)	1920
dense_337 (Dense)	(None, 56)	3416
dense_338 (Dense)	(None, 52)	2964
dense_339 (Dense)	(None, 1)	53

Total params: 8,353
Trainable params: 8,353
Non-trainable params: 0




```
Epoch 89/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 90/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 91/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 92/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 93/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 94/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 95/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 96/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 97/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 98/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 99/100
2/2 - 0s - loss: 0.1660 - mse: 0.1660 - mae: 0.1660 - mape: 16.5986
Epoch 100/100
```

MSE : 0.1660



 # Tanh, Relu, and Logistic activation functions.

```
fn_list = [ "tanh", "relu","sigmoid"]

print(f" Processing - activation function  changes { fn }")
     node = 16 # No. of nodes - fixed
     model.add(Dense(node , input_shape=(31,), activation=fn))
     model.add(Dense(node -4, activation=fn))
     model.add(Dense(node - 8, activation=fn))
```

```
    model.add(Dense( 1, activation=fn))
```

Processing - activation function changes tanh

Model: "sequential_55"

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_236 (Dense)            (None, 16)                512
_________________________________________________________________
dense_237 (Dense)            (None, 12)                204
_________________________________________________________________
dense_238 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_239 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_240 (Dense)            (None, 16)                32
_________________________________________________________________
dense_241 (Dense)            (None, 12)                204
_________________________________________________________________
dense_242 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_243 (Dense)            (None, 1)                 9
=================================================================

Epoch 1/100
2/2 - 0s - loss: 0.2485 - mse: 0.2485 - mae: 0.4984 - mape: 414911616.0000
Epoch 2/100
2/2 - 0s - loss: 0.2175 - mse: 0.2175 - mae: 0.4645 - mape: 372713312.0000
Epoch 3/100
2/2 - 0s - loss: 0.1901 - mse: 0.1901 - mae: 0.4286 - mape: 328104832.0000
Epoch 4/100
2/2 - 0s - loss: 0.1684 - mse: 0.1684 - mae: 0.3921 - mape: 282168896.0000
Epoch 5/100
2/2 - 0s - loss: 0.1519 - mse: 0.1519 - mae: 0.3544 - mape: 235423056.0000
Epoch 6/100
2/2 - 0s - loss: 0.1424 - mse: 0.1424 - mae: 0.3183 - mape: 190164912.0000
Epoch 7/100
2/2 - 0s - loss: 0.1389 - mse: 0.1389 - mae: 0.2849 - mape: 148323472.0000
Epoch 8/100
2/2 - 0s - loss: 0.1393 - mse: 0.1393 - mae: 0.2562 - mape: 112690400.0000
Epoch 9/100
2/2 - 0s - loss: 0.1424 - mse: 0.1424 - mae: 0.2350 - mape: 86172336.0000
Epoch 10/100
```

Processing - activation function changes relu

```
Model: "sequential_55"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_236 (Dense)            (None, 16)                512
_________________________________________________________________
dense_237 (Dense)            (None, 12)                204
_________________________________________________________________
dense_238 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_239 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_240 (Dense)            (None, 16)                32
_________________________________________________________________
dense_241 (Dense)            (None, 12)                204
_________________________________________________________________
dense_242 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_243 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_244 (Dense)            (None, 16)                32
_________________________________________________________________
dense_245 (Dense)            (None, 12)                204
_________________________________________________________________
dense_246 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_247 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_248 (Dense)            (None, 16)                32
_________________________________________________________________
dense_249 (Dense)            (None, 12)                204
_________________________________________________________________
dense_250 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_251 (Dense)            (None, 1)                 9
=================================================================
Total params: 1,876
Trainable params: 1,876
Non-trainable params: 0
_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.1638 - mse: 0.1638 - mae: 0.1743 - mape: 8790954.0000
Epoch 2/100
2/2 - 0s - loss: 0.1601 - mse: 0.1601 - mae: 0.1826 - mape: 19203358.0000
```

```
Epoch 3/100
2/2 - 0s - loss: 0.1565 - mse: 0.1565 - mae: 0.1914 - mape: 30119582.0000
Epoch 4/100
2/2 - 0s - loss: 0.1532 - mse: 0.1532 - mae: 0.2010 - mape: 42025232.0000
Epoch 5/100
2/2 - 0s - loss: 0.1498 - mse: 0.1498 - mae: 0.2111 - mape: 54631900.0000
Epoch 6/100
2/2 - 0s - loss: 0.1468 - mse: 0.1468 - mae: 0.2219 - mape: 68199400.0000
Epoch 7/100
2/2 - 0s - loss: 0.1440 - mse: 0.1440 - mae: 0.2333 - mape: 82511360.0000
Epoch 8/100
2/2 - 0s - loss: 0.1416 - mse: 0.1416 - mae: 0.2450 - mape: 97421848.0000
Epoch 9/100
2/2 - 0s - loss: 0.1402 - mse: 0.1402 - mae: 0.2575 - mape: 112953616.0000
Epoch 10/100
2/2 - 0s - loss: 0.1396 - mse: 0.1396 - mae: 0.2702 - mape: 128649344.0000
Epoch 11/100
2/2 - 0s - loss: 0.1394 - mse: 0.1394 - mae: 0.2815 - mape: 142849216.0000
Epoch 12/100



2/2 - 0s - loss: 0.1394 - mse: 0.1394 - mae: 0.2760 - mape: 135948880.0000
Epoch 99/100
2/2 - 0s - loss: 0.1394 - mse: 0.1394 - mae: 0.2750 - mape: 134735440.0000
Epoch 100/100
2/2 - 0s - loss: 0.1394 - mse: 0.1394 - mae: 0.2742 - mape: 133687088.0000
```

MSE - 0.1394

Processing - activation function changes sigmoid

```
Model: "sequential_55"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_236 (Dense)            (None, 16)                512
_________________________________________________________________
dense_237 (Dense)            (None, 12)                204
_________________________________________________________________
dense_238 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_239 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_240 (Dense)            (None, 16)                32
_________________________________________________________________
```

```
dense_241 (Dense)            (None, 12)                204
_________________________________________________________________
dense_242 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_243 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_244 (Dense)            (None, 16)                32
_________________________________________________________________
dense_245 (Dense)            (None, 12)                204
_________________________________________________________________
dense_246 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_247 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_248 (Dense)            (None, 16)                32
_________________________________________________________________
dense_249 (Dense)            (None, 12)                204
_________________________________________________________________
dense_250 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_251 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_252 (Dense)            (None, 16)                32
_________________________________________________________________
dense_253 (Dense)            (None, 12)                204
_________________________________________________________________
dense_254 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_255 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_256 (Dense)            (None, 16)                32
_________________________________________________________________
dense_257 (Dense)            (None, 12)                204
_________________________________________________________________
dense_258 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_259 (Dense)            (None, 1)                 9
=================================================================
Total params: 2,574
Trainable params: 2,574
Non-trainable params: 0
_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.4282 - mse: 0.4282 - mae: 0.6371 - mape: 588955328.0000
Epoch 2/100
2/2 - 0s - loss: 0.4227 - mse: 0.4227 - mae: 0.6337 - mape: 584730496.0000
Epoch 3/100
```

