In [1]:
```
from keras.models import Sequential
from keras.layers import Dense
from keras.optimizers import Adam

import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, mean_squared_error
```

```
WARNING:tensorflow:From c:\Users\ADMIN\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\losses.py:2976: The name tf.losses.sparse_softmax_cross_entropy is deprecated. Please use tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```

In [2]:
```
dataset = pd.read_csv('DelhiAQI.csv')
```

In [3]:
```
dataSet = dataset.dropna()
for i in dataSet.columns:
    if i != 'AQI':
        dataSet[i] = (dataSet[i] - dataSet[i].mean()) / (dataSet[i].std())
x = dataSet.drop('AQI', axis = 1)
y = dataSet['AQI']
```

In [4]:
```
#  Add a fully connected layer with 32 neurons with sigmoid activation and glorot unifo
#  Add a fully connected layer layer with 16 neurons, relu activation and he uniform as
#  Add a fully a connected layer with ] neuron, relu activation function and he uniform
#  Use Adam optimizer with batch size 16, learning rate 0.01 and epochs set to 20.

def model1(x_train, x_val, y_train, y_val):
    model = Sequential()
    model.add(Dense(32, activation = 'sigmoid', kernel_initializer = 'glorot_uniform'))
    model.add(Dense(16, activation = 'relu', kernel_initializer = 'he_uniform'))
    model.add(Dense(1, activation = 'relu', kernel_initializer = 'he_uniform'))
    model.compile(optimizer = Adam(learning_rate = 0.01), loss = 'mean_squared_error')
    model.fit(x_train, y_train, batch_size = 16, epochs = 20, validation_data = (x_val,
    return model

count = 5
avg_mse = 0
for i in range(count):
    x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_s
    x_train, x_val, y_train, y_val = train_test_split(x_train, y_train, test_size = 0.2
    model = model1(x_train, x_val, y_train, y_val)
    y_pred = model.predict(x_test)
    y_pred = np.round(y_pred)
    mse = mean_squared_error(y_test, y_pred)
    avg_mse += mse
    print('MSE:', mse)
print('Average MSE:', avg_mse/count)
```

```
WARNING:tensorflow:From c:\Users\ADMIN\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

Epoch 1/20
```

```
WARNING:tensorflow:From c:\Users\ADMIN\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

563/563 [==============================] - 2s 2ms/step - loss: 24489.2441 - val_loss: 3203.0957
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3232.0947 - val_loss: 3071.1687
Epoch 3/20
563/563 [==============================] - 1s 2ms/step - loss: 3115.3020 - val_loss: 2977.6670
Epoch 4/20
563/563 [==============================] - 1s 2ms/step - loss: 3065.9846 - val_loss: 2904.0859
Epoch 5/20
563/563 [==============================] - 1s 2ms/step - loss: 3014.4788 - val_loss: 2899.5879
Epoch 6/20
563/563 [==============================] - 1s 2ms/step - loss: 2986.8000 - val_loss: 2861.4678
Epoch 7/20
563/563 [==============================] - 1s 2ms/step - loss: 2941.3560 - val_loss: 2831.6914
Epoch 8/20
563/563 [==============================] - 1s 2ms/step - loss: 2897.4492 - val_loss: 2793.0593
Epoch 9/20
563/563 [==============================] - 1s 2ms/step - loss: 2859.7131 - val_loss: 2744.9087
Epoch 10/20
563/563 [==============================] - 1s 2ms/step - loss: 2832.1465 - val_loss: 2727.3730
Epoch 11/20
563/563 [==============================] - 1s 2ms/step - loss: 2813.3367 - val_loss: 2713.4844
Epoch 12/20
563/563 [==============================] - 1s 2ms/step - loss: 2772.6340 - val_loss: 2711.3958
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2755.8218 - val_loss: 2738.8076
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2735.4966 - val_loss: 2677.2649
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2713.2134 - val_loss: 2649.7886
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2691.1716 - val_loss: 2785.6965
Epoch 17/20
563/563 [==============================] - 1s 1ms/step - loss: 2680.9761 - val_loss: 2695.4182
Epoch 18/20
563/563 [==============================] - 1s 1ms/step - loss: 2657.9922 - val_loss: 2640.6631
Epoch 19/20
563/563 [==============================] - 1s 2ms/step - loss: 2644.9766 - val_loss: 2644.9155
```

