In [ ]:

```
# Deep Learning
# Practical No : 01
```

In [ ]:

```
import tensorflow as tf
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn import metrics
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
from tqdm.notebook import tqdm
import warnings
warnings.filterwarnings("ignore")
```

In [ ]:

```
boston = tf.keras.datasets.boston_housing
```

In [ ]:

```
dir(boston)
```

Out[ ]:

```
['__builtins__',
 '__cached__',
 '__doc__',
 '__file__',
 '__loader__',
 '__name__',
 '__package__',
 '__path__',
 '__spec__',
 'load_data']
```

In [ ]:

```
boston_data = boston.load_data()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/
boston_housing.npz
57026/57026 [==============================] - 0s 0us/step
```

In [ ]:

```
(x_train, y_train), (x_test, y_test) = tf.keras.datasets.boston_housing.load_data(p
```

In [ ]:

```
x_train.shape, y_train.shape, x_test.shape, y_test.shape
```

Out[ ]:

```
((404, 13), (404,), (102, 13), (102,))
```

In [ ]:

```
scaler = StandardScaler()
```

In [ ]:

```
x_train_scaled = scaler.fit_transform(x_train)
x_test_scaled = scaler.transform(x_test)

y_train_scaled = scaler.fit_transform(y_train.reshape(-1, 1))
y_test_scaled = scaler.transform(y_test.reshape(-1, 1))
```

In [ ]:

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Input(shape=(13), name='input-layer'),
    tf.keras.layers.Dense(100, name='hidden-layer-2'),
    tf.keras.layers.BatchNormalization(name='hidden-layer-3'),
    tf.keras.layers.Dense(50, name='hidden-layer-4'),
    tf.keras.layers.Dense(1, name='output-layer')
])
```

In [ ]:

```
model.summary()
```

```
Model: "sequential_10"

_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 hidden-layer-2 (Dense)      (None, 100)               1400      
                                                                 
 hidden-layer-3 (BatchNorma  (None, 100)               400       
 lization)                                                       
                                                                 
 hidden-layer-4 (Dense)      (None, 50)                5050      
                                                                 
 output-layer (Dense)        (None, 1)                 51        
                                                                 
=================================================================
Total params: 6901 (26.96 KB)
Trainable params: 6701 (26.18 KB)
Non-trainable params: 200 (800.00 Byte)
_________________________________________________________________
```

In [ ]:

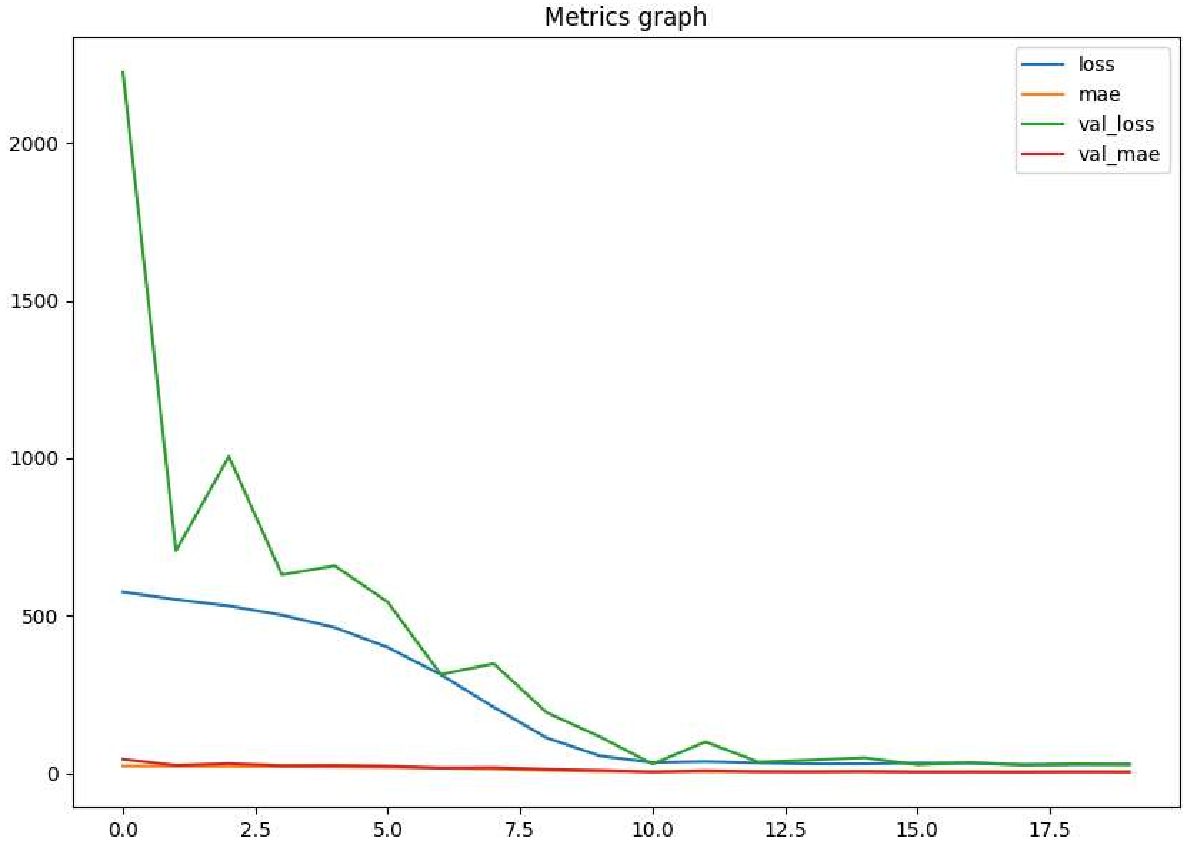
```
model.compile(
    optimizer='adam',
    loss='mse',
    metrics=['mae']
)
```

In [ ]:

```
history = model.fit(x_train, y_train, batch_size=32, epochs=20, validation_data=(x_
Epoch 1/20
13/13 [==============================] - 1s 18ms/step - loss: 574.8789 - mae: 22.3
634 - val_loss: 2224.5266 - val_mae: 44.4160
Epoch 2/20
13/13 [==============================] - 0s 7ms/step - loss: 550.9838 - mae: 22.02
51 - val_loss: 705.3503 - val_mae: 24.4563
Epoch 3/20
13/13 [==============================] - 0s 7ms/step - loss: 530.6443 - mae: 21.60
95 - val_loss: 1005.8787 - val_mae: 30.3659
Epoch 4/20
13/13 [==============================] - 0s 6ms/step - loss: 501.7632 - mae: 21.04
24 - val_loss: 629.7626 - val_mae: 23.7866
Epoch 5/20
13/13 [==============================] - 0s 7ms/step - loss: 462.1404 - mae: 20.13
91 - val_loss: 658.0805 - val_mae: 24.4096
Epoch 6/20
13/13 [==============================] - 0s 6ms/step - loss: 399.1111 - mae: 18.72
22 - val_loss: 542.7188 - val_mae: 22.2311
Epoch 7/20
13/13 [==============================] - 0s 7ms/step - loss: 312.8028 - mae: 16.42
44 - val_loss: 313.3749 - val_mae: 16.6600
Epoch 8/20
13/13 [==============================] - 0s 6ms/step - loss: 209.3056 - mae: 13.10
72 - val_loss: 347.4641 - val_mae: 17.6651
Epoch 9/20
13/13 [==============================] - 0s 7ms/step - loss: 112.0523 - mae: 8.919
0 - val_loss: 192.2844 - val_mae: 12.5691
Epoch 10/20
13/13 [==============================] - 0s 7ms/step - loss: 55.1853 - mae: 5.6105
- val_loss: 115.9377 - val_mae: 9.1478
Epoch 11/20
13/13 [==============================] - 0s 6ms/step - loss: 33.7891 - mae: 4.2850
- val_loss: 29.2040 - val_mae: 3.8567
Epoch 12/20
13/13 [==============================] - 0s 7ms/step - loss: 36.9304 - mae: 4.4974
- val_loss: 99.4068 - val_mae: 8.0226
Epoch 13/20
13/13 [==============================] - 0s 6ms/step - loss: 32.5308 - mae: 4.2865
- val_loss: 35.6296 - val_mae: 4.8049
Epoch 14/20
13/13 [==============================] - 0s 6ms/step - loss: 29.5778 - mae: 4.0588
- val_loss: 41.9396 - val_mae: 4.5167
Epoch 15/20
13/13 [==============================] - 0s 7ms/step - loss: 29.4901 - mae: 4.0193
- val_loss: 49.0794 - val_mae: 5.6884
Epoch 16/20
13/13 [==============================] - 0s 6ms/step - loss: 32.3794 - mae: 4.1094
- val_loss: 26.8985 - val_mae: 3.5455
Epoch 17/20
13/13 [==============================] - 0s 7ms/step - loss: 31.6614 - mae: 4.0583
- val_loss: 33.6451 - val_mae: 3.8305
Epoch 18/20
13/13 [==============================] - 0s 7ms/step - loss: 26.4994 - mae: 3.7155
- val_loss: 26.4998 - val_mae: 3.4068
Epoch 19/20
13/13 [==============================] - 0s 7ms/step - loss: 27.2167 - mae: 3.8110
```