```
2/2 - 0s - loss: 0.4174 - mse: 0.4174 - mae: 0.6302 - mape: 580507648.0000
Epoch 4/100
2/2 - 0s - loss: 0.4120 - mse: 0.4120 - mae: 0.6268 - mape: 576278528.0000
Epoch 5/100
2/2 - 0s - loss: 0.4067 - mse: 0.4067 - mae: 0.6234 - mape: 572015488.0000
Epoch 6/100
2/2 - 0s - loss: 0.4014 - mse: 0.4014 - mae: 0.6199 - mape: 567723840.0000
Epoch 7/100
2/2 - 0s - loss: 0.3962 - mse: 0.3962 - mae: 0.6165 - mape: 563444800.0000
Epoch 8/100
2/2 - 0s - loss: 0.3910 - mse: 0.3910 - mae: 0.6130 - mape: 559137216.0000
Epoch 9/100
2/2 - 0s - loss: 0.3858 - mse: 0.3858 - mae: 0.6095 - mape: 554819840.0000
Epoch 10/100
2/2 - 0s - loss: 0.3806 - mse: 0.3806 - mae: 0.6060 - mape: 550477184.0000
Epoch 11/100
2/2 - 0s - loss: 0.3756 - mse: 0.3756 - mae: 0.6026 - mape: 546187648.0000
Epoch 12/100
2/2 - 0s - loss: 0.3705 - mse: 0.3705 - mae: 0.5991 - mape: 541846016.0000
Epoch 13/100
2/2 - 0s - loss: 0.3656 - mse: 0.3656 - mae: 0.5956 - mape: 537533312.0000
Epoch 14/100
2/2 - 0s - loss: 0.3607 - mse: 0.3607 - mae: 0.5921 - mape: 533212768.0000
Epoch 15/100
2/2 - 0s - loss: 0.3558 - mse: 0.3558 - mae: 0.5886 - mape: 528869952.0000
Epoch 16/100
2/2 - 0s - loss: 0.3510 - mse: 0.3510 - mae: 0.5852 - mape: 524590016.0000
Epoch 17/100
2/2 - 0s - loss: 0.3463 - mse: 0.3463 - mae: 0.5817 - mape: 520295264.0000
Epoch 18/100
2/2 - 0s - loss: 0.3417 - mse: 0.3417 - mae: 0.5783 - mape: 516026720.0000
Epoch 19/100
2/2 - 0s - loss: 0.3370 - mse: 0.3370 - mae: 0.5747 - mape: 511705632.0000
Epoch 20/100
2/2 - 0s - loss: 0.3325 - mse: 0.3325 - mae: 0.5713 - mape: 507470848.0000
Epoch 21/100
2/2 - 0s - loss: 0.3280 - mse: 0.3280 - mae: 0.5679 - mape: 503210432.0000
Epoch 22/100
2/2 - 0s - loss: 0.3236 - mse: 0.3236 - mae: 0.5645 - mape: 498992768.0000
Epoch 23/100
2/2 - 0s - loss: 0.3193 - mse: 0.3193 - mae: 0.5611 - mape: 494764064.0000
Epoch 24/100
2/2 - 0s - loss: 0.3150 - mse: 0.3150 - mae: 0.5577 - mape: 490546048.0000
Epoch 25/100
2/2 - 0s - loss: 0.3108 - mse: 0.3108 - mae: 0.5543 - mape: 486364960.0000
Epoch 26/100
```

```
2/2 - 0s - loss: 0.1672 - mse: 0.1672 - mae: 0.3915 - mape: 284575648.0000
Epoch 96/100
2/2 - 0s - loss: 0.1666 - mse: 0.1666 - mae: 0.3903 - mape: 283030912.0000
Epoch 97/100
2/2 - 0s - loss: 0.1659 - mse: 0.1659 - mae: 0.3890 - mape: 281487136.0000
Epoch 98/100
2/2 - 0s - loss: 0.1653 - mse: 0.1653 - mae: 0.3878 - mape: 279991040.0000
Epoch 99/100
2/2 - 0s - loss: 0.1647 - mse: 0.1647 - mae: 0.3866 - mape: 278499968.0000
Epoch 100/100
2/2 - 0s - loss: 0.1641 - mse: 0.1641 - mae: 0.3854 - mape: 277030912.0000
```

MSE 0.1641

Hyperparameter - Updating learning rate with different values

learning_rate_list = [0.001, 0.010, 0.1, 1]

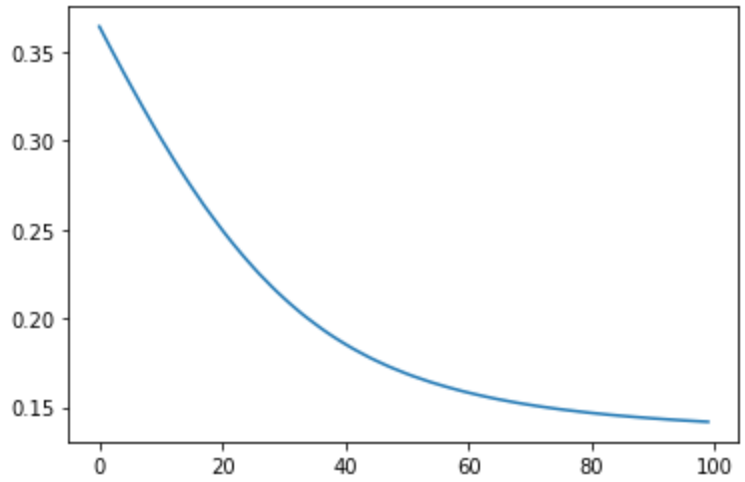
```
print(f" Processing - learning rate  changes { l_r }")
     node = 16 # No. of nodes - fixed
     model.add(Dense(node , input_shape=(31,), activation=fn))
     model.add(Dense(node -4, activation=fn))
     model.add(Dense(node - 8, activation=fn))
     model.add(Dense( 1, activation=fn))
```

```
Processing - learning rate  changes 0.001
Model: "sequential_75"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_340 (Dense)            (None, 60)                1920
_________________________________________________________________
dense_341 (Dense)            (None, 56)                3416
_________________________________________________________________
dense_342 (Dense)            (None, 52)                2964
_________________________________________________________________
```

```
dense_343 (Dense)            (None, 1)                 53
_________________________________________________________________
dense_344 (Dense)            (None, 16)                32
_________________________________________________________________
dense_345 (Dense)            (None, 12)                204
_________________________________________________________________
dense_346 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_347 (Dense)            (None, 1)                 9
=================================================================