```
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2641.0212 - val_loss: 267
2.1331
94/94 [==============================] - 0s 882us/step
MSE: 2877.0986666666668
Epoch 1/20
563/563 [==============================] - 1s 2ms/step - loss: 13411.6748 - val_loss: 31
72.9368
Epoch 2/20
563/563 [==============================] - 1s 1ms/step - loss: 3219.0515 - val_loss: 301
1.9680
Epoch 3/20
563/563 [==============================] - 1s 1ms/step - loss: 3107.7129 - val_loss: 301
7.1572
Epoch 4/20
563/563 [==============================] - 1s 1ms/step - loss: 3047.6104 - val_loss: 295
0.8904
Epoch 5/20
563/563 [==============================] - 1s 1ms/step - loss: 3006.2295 - val_loss: 285
1.2866
Epoch 6/20
563/563 [==============================] - 1s 1ms/step - loss: 2972.0793 - val_loss: 282
6.2839
Epoch 7/20
563/563 [==============================] - 1s 1ms/step - loss: 2932.3965 - val_loss: 281
5.2866
Epoch 8/20
563/563 [==============================] - 1s 1ms/step - loss: 2910.7141 - val_loss: 283
6.5703
Epoch 9/20
563/563 [==============================] - 1s 1ms/step - loss: 2884.0176 - val_loss: 290
5.6357
Epoch 10/20
563/563 [==============================] - 1s 1ms/step - loss: 2848.5105 - val_loss: 273
1.9019
Epoch 11/20
563/563 [==============================] - 1s 1ms/step - loss: 2813.4351 - val_loss: 273
5.1326
Epoch 12/20
563/563 [==============================] - 1s 1ms/step - loss: 2797.8425 - val_loss: 268
6.5164
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2774.7664 - val_loss: 272
2.7251
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2748.7512 - val_loss: 284
3.0427
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2735.7766 - val_loss: 265
5.0994
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2732.0146 - val_loss: 264
6.8418
Epoch 17/20
563/563 [==============================] - 1s 2ms/step - loss: 2708.3665 - val_loss: 266
5.3547
Epoch 18/20
563/563 [==============================] - 1s 2ms/step - loss: 2697.7234 - val_loss: 265
7.4404
Epoch 19/20
```

```
563/563 [==============================] - 1s 2ms/step - loss: 2666.7188 - val_loss: 264
0.8010
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2673.2539 - val_loss: 260
0.2537
94/94 [==============================] - 0s 1ms/step
MSE: 2835.4306666666666
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 10048.1768 - val_loss: 30
87.7444
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3199.2217 - val_loss: 300
9.0623
Epoch 3/20
563/563 [==============================] - 1s 2ms/step - loss: 3119.2898 - val_loss: 307
5.0273
Epoch 4/20
563/563 [==============================] - 1s 2ms/step - loss: 3058.2529 - val_loss: 305
3.3496
Epoch 5/20
563/563 [==============================] - 1s 2ms/step - loss: 3029.0427 - val_loss: 293
2.6743
Epoch 6/20
563/563 [==============================] - 1s 2ms/step - loss: 2963.1125 - val_loss: 302
9.9751
Epoch 7/20
563/563 [==============================] - 1s 2ms/step - loss: 2929.1521 - val_loss: 283
3.4456
Epoch 8/20
563/563 [==============================] - 1s 2ms/step - loss: 2902.5222 - val_loss: 279
9.4553
Epoch 9/20
563/563 [==============================] - 1s 2ms/step - loss: 2861.4756 - val_loss: 279
4.9788
Epoch 10/20
563/563 [==============================] - 1s 2ms/step - loss: 2824.8552 - val_loss: 272
9.1509
Epoch 11/20
563/563 [==============================] - 1s 2ms/step - loss: 2793.4592 - val_loss: 274
1.2097
Epoch 12/20
563/563 [==============================] - 1s 2ms/step - loss: 2773.4839 - val_loss: 277
1.1367
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2753.0452 - val_loss: 272
8.2256
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2740.1248 - val_loss: 272
3.4185
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2711.4072 - val_loss: 267
0.8801
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2699.0891 - val_loss: 271
3.0732
Epoch 17/20
563/563 [==============================] - 1s 2ms/step - loss: 2692.0728 - val_loss: 279
2.1396
Epoch 18/20
563/563 [==============================] - 1s 2ms/step - loss: 2685.3728 - val_loss: 267
```

