Assingnment No- 01

Title: Linear regression by using Deep Neural network: Implement Boston housing price.prediction problem by linear regression using Deep Neural network. Use Boston House price prediction dataset.

```
import numpy as np
import pandas as pd
from sklearn.datasets import load_boston

boston = load_boston()
data = pd.DataFrame(boston.data)

data.head()

data.columns = boston.feature_names
```

	0	1	2	3	4	5	6	7	8	9	10	11	12
0	0.00632	18.0	2.31	0.0	0.538	6.575	65.2	4.0900	1.0	296.0	15.3	396.90	4.98
1	0.02731	0.0	7.07	0.0	0.469	6.421	78.9	4.9671	2.0	242.0	17.8	396.90	9.14
2	0.02729	0.0	7.07	0.0	0.469	7.185	61.1	4.9671	2.0	242.0	17.8	392.83	4.03
3	0.03237	0.0	2.18	0.0	0.458	6.998	45.8	6.0622	3.0	222.0	18.7	394.63	2.94
4	0.06905	0.0	2.18	0.0	0.458	7.147	54.2	6.0622	3.0	222.0	18.7	396.90	5.33

```
data['PRICE'] = boston.target

data.head(n=10)
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	PRICE
0	0.00632	18.0	2.31	0.0	0.538	6.575	65.2	4.0900	1.0	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0.0	0.469	6.421	78.9	4.9671	2.0	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0.0	0.469	7.185	61.1	4.9671	2.0	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0.0	0.458	6.998	45.8	6.0622	3.0	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0.0	0.458	7.147	54.2	6.0622	3.0	222.0	18.7	396.90	5.33	36.2
5	0.02985	0.0	2.18	0.0	0.458	6.430	58.7	6.0622	3.0	222.0	18.7	394.12	5.21	28.7
6	0.08829	12.5	7.87	0.0	0.524	6.012	66.6	5.5605	5.0	311.0	15.2	395.60	12.43	22.9
7	0.14455	12.5	7.87	0.0	0.524	6.172	96.1	5.9505	5.0	311.0	15.2	396.90	19.15	27.1
8	0.21124	12.5	7.87	0.0	0.524	5.631	100.0	6.0821	5.0	311.0	15.2	386.63	29.93	16.5
9	0.17004	12.5	7.87	0.0	0.524	6.004	85.9	6.5921	5.0	311.0	15.2	386.71	17.10	18.9

```
print(data.shape)
```

```
data.isnull().sum()
```

```
CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
PRICE      0
dtype: int64
```

```
data.describe()
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO
count	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000
mean	3.613524	11.363636	11.136779	0.069170	0.554695	6.284634	68.574901	3.795043	9.549407	408.237154	18.455534
std	8.601545	23.322453	6.860353	0.253994	0.115878	0.702617	28.148861	2.105710	8.707259	168.537116	2.164946
min	0.006320	0.000000	0.460000	0.000000	0.385000	3.561000	2.900000	1.129600	1.000000	187.000000	12.600000
25%	0.082045	0.000000	5.190000	0.000000	0.449000	5.885500	45.025000	2.100175	4.000000	279.000000	17.400000
50%	0.256510	0.000000	9.690000	0.000000	0.538000	6.208500	77.500000	3.207450	5.000000	330.000000	19.050000
75%	3.677083	12.500000	18.100000	0.000000	0.624000	6.623500	94.075000	5.188425	24.000000	666.000000	20.200000
max	88.976200	100.000000	27.740000	1.000000	0.871000	8.780000	100.000000	12.126500	24.000000	711.000000	22.000000

```
data.info()
```