Epoch 1/100
2/2 - 0s - loss: 0.3643 - mse: 0.3643 - mae: 0.5947 - mape: 536381312.0000
Epoch 2/100
2/2 - 0s - loss: 0.3577 - mse: 0.3577 - mae: 0.5900 - mape: 530528768.0000
Epoch 3/100
2/2 - 0s - loss: 0.3510 - mse: 0.3510 - mae: 0.5852 - mape: 524621792.0000
Epoch 4/100
2/2 - 0s - loss: 0.3446 - mse: 0.3446 - mae: 0.5804 - mape: 518719520.0000
Epoch 5/100
2/2 - 0s - loss: 0.3381 - mse: 0.3381 - mae: 0.5756 - mape: 512749888.0000
Epoch 6/100
2/2 - 0s - loss: 0.3317 - mse: 0.3317 - mae: 0.5708 - mape: 506796032.0000
Epoch 7/100
2/2 - 0s - loss: 0.3255 - mse: 0.3255 - mae: 0.5660 - mape: 500818848.0000
Epoch 8/100
2/2 - 0s - loss: 0.3193 - mse: 0.3193 - mae: 0.5611 - mape: 494807712.0000
Epoch 9/100
2/2 - 0s - loss: 0.3132 - mse: 0.3132 - mae: 0.5563 - mape: 488821376.0000
Epoch 10/100
2/2 - 0s - loss: 0.3072 - mse: 0.3072 - mae: 0.5514 - ma
```

2/2 - 0s - loss: 0.1421 - mse: 0.1421 - mae: 0.3255 - mape: 202735664.0000
Epoch 99/100
2/2 - 0s - loss: 0.1419 - mse: 0.1419 - mae: 0.3246 - mape: 201703520.0000
Epoch 100/100
2/2 - 0s - loss: 0.1417 - mse: 0.1417 - mae: 0.3238 - mape: 200701552.0000
<tensorflow.python.keras.callbacks.History object at 0x7fde56103ac8>

MSE = 0.3072



Processing - learning rate changes 0.001

Model: "sequential_75"

Layer (type)	Output Shape	Param #
dense_340 (Dense)	(None, 60)	1920
dense_341 (Dense)	(None, 56)	3416
dense_342 (Dense)	(None, 52)	2964
dense_343 (Dense)	(None, 1)	53
dense_344 (Dense)	(None, 16)	32
dense_345 (Dense)	(None, 12)	204
dense_346 (Dense)	(None, 8)	104
dense_347 (Dense)	(None, 1)	9
dense_348 (Dense)	(None, 16)	32
dense_349 (Dense)	(None, 12)	204
dense_350 (Dense)	(None, 8)	104

```
dense_351 (Dense)            (None, 1)                 9
=================================================================
Total params: 9,051
Trainable params: 9,051
Non-trainable params: 0

_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.4698 - mse: 0.4698 - mae: 0.6625 - mape: 620697856.0000
Epoch 2/100
2/2 - 0s - loss: 0.4650 - mse: 0.4650 - mae: 0.6597 - mape: 617130432.0000
Epoch 3/100
2/2 - 0s - loss: 0.4599 - mse: 0.4599 - mae: 0.6566 - mape: 613437184.0000
Epoch 4/100
2/2 - 0s - loss: 0.4551 - mse: 0.4551 - mae: 0.6538 - mape: 609836480.0000
Epoch 5/100
2/2 - 0s - loss: 0.4501 - mse: 0.4501 - mae: 0.6508 - mape: 606132672.0000
Epoch 6/100
```

Processing - learning rate changes 0.01

```
Model: "sequential_75"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_340 (Dense)            (None, 60)                1920
_________________________________________________________________
dense_341 (Dense)            (None, 56)                3416
_________________________________________________________________
dense_342 (Dense)            (None, 52)                2964
_________________________________________________________________
dense_343 (Dense)            (None, 1)                 53
_________________________________________________________________
dense_344 (Dense)            (None, 16)                32
_________________________________________________________________
dense_345 (Dense)            (None, 12)                204
_________________________________________________________________
dense_346 (Dense)            (None, 8)                 104
_________________________________________________________________
dense_347 (Dense)            (None, 1)                 9
_________________________________________________________________
dense_348 (Dense)            (None, 16)                32
_________________________________________________________________
dense_349 (Dense)            (None, 12)                204
_________________________________________________________________
dense_350 (Dense)

poch 1/100
2/2 - 0s - loss: 0.1378 - mse: 0.1378 - mae: 0.3135 - mape: 191614064.0000
```

```
Epoch 2/100
2/2 - 0s - loss: 0.1372 - mse: 0.1372 - mae: 0.3107 - mape: 188079936.0000
Epoch 3/100
2/2 - 0s - loss: 0.1367 - mse: 0.1367 - mae: 0.3078 - mape: 184612832.0000
Epoch 4/100
2/2 - 0s - loss: 0.1362 - mse: 0.1362 - mae: 0.3051 - mape: 181218944.0000
Epoch 5/100
2/2 - 0s - loss: 0.1358 - mse: 0.1358 - mae: 0.3024 - mape: 177920144.0000
Epoch 6/100
2/2 - 0s - loss: 0
2/2 - 0s - loss: 0.1329 - mse: 0.1329 - mae: 0.2649 - mape: 131811936.0000
Epoch 99/100
2/2 - 0s - loss: 0.1329 - mse: 0.1329 - mae: 0.2648 - mape: 131626288.0000
Epoch 100/100
2/2 - 0s - loss: 0.1329 - mse: 0.1329 - mae: 0.2646 - mape: 131436056.0000
<tensorflow.python.keras.callbacks.History object at 0x7fde5681cdd8>
```

dense_350 (Dense)	(None, 8)	104
dense_351 (Dense)	(None, 1)	9
dense_352 (Dense)	(None, 16)	32
dense_353 (Dense)	(None, 12)	204
dense_354 (Dense)	(None, 8)	104
dense_355 (Dense)	(None, 1)	9
dense_356 (Dense)	(None, 16)	32
dense_357 (Dense)	(None, 12)	204
dense_358 (Dense)	(None, 8)	104
dense_359 (Dense)	(None, 1)	9
dense_360 (Dense)	(None, 16)	32
dense_361 (Dense)	(None, 12)	204
dense_362 (Dense)	(None, 8)	104
dense_363 (Dense)	(None, 1)	9