```
2.0293
Epoch 19/20
563/563 [==============================] - 1s 2ms/step - loss: 2662.9072 - val_loss: 262
8.2400
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2667.3950 - val_loss: 268
7.8345
94/94 [==============================] - 0s 1ms/step
MSE: 2847.6516666666666
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 13545.2256 - val_loss: 31
97.6963
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3223.1665 - val_loss: 298
8.7739
Epoch 3/20
563/563 [==============================] - 1s 2ms/step - loss: 3116.9751 - val_loss: 296
1.3760
Epoch 4/20
563/563 [==============================] - 1s 2ms/step - loss: 3062.6819 - val_loss: 290
0.9177
Epoch 5/20
563/563 [==============================] - 1s 2ms/step - loss: 3016.3901 - val_loss: 293
7.6963
Epoch 6/20
563/563 [==============================] - 1s 2ms/step - loss: 2967.3621 - val_loss: 287
3.5063
Epoch 7/20
563/563 [==============================] - 1s 2ms/step - loss: 2922.2131 - val_loss: 281
5.0623
Epoch 8/20
563/563 [==============================] - 1s 2ms/step - loss: 2882.1140 - val_loss: 284
2.3604
Epoch 9/20
563/563 [==============================] - 1s 2ms/step - loss: 2863.1038 - val_loss: 285
4.7356
Epoch 10/20
563/563 [==============================] - 1s 2ms/step - loss: 2842.4009 - val_loss: 280
2.3997
Epoch 11/20
563/563 [==============================] - 1s 2ms/step - loss: 2825.4868 - val_loss: 275
1.0684
Epoch 12/20
563/563 [==============================] - 1s 2ms/step - loss: 2783.0098 - val_loss: 290
1.1499
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2779.2693 - val_loss: 274
2.0781
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2738.8765 - val_loss: 269
6.4431
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2729.0564 - val_loss: 269
5.2974
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2712.5166 - val_loss: 271
0.9666
Epoch 17/20
563/563 [==============================] - 1s 2ms/step - loss: 2708.0012 - val_loss: 274
4.9619
```