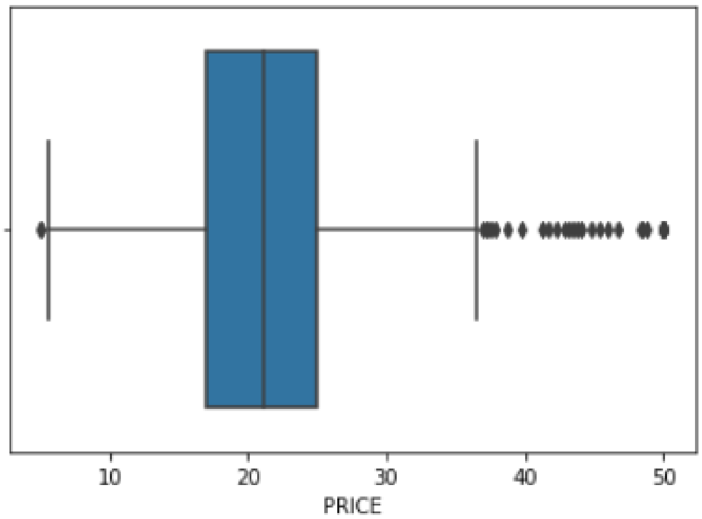
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 14 columns):
 #    Column   Non-Null Count   Dtype
---   ------   --------------   -----
 0    CRIM     506 non-null     float64
 1    ZN       506 non-null     float64
 2    INDUS    506 non-null     float64
 3    CHAS     506 non-null     float64
 4    NOX      506 non-null     float64
 5    RM       506 non-null     float64
 6    AGE      506 non-null     float64
 7    DIS      506 non-null     float64
 8    RAD      506 non-null     float64
 9    TAX      506 non-null     float64
 10   PTRATIO  506 non-null     float64
 11   B        506 non-null     float64
 12   LSTAT    506 non-null     float64
 13   PRICE    506 non-null     float64
dtypes: float64(14)
memory usage: 55.5 KB
```

```
import seaborn as sns
```

```
sns.distplot(data.PRICE)
```

```
 sns.boxplot(data.PRICE)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f44d077ed60>
```

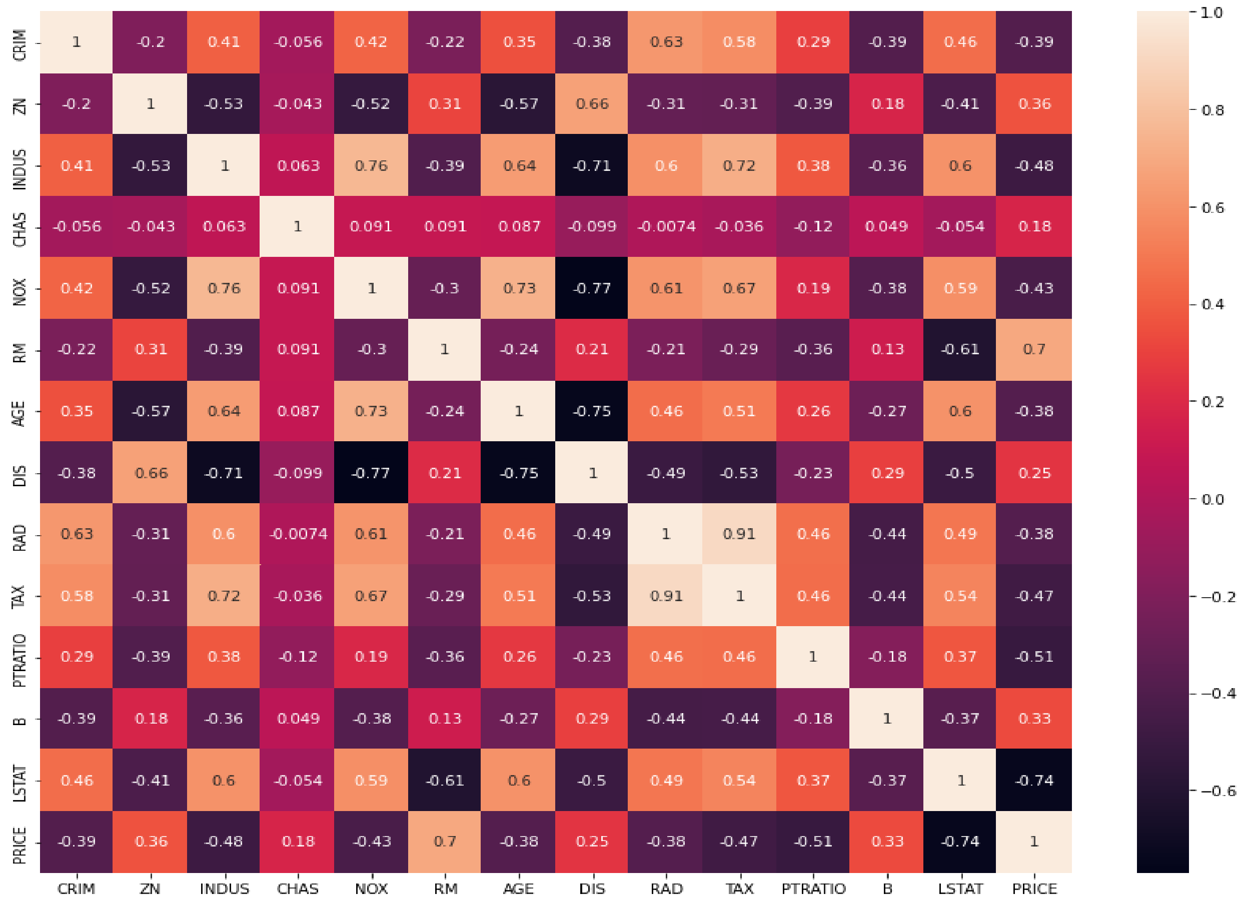