```
=================================================================
Total params: 10,098
Trainable params: 10,098
Non-trainable params: 0
_________________________________________________________________
Epoch 1/100
2/2 - 0s - loss: 0.3325 - mse: 0.3325 - mae: 0.5717 - mape: 510276640.0000
Epoch 2/100
2/2 - 0s - loss: 0.3270 - mse: 0.3270 - mae: 0.5674 - mape: 505047744.0000
Epoch 3/100
2/2 - 0s - loss: 0.3216 - mse: 0.3216 - mae: 0.5632 - mape: 499807168.0000
Epoch 4/100
2/2 - 0s - loss: 0.3162 - mse: 0.3162 - mae: 0.5589 - mape: 494535232.0000
Epoch 5/100
2/2 - 0s - loss: 0.3108 - mse: 0.3108 - mae: 0.5546 - mape: 489254208.0000
Epoch 6/100
2/2 - 0s - loss: 0.3055 - mse: 0.3055 - mae: 0.5502 - mape: 483912384.0000
Epoch 7/100
2/2 - 0s - loss: 0.3003 - mse: 0.3003 - mae: 0.5459 - mape: 478637856.0000
Epoch 8/100
2/2 - 0s - loss: 0.2951 - mse: 0.2951 - mae: 0.5415 - mape: 473274368.0000
Epoch 9/100
2/2 - 0s - loss: 0.2901 - mse: 0.2901 - mae: 0.5372 - mape: 467965216.0000
Epoch 10/100
2/2 - 0s - loss: 0.2850 - mse: 0.2850 - mae: 0.5328 - mape: 462618080.0000
Epoch 11/100
2/2 - 0s - loss: 0.2802 - mse: 0.2802 - mae: 0.5285 - mape: 457305472.0000
Epoch 12/100
2/2 - 0s - loss: 0.2753 - mse: 0.2753 - mae: 0.5241 - mape: 451969216.0000
Epoch 13/100
2/2 - 0s - loss: 0.2706 - mse: 0.2706 - mae: 0.5198 - mape: 446660928.0000
Epoch 14/100
2/2 - 0s - loss: 0.2660 - mse: 0.2660 - mae: 0.5155 - mape: 441376192.0000
Epoch 15/100
2/2 - 0s - loss: 0.2614 - mse: 0.2614 - mae: 0.5111 - mape: 436100000.0000
Epoch 16/100
2/2 - 0s - loss: 0.2570 - mse: 0.2570 - mae: 0.5069 - mape: 430881888.0000
Epoch 17/100
2/2 - 0s - loss: 0.2526 - mse: 0.2526 - mae: 0.5026 - mape: 425654368.0000
Epoch 18/100
2/2 - 0s - loss: 0.2484 - mse: 0.2484 - mae: 0.4984 - mape: 420479680.0000
Epoch 19/100
2/2 - 0s - loss: 0.2442 - mse: 0.2442 - mae: 0.4941 - mape: 415317248.0000
Epoch 20/100
2/2 - 0s - loss: 0.2402 - mse: 0.2402 - mae: 0.4900 - mape: 410240704.0000
Epoch 21/100
2/2 - 0s - loss: 0.2363 - mse: 0.2363 - mae: 0.4859 - mape: 405179584.0000
```

```
Epoch 22/100
2/2 - 0s - loss: 0.2325 - mse: 0.2325 - mae: 0.4818 - mape: 400158720.0000
Epoch 23/100
2/2 - 0s - loss: 0.2288 - mse: 0.2288 - mae: 0.4777 - mape: 395178560.0000
Epoch 24/100
2/2 - 0s - loss: 0.2252 - mse: 0.2252 - mae: 0.4737 - mape: 390278432.0000
Epoch 25/100
2/2 - 0s - loss: 0.2217 - mse: 0.2217 - mae: 0.4698 - mape: 385448704.0000
Epoch 26/100
2/2 - 0s - loss: 0.2183 - mse: 0.2183 - mae: 0.4659 - mape: 380638080.0000
Epoch 27/100
2/2 - 0s - loss: 0.2150 - mse: 0.2150 - mae: 0.4620 - mape: 375906368.0000
Epoch 28/100
2/2 - 0s - loss: 0.2119 - mse: 0.2119 - mae: 0.4582 - mape: 371246848.0000
Epoch 29/100
2/2 - 0s - loss: 0.2088 - mse: 0.2088 - mae: 0.
```

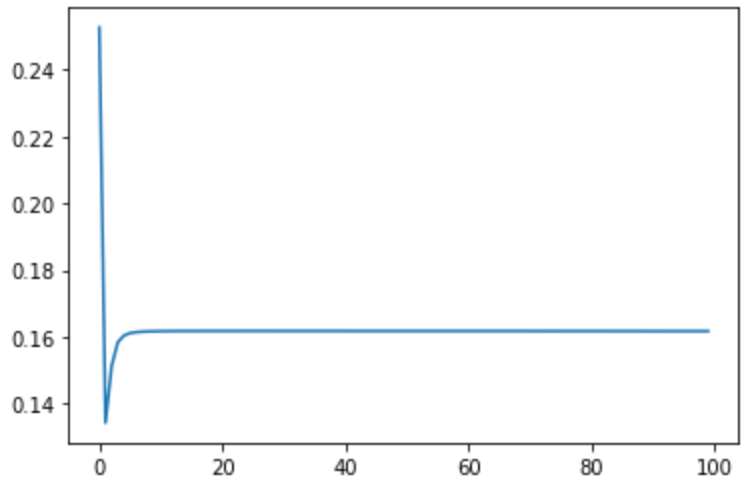
MSE 0.2088

```
momentum_list = [ 0.0, 0.2, 0.4, 0.9]

for momentum in  momentum_list:

      opt=keras.optimizers.SGD(lr=l_r, momentum=momentum)


     print(f" Processing - momemtum  changes { momentum }")
     node = 16 # No. of nodes - fixed
     model.add(Dense(node , input_shape=(31,), activation=fn))
     model.add(Dense(node -4, activation=fn))
     model.add(Dense(node - 8, activation=fn))
     model.add(Dense( 1, activation=fn))


poch 1/100
2/2 - 0s - loss: 0.3123 - mse: 0.3123 - mae: 0.5479 - mape: 483405568.0000
Epoch 2/100
2/2 - 0s - loss: 0.1458 - mse: 0.1458 - mae: 0.3518 - mape: 249633952.0000
Epoch 3/100
2/2 - 0s - loss: 0.1292 - mse: 0.1292 - mae: 0.3001 - mape: 187314096.0000
Epoch 4/100
2/2 - 0s - loss: 0.1258 - mse: 0.1258 - mae: 0.2809 - mape: 164267808.0000
```

```
Epoch 5/100
2/2 - 0s - loss: 0.1246 - mse: 0.1246 - mae: 0.2706 - mape: 151944464.0000
Epoch 6/100
2/2 - 0s - loss: 0.1240 - mse: 0.1240 - mae: 0.2643 - mape: 144419472.0000
Epoch 7/100
2/2 - 0s - loss: 0.1237 - mse: 0.1237 - mae: 0.2582 - mape: 136984800.0000
Epoch 8/100
2/2 - 0s - loss: 0.1236 - mse: 0.1236 - mae: 0.2569 - mape: 135468224.0000
Epoch 9/100
2/2 - 0s - loss: 0.1234 - mse: 0.1234 - mae: 0.2440 - mape: 120024056.0000
Epoch 100/100
2/2 - 0s - loss: 0.1234 - mse: 0.1234 - mae: 0.2448 - mape: 120934392.0000
```

poch 96/100
2/2 - 0s - loss: 0.1618 - mse: 0.1618 - mae: 0.1622 - mape: 313970.1875
Epoch 97/100
2/2 - 0s - loss: 0.1618 - mse: 0.1618 - mae: 0.1622 - mape: 317900.0312
Epoch 98/100
2/2 - 0s - loss: 0.1618 - mse: 0.1618 - mae: 0.1622 - mape: 321914.9062
Epoch 99/100
2/2 - 0s - loss: 0.1618 - mse: 0.1618 - mae: 0.1622 - mape: 326058.9688
Epoch 100/100
2/2 - 0s - loss: 0.1618 - mse: 0.1618 - mae: 0.1622 - mape: 330319.1562
<tensorflow.python.keras.callbacks.History object at 0x7f039ccf16a0>