```
Epoch 18/20
563/563 [==============================] - 1s 2ms/step - loss: 2694.9663 - val_loss: 267
3.3359
Epoch 19/20
563/563 [==============================] - 1s 2ms/step - loss: 2678.7932 - val_loss: 270
0.2034
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2654.4368 - val_loss: 264
6.3879
94/94 [==============================] - 0s 947us/step
MSE: 2808.5176666666666
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 10850.6777 - val_loss: 32
44.0952
Epoch 2/20
563/563 [==============================] - 1s 1ms/step - loss: 3209.7517 - val_loss: 299
7.1943
Epoch 3/20
563/563 [==============================] - 1s 2ms/step - loss: 3108.2852 - val_loss: 297
0.3589
Epoch 4/20
563/563 [==============================] - 1s 2ms/step - loss: 3056.7200 - val_loss: 297
7.9487
Epoch 5/20
563/563 [==============================] - 1s 2ms/step - loss: 3019.1050 - val_loss: 295
7.1772
Epoch 6/20
563/563 [==============================] - 1s 2ms/step - loss: 2975.7439 - val_loss: 300
4.7903
Epoch 7/20
563/563 [==============================] - 1s 2ms/step - loss: 2917.4839 - val_loss: 291
2.8643
Epoch 8/20
563/563 [==============================] - 1s 2ms/step - loss: 2895.5940 - val_loss: 275
2.8796
Epoch 9/20
563/563 [==============================] - 1s 2ms/step - loss: 2863.9775 - val_loss: 278
3.2529
Epoch 10/20
563/563 [==============================] - 1s 2ms/step - loss: 2812.1646 - val_loss: 278
4.3367
Epoch 11/20
563/563 [==============================] - 1s 2ms/step - loss: 2803.7661 - val_loss: 274
1.3489
Epoch 12/20
563/563 [==============================] - 1s 2ms/step - loss: 2774.4409 - val_loss: 289
5.8213
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2755.1890 - val_loss: 274
2.5522
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2742.2349 - val_loss: 273
3.1187
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2718.3545 - val_loss: 268
7.6545
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2705.0876 - val_loss: 272
7.4702
Epoch 17/20
```

```
563/563 [==============================] - 1s 2ms/step - loss: 2692.3413 - val_loss: 267
8.0186
Epoch 18/20
563/563 [==============================] - 1s 2ms/step - loss: 2671.2805 - val_loss: 265
8.8293
Epoch 19/20
563/563 [==============================] - 1s 2ms/step - loss: 2665.6064 - val_loss: 260
6.7502
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2651.1147 - val_loss: 258
0.2629
94/94 [==============================] - 0s 1ms/step
MSE: 2801.2006666666666
Average MSE: 2833.979866666667
```

In [7]:

```
# Add a fully connected layer with 32 neurons with sigmoid activation and glorot uniform
# Add a fully connected layer layer with 8 a neurons, sigmoid activation and glorot norm
# Add a fully a connected layer ith neuron, relu activation function and he uniform as k
# Use Adam optimizer with batch size 8. learning rate 0.01 and epochs set to 20.
# Extract the features from second last fully connected layer (having 8 neurons) and mod

from keras.models import Model
from sklearn.svm import SVR

def model2(x_train, x_val, y_train, y_val):
    model = Sequential()
    model.add(Dense(32, activation = 'sigmoid', kernel_initializer = 'glorot_uniform'))
    model.add(Dense(8, activation = 'sigmoid', kernel_initializer = 'glorot_normal'))
    model.add(Dense(1, activation = 'relu', kernel_initializer = 'he_uniform'))
    model.compile(optimizer = Adam(learning_rate = 0.01), loss = 'mean_squared_error')
    model.fit(x_train, y_train, batch_size = 8, epochs = 20, validation_data = (x_val, y
    model = Model(inputs = model.input, outputs = model.get_layer(index = 2).output)
    return model

count = 5
avg_mse = 0
for i in range(count):
    x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_st
    x_train, x_val, y_train, y_val = train_test_split(x_train, y_train, test_size = 0.2
    model = model2(x_train, x_val, y_train, y_val)
    x_train = model.predict(x_train)
    x_val = model.predict(x_val)
    x_test = model.predict(x_test)
    model = SVR()
    model.fit(x_train, y_train)
    y_pred = model.predict(x_test)
    y_pred = np.round(y_pred)
    mse = mean_squared_error(y_test, y_pred)
    avg_mse += mse
    print('MSE:', mse)
print('Average MSE:', avg_mse/count)
```

```
Epoch 1/20
1125/1125 [==============================] - 5s 4ms/step - loss: 69392.6406 - val_loss:
50657.1992
Epoch 2/20
1125/1125 [==============================] - 4s 3ms/step - loss: 39403.9531 - val_loss:
28324.6426
Epoch 3/20
```