```
correlation = data.corr()
correlation.loc['PRICE']
```

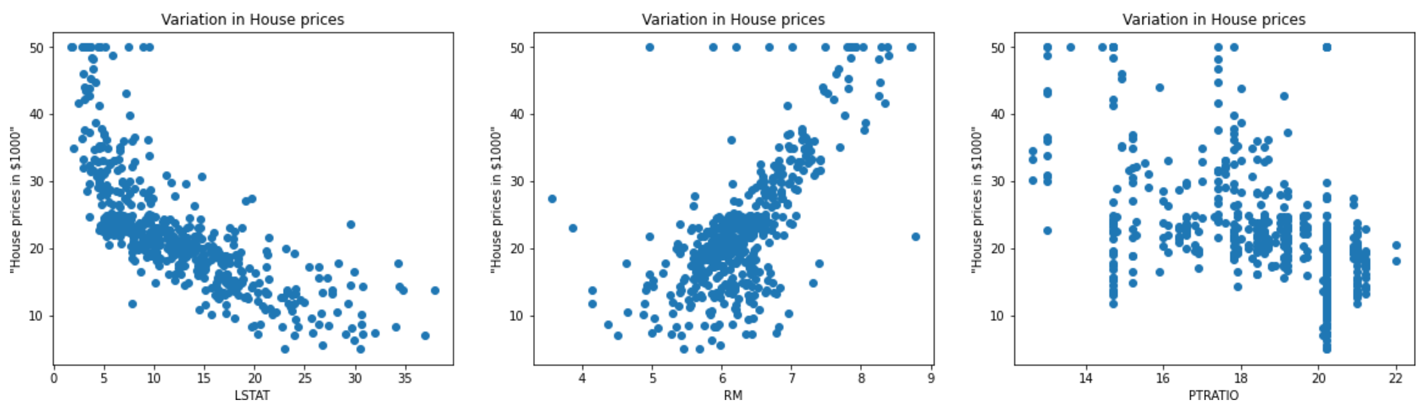
```
CRIM       -0.388305


ZN          0.360445
INDUS      -0.483725
CHAS        0.175260
NOX        -0.427321
RM          0.695360
AGE        -0.376955
DIS         0.249929
RAD        -0.381626
TAX        -0.468536
PTRATIO    -0.507787
B           0.333461
LSTAT      -0.737663
PRICE       1.000000
```