```
MSE 0.618
```



```
early_stopping_list = [ 'min','max','auto']
for e_s in  early_stopping_list:

print(f" Processing - early stopping  changes { e_s }")
      node = 16 # No. of nodes - fixed
     model.add(Dense(node , input_shape=(31,), activation=fn))
     model.add(Dense(node -4, activation=fn))
     model.add(Dense(node - 8, activation=fn))
     model.add(Dense( 1, activation=fn))


     callback = k.callbacks.EarlyStopping(
     monitor='loss', min_delta=0.0001,patience=1)

     l_r = 1
     momentum=0.9
     opt=keras.optimizers.SGD(lr=l_r, momentum=momentum)



     history = model.fit(X_train, Y_train, validation_split=0.3,
epochs=100, callbacks=[callback])


     model.compile(optimizer=opt,loss='mse', metrics=['mse', 'mae',
'mape'])
```

odel: "sequential_17"

_____

Layer (type) Output Shape Param #

==========

dense_64 (Dense)	(None, 60)	1920
dense_65 (Dense)	(None, 56)	3416
dense_66 (Dense)	(None, 52)	2964
dense_67 (Dense)	(None, 1)	53
dense_68 (Dense)	(None, 16)	32
dense_69 (Dense)	(None, 12)	204
dense_70 (Dense)	(None, 8)	104
dense_71 (Dense)	(None, 1)	9
dense_72 (Dense)	(None, 16)	32
dense_73 (Dense)	(None, 12)	204
dense_74 (Dense)	(None, 8)	104
dense_75 (Dense)	(None, 1)	9
dense_76 (Dense)	(None, 16)	32
dense_77 (Dense)	(None, 12)	204
dense_78 (Dense)	(None, 8)	104
dense_79 (Dense)	(None, 1)	9
dense_80 (Dense)	(None, 16)	32
dense_81 (Dense)	(None, 12)	204
dense_82 (Dense)	(None, 8)	104

dense_83 (Dense)	(None, 1)	9
dense_84 (Dense)	(None, 16)	32
dense_85 (Dense)	(None, 12)	204
dense_86 (Dense)	(None, 8)	104
dense_87 (Dense)	(None, 1)	9
dense_88 (Dense)	(None, 16)	32
dense_89 (Dense)	(None, 12)	204
dense_90 (Dense)	(None, 8)	104
dense_91 (Dense)	(None, 1)	9
dense_92 (Dense)	(None, 16)	32
dense_93 (Dense)	(None, 12)	204
dense_94 (Dense)	(None, 8)	104
dense_95 (Dense)	(None, 1)	9
dense_96 (Dense)	(None, 16)	32
dense_97 (Dense)	(None, 12)	204
dense_98 (Dense)	(None, 8)	104
dense_99 (Dense)	(None, 1)	9
dense_100 (Dense)	(None, 16)	32
dense_101 (Dense)	(None, 12)	204

dense_102 (Dense)	(None, 8)	104
dense_103 (Dense)	(None, 1)	9
dense_104 (Dense)	(None, 16)	32
dense_105 (Dense)	(None, 12)	204
dense_106 (Dense)	(None, 8)	104
dense_107 (Dense)	(None, 1)	9
dense_108 (Dense)	(None, 16)	32
dense_109 (Dense)	(None, 12)	204
dense_110 (Dense)	(None, 8)	104
dense_111 (Dense)	(None, 1)	9
dense_112 (Dense)	(None, 16)	32
dense_113 (Dense)	(None, 12)	204
dense_114 (Dense)	(None, 8)	104
dense_115 (Dense)	(None, 1)	9
dense_116 (Dense)	(None, 16)	32
dense_117 (Dense)	(None, 12)	204
dense_118 (Dense)	(None, 8)	104
dense_119 (Dense)	(None, 1)	9
dense_120 (Dense)	(None, 16)	32

dense_121 (Dense)	(None, 12)	204
dense_122 (Dense)	(None, 8)	104
dense_123 (Dense)	(None, 1)	9
dense_124 (Dense)	(None, 16)	32
dense_125 (Dense)	(None, 12)	204
dense_126 (Dense)	(None, 8)	104
dense_127 (Dense)	(None, 1)	9
dense_128 (Dense)	(None, 16)	32
dense_129 (Dense)	(None, 12)	204
dense_130 (Dense)	(None, 8)	104
dense_131 (Dense)	(None, 1)	9
dense_132 (Dense)	(None, 16)	32
dense_133 (Dense)	(None, 12)	204
dense_134 (Dense)	(None, 8)	104
dense_135 (Dense)	(None, 1)	9
dense_136 (Dense)	(None, 16)	32
dense_137 (Dense)	(None, 12)	204
dense_138 (Dense)	(None, 8)	104
dense_139 (Dense)	(None, 1)	9

dense_140 (Dense)	(None, 16)	32
dense_141 (Dense)	(None, 12)	204
dense_142 (Dense)	(None, 8)	104
dense_143 (Dense)	(None, 1)	9
dense_144 (Dense)	(None, 16)	32
dense_145 (Dense)	(None, 12)	204
dense_146 (Dense)	(None, 8)	104
dense_147 (Dense)	(None, 1)	9
dense_148 (Dense)	(None, 16)	32
dense_149 (Dense)	(None, 12)	204
dense_150 (Dense)	(None, 8)	104
dense_151 (Dense)	(None, 1)	9
dense_152 (Dense)	(None, 16)	32
dense_153 (Dense)	(None, 12)	204
dense_154 (Dense)	(None, 8)	104
dense_155 (Dense)	(None, 1)	9
dense_156 (Dense)	(None, 16)	32
dense_157 (Dense)	(None, 12)	204
dense_158 (Dense)	(None, 8)	104

dense_159 (Dense)	(None, 1)	9
dense_160 (Dense)	(None, 16)	32
dense_161 (Dense)	(None, 12)	204
dense_162 (Dense)	(None, 8)	104
dense_163 (Dense)	(None, 1)	9
dense_164 (Dense)	(None, 16)	32
dense_165 (Dense)	(None, 12)	204
dense_166 (Dense)	(None, 8)	104
dense_167 (Dense)	(None, 1)	9
dense_168 (Dense)	(None, 16)	32
dense_169 (Dense)	(None, 12)	204
dense_170 (Dense)	(None, 8)	104
dense_171 (Dense)	(None, 1)	9
dense_172 (Dense)	(None, 16)	32
dense_173 (Dense)	(None, 12)	204
dense_174 (Dense)	(None, 8)	104
dense_175 (Dense)	(None, 1)	9
dense_176 (Dense)	(None, 16)	32
dense_177 (Dense)	(None, 12)	204

dense_178 (Dense) (None, 8) 104