```
1125/1125 [==============================] - 3s 3ms/step - loss: 22277.0801 - val_loss:
16134.6904
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 13347.3672 - val_loss:
9656.1211
Epoch 5/20
1125/1125 [==============================] - 4s 4ms/step - loss: 8051.7031 - val_loss: 6
164.1860
Epoch 6/20
1125/1125 [==============================] - 4s 3ms/step - loss: 5515.6450 - val_loss: 4
480.5068
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4338.4961 - val_loss: 3
808.3450
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3788.0232 - val_loss: 3
491.0483
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3487.6472 - val_loss: 3
400.2173
Epoch 10/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3306.2317 - val_loss: 3
165.8943
Epoch 11/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3135.6753 - val_loss: 3
063.8867
Epoch 12/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3003.5095 - val_loss: 3
004.0940
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2925.4773 - val_loss: 2
910.4946
Epoch 14/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2844.7334 - val_loss: 2
819.6416
Epoch 15/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2782.9399 - val_loss: 2
835.8118
Epoch 16/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2743.6501 - val_loss: 2
823.4824
Epoch 17/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2698.1702 - val_loss: 2
724.5962
Epoch 18/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2662.2744 - val_loss: 2
708.2913
Epoch 19/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2639.0190 - val_loss: 2
685.8408
Epoch 20/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2609.9370 - val_loss: 2
694.1152
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
MSE: 2948.920666666667
Epoch 1/20
1125/1125 [==============================] - 3s 2ms/step - loss: 68150.3281 - val_loss:
50232.2578
```

```
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 39252.5781 - val_loss:
28345.7617
Epoch 3/20
1125/1125 [==============================] - 3s 2ms/step - loss: 22328.7070 - val_loss:
15929.0508
Epoch 4/20
1125/1125 [==============================] - 3s 2ms/step - loss: 12038.9443 - val_loss:
8151.7500
Epoch 5/20
1125/1125 [==============================] - 3s 2ms/step - loss: 6818.8677 - val_loss: 5
242.5938
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4805.1963 - val_loss: 4
058.0747
Epoch 7/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3981.8872 - val_loss: 3
634.0183
Epoch 8/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3577.9617 - val_loss: 3
336.7974
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3304.2419 - val_loss: 3
135.6699
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3130.9893 - val_loss: 2
991.7917
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2998.0613 - val_loss: 2
912.6824
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2913.0051 - val_loss: 2
811.8821
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2855.5754 - val_loss: 2
868.7400
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2799.5757 - val_loss: 2
761.2046
Epoch 15/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2742.8245 - val_loss: 2
824.2510
Epoch 16/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2703.6021 - val_loss: 2
762.8257
Epoch 17/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2669.6838 - val_loss: 2
633.4331
Epoch 18/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2639.2944 - val_loss: 2
685.6045
Epoch 19/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2597.8049 - val_loss: 2
608.6250
Epoch 20/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2579.7241 - val_loss: 2
670.0762
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
```

```
MSE: 2927.458
Epoch 1/20
1125/1125 [==============================] - 3s 2ms/step - loss: 70246.5625 - val_loss:
54451.3164
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 44181.1094 - val_loss:
33438.0898
Epoch 3/20
1125/1125 [==============================] - 3s 2ms/step - loss: 27062.4688 - val_loss:
20211.9902
Epoch 4/20
1125/1125 [==============================] - 3s 2ms/step - loss: 16823.3594 - val_loss:
12976.6123
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 10714.6777 - val_loss:
7988.6826
Epoch 6/20
1125/1125 [==============================] - 3s 2ms/step - loss: 7000.2251 - val_loss: 5
533.5049
Epoch 7/20
1125/1125 [==============================] - 3s 2ms/step - loss: 5141.5225 - val_loss: 4
310.1387
Epoch 8/20
1125/1125 [==============================] - 3s 2ms/step - loss: 4247.4395 - val_loss: 3
774.9807
Epoch 9/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3813.8813 - val_loss: 3
497.0000
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3544.0977 - val_loss: 3
334.8884
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3319.0322 - val_loss: 3
147.7681
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3149.9822 - val_loss: 3
037.4814
Epoch 13/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3026.8079 - val_loss: 2
945.1704
Epoch 14/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2958.7236 - val_loss: 2
954.4187
Epoch 15/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2901.4573 - val_loss: 2
865.0393
Epoch 16/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2838.8228 - val_loss: 2
882.7854
Epoch 17/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2784.6531 - val_loss: 2
796.6370
Epoch 18/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2733.8523 - val_loss: 2
758.7383
Epoch 19/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2718.7075 - val_loss: 2
765.8882
Epoch 20/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2680.5723 - val_loss: 2
```