```
Name: PRICE, dtype: float64
```

```python
import matplotlib.pyplot as plt
fig,axes = plt.subplots(figsize=(15,12))
sns.heatmap(correlation,square = True,annot = True)
```



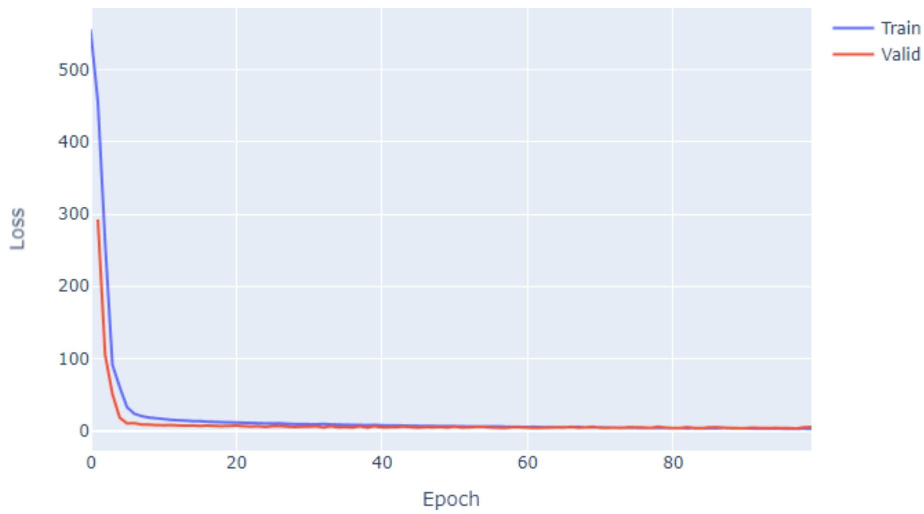
```
plt.figure(figsize = (20,5))

features = ['LSTAT','RM','PTRATIO']
for i, col in enumerate(features):
    plt.subplot(1, len(features) , i+1)
    x = data[col]

    y = data.PRICE
    plt.scatter(x, y, marker='o')
    plt.title("Variation in House prices")
    plt.xlabel(col)

    plt.ylabel('"House prices in $1000"')
```



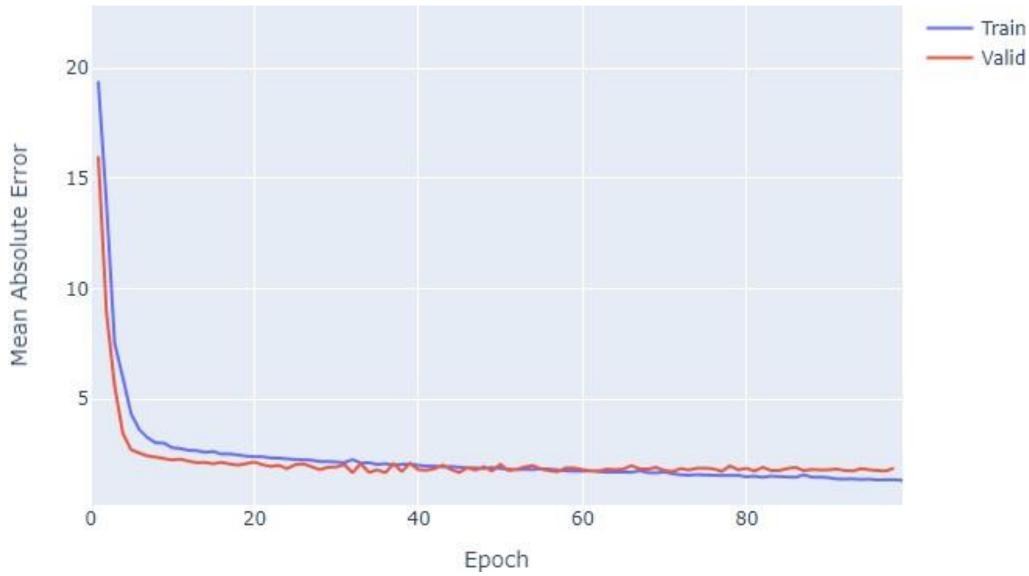