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dense_179 (Dense) (None, 1) 9

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dense_180 (Dense) (None, 16) 32

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dense_181 (Dense) (None, 12) 204

_____

dense_182 (Dense) (None, 8) 104

_____

dense_183 (Dense) (None, 1) 9

_____

dense_184 (Dense) (None, 16) 32

_____

dense_185 (Dense) (None, 12) 204

_____

dense_186 (Dense) (None, 8) 104

_____

dense_187 (Dense) (None, 1) 9

_____

dense_188 (Dense) (None, 16) 32

_____

dense_189 (Dense) (None, 12) 204

_____

dense_190 (Dense) (None, 8) 104

_____

dense_191 (Dense) (None, 1) 9

==========

Total params: 19,172

Trainable params: 19,172

Non-trainable params: 0

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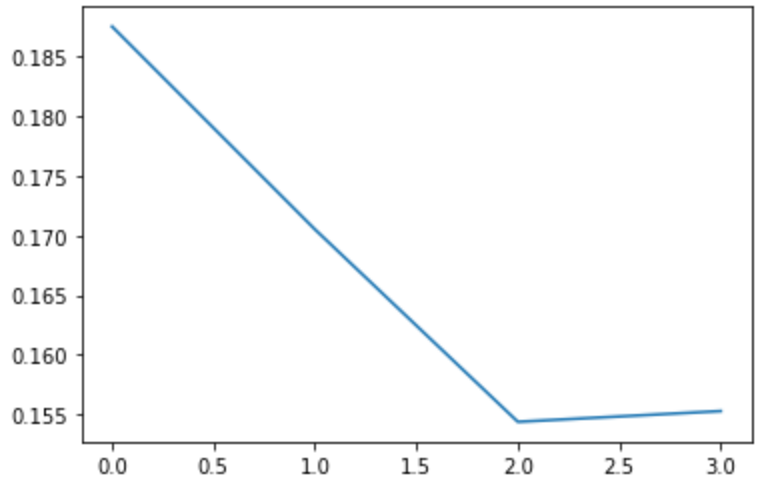
Epoch 1/100

17/17 [==========] - 1s 57ms/step - loss: 0.1875 - mse: 0.1875 - mae: 0.1960 - mape: 6989005.0000 - val_loss: 0.3391 - val_mse: 0.3391 - val_mae: 0.5768 - val_mape: 516953184.0000

Epoch 2/100

17/17 [==============================] - 0s 14ms/step - loss: 0.1705 - mse: 0.1705 - mae: 0.2414 - mape: 66502712.0000 - val_loss: 0.3389 - val_mse: 0.3389 - val_mae: 0.5767 - val_mape: 516783136.0000
Epoch 3/100
17/17 [==============================] - 0s 14ms/step - loss: 0.1544 - mse: 0.1544 - mae: 0.3089 - mape: 155124736.0000 - val_loss: 0.3390 - val_mse: 0.3390 - val_mae: 0.5767 - val_mape: 516838272.0000
Epoch 4/100
17/17 [==============================] - 0s 14ms/step - loss: 0.1553 - mse: 0.1553 - mae: 0.3190 - mape: 167551120.0000 - val_loss: 0.3390 - val_mse: 0.3390 - val_mae: 0.5767 - val_mape: 516856224.0000
<tensorflow.python.keras.callbacks.History object at 0x7f037768d710>



Layer (type)	Output Shape	Param #
dense_64 (Dense)	(None, 60)	1920
dense_65 (Dense)	(None, 56)	3416
dense_66 (Dense)	(None, 52)	2964
dense_67 (Dense)	(None, 1)	53
dense_68 (Dense)	(None, 16)	32

dense_69 (Dense)	(None, 12)	204
dense_70 (Dense)	(None, 8)	104
dense_71 (Dense)	(None, 1)	9
dense_72 (Dense)	(None, 16)	32
dense_73 (Dense)	(None, 12)	204
dense_74 (Dense)	(None, 8)	104
dense_75 (Dense)	(None, 1)	9
dense_76 (Dense)	(None, 16)	32
dense_77 (Dense)	(None, 12)	204
dense_78 (Dense)	(None, 8)	104
dense_79 (Dense)	(None, 1)	9
dense_80 (Dense)	(None, 16)	32
dense_81 (Dense)	(None, 12)	204
dense_82 (Dense)	(None, 8)	104
dense_83 (Dense)	(None, 1)	9
dense_84 (Dense)	(None, 16)	32
dense_85 (Dense)	(None, 12)	204
dense_86 (Dense)	(None, 8)	104
dense_87 (Dense)	(None, 1)	9

dense_88 (Dense)	(None, 16)	32
dense_89 (Dense)	(None, 12)	204
dense_90 (Dense)	(None, 8)	104
dense_91 (Dense)	(None, 1)	9
dense_92 (Dense)	(None, 16)	32
dense_93 (Dense)	(None, 12)	204
dense_94 (Dense)	(None, 8)	104
dense_95 (Dense)	(None, 1)	9
dense_96 (Dense)	(None, 16)	32
dense_97 (Dense)	(None, 12)	204
dense_98 (Dense)	(None, 8)	104
dense_99 (Dense)	(None, 1)	9
dense_100 (Dense)	(None, 16)	32
dense_101 (Dense)	(None, 12)	204
dense_102 (Dense)	(None, 8)	104
dense_103 (Dense)	(None, 1)	9
dense_104 (Dense)	(None, 16)	32
dense_105 (Dense)	(None, 12)	204
dense_106 (Dense)	(None, 8)	104

dense_107 (Dense)	(None, 1)	9
dense_108 (Dense)	(None, 16)	32
dense_109 (Dense)	(None, 12)	204
dense_110 (Dense)	(None, 8)	104
dense_111 (Dense)	(None, 1)	9
dense_112 (Dense)	(None, 16)	32
dense_113 (Dense)	(None, 12)	204
dense_114 (Dense)	(None, 8)	104
dense_115 (Dense)	(None, 1)	9
dense_116 (Dense)	(None, 16)	32
dense_117 (Dense)	(None, 12)	204
dense_118 (Dense)	(None, 8)	104
dense_119 (Dense)	(None, 1)	9
dense_120 (Dense)	(None, 16)	32
dense_121 (Dense)	(None, 12)	204
dense_122 (Dense)	(None, 8)	104
dense_123 (Dense)	(None, 1)	9
dense_124 (Dense)	(None, 16)	32
dense_125 (Dense)	(None, 12)	204

dense_126 (Dense)	(None, 8)	104
dense_127 (Dense)	(None, 1)	9
dense_128 (Dense)	(None, 16)	32
dense_129 (Dense)	(None, 12)	204
dense_130 (Dense)	(None, 8)	104
dense_131 (Dense)	(None, 1)	9
dense_132 (Dense)	(None, 16)	32
dense_133 (Dense)	(None, 12)	204
dense_134 (Dense)	(None, 8)	104
dense_135 (Dense)	(None, 1)	9
dense_136 (Dense)	(None, 16)	32
dense_137 (Dense)	(None, 12)	204
dense_138 (Dense)	(None, 8)	104
dense_139 (Dense)	(None, 1)	9
dense_140 (Dense)	(None, 16)	32
dense_141 (Dense)	(None, 12)	204
dense_142 (Dense)	(None, 8)	104
dense_143 (Dense)	(None, 1)	9
dense_144 (Dense)	(None, 16)	32

dense_145 (Dense)	(None, 12)	204
dense_146 (Dense)	(None, 8)	104
dense_147 (Dense)	(None, 1)	9
dense_148 (Dense)	(None, 16)	32
dense_149 (Dense)	(None, 12)	204
dense_150 (Dense)	(None, 8)	104
dense_151 (Dense)	(None, 1)	9