```
- val_loss: 29.5473 - val_mae: 4.1069
Epoch 20/20
13/13 [==============================] - 0s 7ms/step - loss: 27.8241 - mae: 3.9048
- val_loss: 27.6318 - val_mae: 3.7487
```

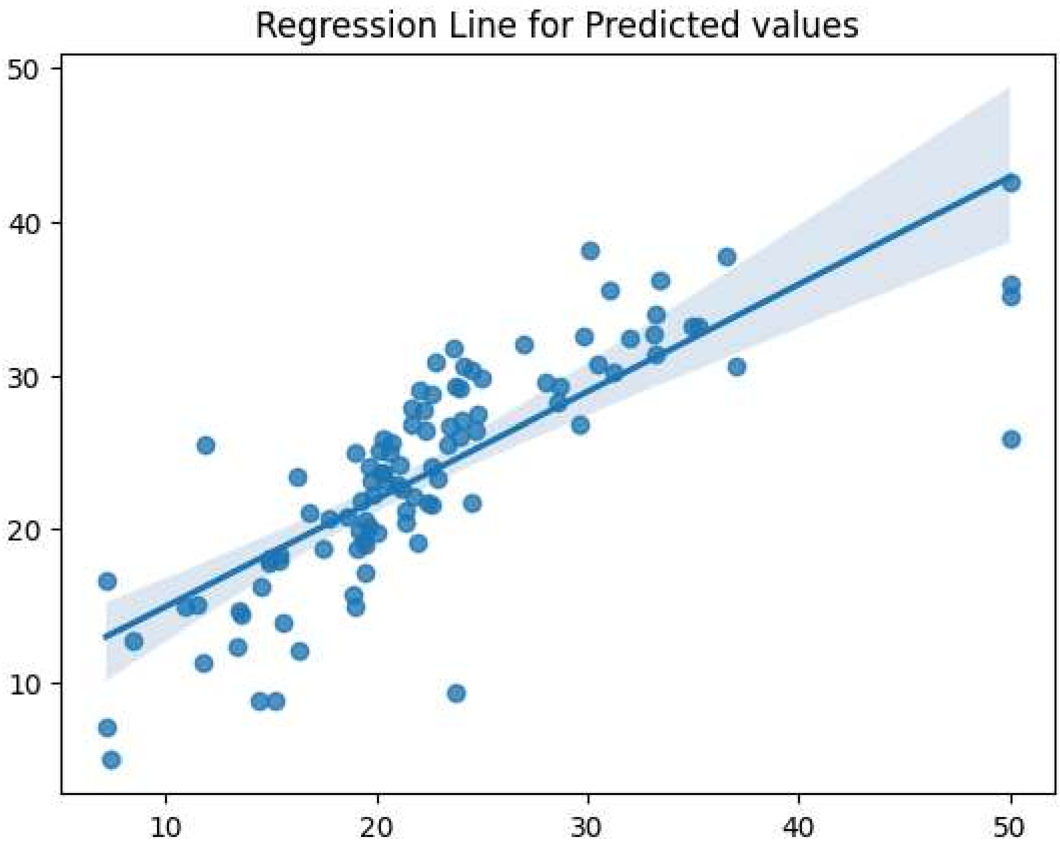
```
In [ ]: pd.DataFrame(history.history).plot(figsize=(10,7))
        plt.title("Metrics graph")
        plt.show()
```



```
In [ ]: y_pred = model.predict(x_test)
```

```
4/4 [==============================] - 0s 4ms/step
```

```
In [ ]: sns.regplot(x=y_test, y=y_pred)
        plt.title("Regression Line for Predicted values")
        plt.show()
```



In [ ]:

```
def regression_metrics_display(y_test, y_pred):
  print(f"MAE is {metrics.mean_absolute_error(y_test, y_pred)}")
  print(f"MSE is {metrics.mean_squared_error(y_test,y_pred)}")
  print(f"R2 score is {metrics.r2_score(y_test, y_pred)}")
```

In [ ]:

```
regression_metrics_display(y_test, y_pred)
```

```
MAE is 3.7487237733953136
MSE is 27.631791791938596
R2 score is 0.6119240015553091
```