```
X = data.iloc[:,:-1]
y= data.PRICE

mean = X_train.mean(axis=0)
std = X_train.std(axis=0)


X_train = (X_train - mean) / std
X_test = (X_test - mean) / std
#Linear Regression

from sklearn.linear_model import LinearRegression
```

```python
regressor = LinearRegression()
regressor.fit(X_train,y_train)


y_pred = regressor.predict(X_test)


from sklearn.metrics import mean_squared_error
rmse = (np.sqrt(mean_squared_error(y_test, y_pred)))
print(rmse)


from sklearn.metrics import r2_score
r2 = r2_score(y_test, y_pred)
print(r2)
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
import keras
from keras.layers import Dense, Activation,Dropout
from keras.models import Sequential


model = Sequential()
model.add(Dense(128,activation  = 'relu',input_dim =13))
model.add(Dense(64,activation  = 'relu'))
```

```
model.add(Dense(32,activation         =
'relu'))  model.add(Dense(16,activation
= 'relu')) model.add(Dense(1))

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

!pip install ann_visualizer

!pip install graphviz

from ann_visualizer.visualize import
ann_viz;

ann_viz(model, title="DEMO ANN");

history = model.fit(X_train, y_train, epochs=100, validation_split=0.05)

from       plotly.subplots       import
make_subplots                    import
plotly.graph_objects as go


fig = go.Figure()
fig.add_trace(go.Scattergl(y=history.history['loss
'],

                    name='Train'))


fig.add_trace(go.Scattergl(y=history.history['val_loss'],

                    name='Valid'))



fig.update_layout(height=500, width=700,

                  xaxis_title='Epoc
                  h',
                  yaxis_title='Loss
                  ')

fig.show()
```




```
fig = go.Figure()

fig.add_trace(go.Scattergl(y=history.history['mae'],
                           name='Train'))

fig.add_trace(go.Scattergl(y=history.history['val_mae'],
                           name='Valid'))


fig.update_layout(height=500, width=700,
                  xaxis_title='Epoch',
                  yaxis_title='Mean Absolute
                  Error')
fig.show()
```




```
y_pred =
model.predict(X_test)

mse_nn, mae_nn = model.evaluate(X_test, y_test)


print('Mean squared error on test data: ',
mse_nn) print('Mean absolute error on test data:
', mae_nn)
```

4/4 [==============================] - 0s 4ms/step - loss: 10.5717 - mae: 2.2670

Mean squared error on test data: 10.571733474731445 Mean absolute error on test data: 2.2669904232025146

```
#Comparison with traditional
approaches

#First let's try with a simple algorithm, the Linear Regression:
from sklearn.metrics import mean_absolute_error


lr_model =
LinearRegression()
lr_model.fit(X_train,
y_train)

y_pred_lr = lr_model.predict(X_test)
```

```
mse_lr = mean_squared_error(y_test,
y_pred_lr) mae_lr =
mean_absolute_error(y_test, y_pred_lr)


print('Mean squared error on test data: ',
mse_lr) print('Mean absolute error on test data:
', mae_lr)from sklearn.metrics import r2_score

r2 = r2_score(y_test,
y_pred)print(r2)
```

```
0.8812832788381159
```

```
# Predicting RMSE the Test set results

from sklearn.metrics import mean_squared_error

rmse = (np.sqrt(mean_squared_error(y_test,
y_pred)))print(rmse)
```

```
3.320768607496587
```

```
# Make predictions on new
dataimport sklearn

new_data = sklearn.preprocessing.StandardScaler().fit_transform(([[0.1,
10.0,5.0, 0, 0.4, 6.0, 50, 6.0, 1, 400, 20, 300, 10]]))

prediction = model.predict(new_data)
print("Predicted house price:",
prediction)
```