dense_152 (Dense)	(None, 16)	32
dense_153 (Dense)	(None, 12)	204
dense_154 (Dense)	(None, 8)	104
dense_155 (Dense)	(None, 1)	9
dense_156 (Dense)	(None, 16)	32
dense_157 (Dense)	(None, 12)	204
dense_158 (Dense)	(None, 8)	104
dense_159 (Dense)	(None, 1)	9
dense_160 (Dense)	(None, 16)	32
dense_161 (Dense)	(None, 12)	204
dense_162 (Dense)	(None, 8)	104
dense_163 (Dense)	(None, 1)	9

dense_164 (Dense)	(None, 16)	32
dense_165 (Dense)	(None, 12)	204
dense_166 (Dense)	(None, 8)	104
dense_167 (Dense)	(None, 1)	9
dense_168 (Dense)	(None, 16)	32
dense_169 (Dense)	(None, 12)	204
dense_170 (Dense)	(None, 8)	104
dense_171 (Dense)	(None, 1)	9
dense_172 (Dense)	(None, 16)	32
dense_173 (Dense)	(None, 12)	204
dense_174 (Dense)	(None, 8)	104
dense_175 (Dense)	(None, 1)	9
dense_176 (Dense)	(None, 16)	32
dense_177 (Dense)	(None, 12)	204
dense_178 (Dense)	(None, 8)	104
dense_179 (Dense)	(None, 1)	9
dense_180 (Dense)	(None, 16)	32
dense_181 (Dense)	(None, 12)	204
dense_182 (Dense)	(None, 8)	104

dense_183 (Dense)	(None, 1)	9
dense_184 (Dense)	(None, 16)	32
dense_185 (Dense)	(None, 12)	204
dense_186 (Dense)	(None, 8)	104
dense_187 (Dense)	(None, 1)	9
dense_188 (Dense)	(None, 16)	32
dense_189 (Dense)	(None, 12)	204
dense_190 (Dense)	(None, 8)	104
dense_191 (Dense)	(None, 1)	9
dense_192 (Dense)	(None, 16)	32
dense_193 (Dense)	(None, 12)	204
dense_194 (Dense)	(None, 8)	104
dense_195 (Dense)	(None, 1)	9
dense_196 (Dense)	(None, 16)	32
dense_197 (Dense)	(None, 12)	204
dense_198 (Dense)	(None, 8)	104
dense_199 (Dense)	(None, 1)	9
dense_200 (Dense)	(None, 16)	32
dense_201 (Dense)	(None, 12)	204

dense_202 (Dense) (None, 8) 104

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dense_203 (Dense) (None, 1) 9

===

Total params: 20,219

Trainable params: 20,219

Non-trainable params: 0

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Epoch 1/100

17/17 [==============================] - 1s 61ms/step - loss: 0.1468 - mse: 0.1468 - mae: 0.2789 - mape: 134038776.0000 - val_loss: 0.1338 - val_mse: 0.1338 - val_mae: 0.2813 - val_mape: 151367200.0000

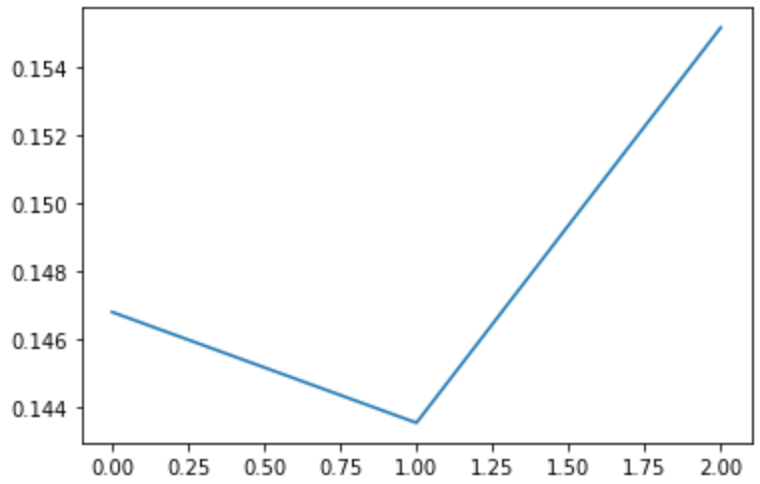
Epoch 2/100

17/17 [==============================] - 0s 16ms/step - loss: 0.1435 - mse: 0.1435 - mae: 0.2663 - mape: 119554168.0000 - val_loss: 0.1373 - val_mse: 0.1373 - val_mae: 0.3097 - val_mape: 186410816.0000

Epoch 3/100

17/17 [==============================] - 0s 16ms/step - loss: 0.1551 - mse: 0.1551 - mae: 0.2649 - mape: 118791144.0000 - val_loss: 0.1438 - val_mse: 0.1438 - val_mae: 0.1966 - val_mape: 47138352.0000

<tensorflow.python.keras.callbacks.History object at 0x7f03738116a0>



/usr/local/lib/python3.6/dist-packages/pandas/core/frame.py:4174: SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
errors=errors,
Processing - early stopping changes auto
Model: "sequential_17"

Layer (type)	Output Shape	Param #
dense_64 (Dense)	(None, 60)	1920
dense_65 (Dense)	(None, 56)	3416
dense_66 (Dense)	(None, 52)	2964
dense_67 (Dense)	(None, 1)	53
dense_68 (Dense)	(None, 16)	32
dense_69 (Dense)	(None, 12)	204
dense_70 (Dense)	(None, 8)	104
dense_71 (Dense)	(None, 1)	9
dense_72 (Dense)	(None, 16)	32
dense_73 (Dense)	(None, 12)	204
dense_74 (Dense)	(None, 8)	104
dense_75 (Dense)	(None, 1)	9
dense_76 (Dense)	(None, 16)	32
dense_77 (Dense)	(None, 12)	204
dense_78 (Dense)	(None, 8)	104

dense_79 (Dense)	(None, 1)	9
dense_80 (Dense)	(None, 16)	32
dense_81 (Dense)	(None, 12)	204
dense_82 (Dense)	(None, 8)	104
dense_83 (Dense)	(None, 1)	9
dense_84 (Dense)	(None, 16)	32
dense_85 (Dense)	(None, 12)	204
dense_86 (Dense)	(None, 8)	104
dense_87 (Dense)	(None, 1)	9
dense_88 (Dense)	(None, 16)	32
dense_89 (Dense)	(None, 12)	204
dense_90 (Dense)	(None, 8)	104
dense_91 (Dense)	(None, 1)	9
dense_92 (Dense)	(None, 16)	32
dense_93 (Dense)	(None, 12)	204
dense_94 (Dense)	(None, 8)	104
dense_95 (Dense)	(None, 1)	9
dense_96 (Dense)	(None, 16)	32
dense_97 (Dense)	(None, 12)	204

dense_98 (Dense)	(None, 8)	104
dense_99 (Dense)	(None, 1)	9
dense_100 (Dense)	(None, 16)	32
dense_101 (Dense)	(None, 12)	204
dense_102 (Dense)	(None, 8)	104
dense_103 (Dense)	(None, 1)	9
dense_104 (Dense)	(None, 16)	32
dense_105 (Dense)	(None, 12)	204
dense_106 (Dense)	(None, 8)	104
dense_107 (Dense)	(None, 1)	9
dense_108 (Dense)	(None, 16)	32
dense_109 (Dense)	(None, 12)	204
dense_110 (Dense)	(None, 8)	104
dense_111 (Dense)	(None, 1)	9
dense_112 (Dense)	(None, 16)	32
dense_113 (Dense)	(None, 12)	204
dense_114 (Dense)	(None, 8)	104
dense_115 (Dense)	(None, 1)	9
dense_116 (Dense)	(None, 16)	32

dense_117 (Dense)	(None, 12)	204
dense_118 (Dense)	(None, 8)	104
dense_119 (Dense)	(None, 1)	9
dense_120 (Dense)	(None, 16)	32
dense_121 (Dense)	(None, 12)	204
dense_122 (Dense)	(None, 8)	104
dense_123 (Dense)	(None, 1)	9
dense_124 (Dense)	(None, 16)	32
dense_125 (Dense)	(None, 12)	204
dense_126 (Dense)	(None, 8)	104
dense_127 (Dense)	(None, 1)	9
dense_128 (Dense)	(None, 16)	32
dense_129 (Dense)	(None, 12)	204
dense_130 (Dense)	(None, 8)	104
dense_131 (Dense)	(None, 1)	9
dense_132 (Dense)	(None, 16)	32
dense_133 (Dense)	(None, 12)	204
dense_134 (Dense)	(None, 8)	104
dense_135 (Dense)	(None, 1)	9

dense_136 (Dense)	(None, 16)	32
dense_137 (Dense)	(None, 12)	204
dense_138 (Dense)	(None, 8)	104
dense_139 (Dense)	(None, 1)	9
dense_140 (Dense)	(None, 16)	32
dense_141 (Dense)	(None, 12)	204
dense_142 (Dense)	(None, 8)	104
dense_143 (Dense)	(None, 1)	9
dense_144 (Dense)	(None, 16)	32
dense_145 (Dense)	(None, 12)	204
dense_146 (Dense)	(None, 8)	104
dense_147 (Dense)	(None, 1)	9
dense_148 (Dense)	(None, 16)	32
dense_149 (Dense)	(None, 12)	204
dense_150 (Dense)	(None, 8)	104
dense_151 (Dense)	(None, 1)	9
dense_152 (Dense)	(None, 16)	32
dense_153 (Dense)	(None, 12)	204
dense_154 (Dense)	(None, 8)	104

dense_155 (Dense)	(None, 1)	9
dense_156 (Dense)	(None, 16)	32
dense_157 (Dense)	(None, 12)	204
dense_158 (Dense)	(None, 8)	104
dense_159 (Dense)	(None, 1)	9
dense_160 (Dense)	(None, 16)	32
dense_161 (Dense)	(None, 12)	204
dense_162 (Dense)	(None, 8)	104
dense_163 (Dense)	(None, 1)	9
dense_164 (Dense)	(None, 16)	32
dense_165 (Dense)	(None, 12)	204
dense_166 (Dense)	(None, 8)	104
dense_167 (Dense)	(None, 1)	9
dense_168 (Dense)	(None, 16)	32
dense_169 (Dense)	(None, 12)	204
dense_170 (Dense)	(None, 8)	104
dense_171 (Dense)	(None, 1)	9
dense_172 (Dense)	(None, 16)	32
dense_173 (Dense)	(None, 12)	204

dense_174 (Dense)	(None, 8)	104
dense_175 (Dense)	(None, 1)	9
dense_176 (Dense)	(None, 16)	32
dense_177 (Dense)	(None, 12)	204
dense_178 (Dense)	(None, 8)	104
dense_179 (Dense)	(None, 1)	9
dense_180 (Dense)	(None, 16)	32
dense_181 (Dense)	(None, 12)	204
dense_182 (Dense)	(None, 8)	104
dense_183 (Dense)	(None, 1)	9
dense_184 (Dense)	(None, 16)	32
dense_185 (Dense)	(None, 12)	204
dense_186 (Dense)	(None, 8)	104
dense_187 (Dense)	(None, 1)	9
dense_188 (Dense)	(None, 16)	32
dense_189 (Dense)	(None, 12)	204
dense_190 (Dense)	(None, 8)	104
dense_191 (Dense)	(None, 1)	9
dense_192 (Dense)	(None, 16)	32

dense_193 (Dense)	(None, 12)	204
dense_194 (Dense)	(None, 8)	104
dense_195 (Dense)	(None, 1)	9
dense_196 (Dense)	(None, 16)	32
dense_197 (Dense)	(None, 12)	204
dense_198 (Dense)	(None, 8)	104
dense_199 (Dense)	(None, 1)	9
dense_200 (Dense)	(None, 16)	32
dense_201 (Dense)	(None, 12)	204
dense_202 (Dense)	(None, 8)	104
dense_203 (Dense)	(None, 1)	9
dense_204 (Dense)	(None, 16)	32
dense_205 (Dense)	(None, 12)	204
dense_206 (Dense)	(None, 8)	104
dense_207 (Dense)	(None, 1)	9

Total params: 20,568

Trainable params: 20,568

Non-trainable params: 0

Epoch 1/100

17/17 [==============================] - 1s 62ms/step - loss: 0.1547 - mse: 0.1547 - mae: 0.3035 - mape: 151697712.0000 - val_loss: 0.1174 - val_mse: 0.1174 - val_mae: 0.2296 - val_mape: 111305184.0000
Epoch 2/100
17/17 [==============================] - 0s 16ms/step - loss: 0.1610 - mse: 0.1610 - mae: 0.2928 - mape: 130924760.0000 - val_loss: 0.1186 - val_mse: 0.1186 - val_mae: 0.2611 - val_mape: 148672512.0000
<tensorflow.python.keras.callbacks.History object at 0x7f036ff9fa90>

Summary:

Trained the model by changing parameters:

Processing the model using Node = [12,24,36,48,60] obtained "Accuracy" [0.9995, 0.9995,0.9991, 1.000 and 0.9991] for MNIST Data set and "MSE" for Kaggle Data set[0.1578,0.1578,0.1483,0.1741,0.1381,0.1578]

Processing the model using Tanh, Relu, and Logistic activation functions. [Tanh , Relu and Logistic activation Fn] obtained 'Accuracy' [0.9981, 0.9991, 0.9981] and 'MSE" for Kaggle Data set [0.1394,0.1311,0.1338]

Processing the model using Learning Rate [0.001, 0.010, 0.1, 1] obtained "Accuracy' [0.9981, 0.9986, 0.9991,0.9986,] and MSE" for Kaggle Data set [0.136,0.1640,0.1421,0.1283,0.1316]

Processing the model using
Momentum [0.0, 0.2, 0.4, 0.9] obtained "Accuracy" [0.9995, 0.9986, 0.9981,0.9986] and "MSE" for Kaggle Data set [0.1234,0.1282,0.1456,0.1348]

Processing the model using
Early Stopping [min, max,auto] obtained "Accuracy" [0.9976, 0.9991,0.9986] and "MSE" for Kaggle Data set [0.1553,0.1673,0,1419]

Overall Accuracy is 100% with different inputs of the above parameters
And MSE is 0.1553.

Thank you