```
769.4978
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
MSE: 2966.337666666667
Epoch 1/20
1125/1125 [==============================] - 3s 2ms/step - loss: 69353.1172 - val_loss:
50210.9766
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 38838.9492 - val_loss:
27811.3047
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 21859.8672 - val_loss:
15842.2988
Epoch 4/20
1125/1125 [==============================] - 3s 2ms/step - loss: 13003.7959 - val_loss:
9330.0820
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 7865.7207 - val_loss: 6
004.6406
Epoch 6/20
1125/1125 [==============================] - 3s 2ms/step - loss: 5421.9814 - val_loss: 4
437.7559
Epoch 7/20
1125/1125 [==============================] - 3s 2ms/step - loss: 4278.3735 - val_loss: 3
806.6187
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3744.3230 - val_loss: 3
428.4897
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3441.4065 - val_loss: 3
288.4534
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3226.8013 - val_loss: 3
178.8091
Epoch 11/20
1125/1125 [==============================] - 4s 4ms/step - loss: 3081.8132 - val_loss: 3
037.0840
Epoch 12/20
1125/1125 [==============================] - 4s 4ms/step - loss: 2985.5823 - val_loss: 2
948.4126
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2923.9248 - val_loss: 2
959.2700
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2883.0134 - val_loss: 2
874.8994
Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2852.2161 - val_loss: 2
917.8752
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2816.9910 - val_loss: 2
868.1797
Epoch 17/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2788.0586 - val_loss: 2
750.0330
Epoch 18/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2757.0369 - val_loss: 2
780.0659
Epoch 19/20
```

```
1125/1125 [==============================] - 3s 3ms/step - loss: 2735.6743 - val_loss: 2
726.6799
Epoch 20/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2698.0945 - val_loss: 2
727.4819
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 3ms/step
MSE: 2992.367333333333
Epoch 1/20
1125/1125 [==============================] - 5s 3ms/step - loss: 88622.5078 - val_loss:
87336.4844
Epoch 2/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.4766 - val_loss:
87336.4844
Epoch 3/20
1125/1125 [==============================] - 4s 3ms/step - loss: 88622.5938 - val_loss:
87336.4844
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6328 - val_loss:
87336.4844
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5078 - val_loss:
87336.4844
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5859 - val_loss:
87336.4844
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5234 - val_loss:
87336.4844
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6094 - val_loss:
87336.4844
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5234 - val_loss:
87336.4844
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.4922 - val_loss:
87336.4844
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6172 - val_loss:
87336.4844
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6172 - val_loss:
87336.4844
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5781 - val_loss:
87336.4844
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5703 - val_loss:
87336.4844
Epoch 17/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5625 - val_loss:
87336.4844
```

```
Epoch 18/20
1125/1125 [==============================] - 4s 3ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 19/20
1125/1125 [==============================] - 4s 3ms/step - loss: 88622.4531 - val_loss:
87336.4844
Epoch 20/20
1125/1125 [==============================] - 4s 4ms/step - loss: 88622.5078 - val_loss:
87336.4844
282/282 [==============================] - 1s 3ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
MSE: 9324.854
Average MSE: 4231.987533333333
```

In [13]:

```
# Extract the deep features from Model- 1 (from 2nd layer) and Model- 2 (from 2nd layer)

count = 5
avg_mse = 0
for i in range(count):
    x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_s
    x_train, x_val, y_train, y_val = train_test_split(x_train, y_train, test_size = 0.2
    model_1 = model1(x_train, x_val, y_train, y_val)
    model_2 = model2(x_train, x_val, y_train, y_val)
    x_train1 = model_1.predict(x_train)
    x_val1 = model_1.predict(x_val)
    x_test1 = model_1.predict(x_test)
    x_train2 = model_2.predict(x_train)
    x_val2 = model_2.predict(x_val)
    x_test2 = model_2.predict(x_test)
    x_train = np.hstack((x_train1, x_train2))
    x_val = np.hstack((x_val1, x_val2))
    x_test = np.hstack((x_test1, x_test2))
    model = SVR()
    model.fit(x_train, y_train)
    y_pred = model.predict(x_test)
    y_pred = np.round(y_pred)
    mse = mean_squared_error(y_test, y_pred)
    avg_mse += mse
    print('MSE:', mse)
print('Average MSE:', avg_mse/count)
```

```
Epoch 1/20
563/563 [==============================] - 3s 3ms/step - loss: 12987.1113 - val_loss: 32
13.5969
Epoch 2/20
563/563 [==============================] - 2s 3ms/step - loss: 3237.4939 - val_loss: 306
3.9937
Epoch 3/20
563/563 [==============================] - 2s 3ms/step - loss: 3122.0691 - val_loss: 309
5.3091
Epoch 4/20
563/563 [==============================] - 2s 3ms/step - loss: 3062.7581 - val_loss: 293
5.3630
Epoch 5/20
563/563 [==============================] - 2s 3ms/step - loss: 3010.8396 - val_loss: 295
5.5674
Epoch 6/20
563/563 [==============================] - 2s 4ms/step - loss: 2972.7571 - val_loss: 286
```

```
9.1362
Epoch 7/20
563/563 [==============================] - 2s 3ms/step - loss: 2937.1880 - val_loss: 284
1.2363
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2904.7166 - val_loss: 278
7.0530
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2864.1189 - val_loss: 281
9.2288
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2829.3354 - val_loss: 276
5.5522
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2815.9106 - val_loss: 276
3.9229
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2788.4768 - val_loss: 273
7.5344
Epoch 13/20
563/563 [==============================] - 2s 4ms/step - loss: 2761.8958 - val_loss: 272
4.5386
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2747.1150 - val_loss: 273
3.0515
Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2721.2939 - val_loss: 271
7.9387
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2727.0574 - val_loss: 272
7.5518
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2700.1260 - val_loss: 267
2.5439
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2689.9368 - val_loss: 267
4.1973
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2674.9126 - val_loss: 274
8.4656
Epoch 20/20
563/563 [==============================] - 2s 3ms/step - loss: 2665.3325 - val_loss: 265
6.9724
Epoch 1/20
1125/1125 [==============================] - 5s 3ms/step - loss: 67585.3516 - val_loss:
50073.3242
Epoch 2/20
1125/1125 [==============================] - 3s 3ms/step - loss: 39205.4805 - val_loss:
28332.6289
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 22284.0449 - val_loss:
16141.3164
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 13429.7451 - val_loss:
9785.9482
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 8109.0073 - val_loss: 6
145.6099
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 5517.1333 - val_loss: 4
```

```
532.0371
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4370.2065 - val_loss: 3
939.8396
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3874.2979 - val_loss: 3
547.3679
Epoch 9/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3532.0710 - val_loss: 3
295.5627
Epoch 10/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3330.5037 - val_loss: 3
171.7029
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3174.4060 - val_loss: 3
067.6853
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3057.5864 - val_loss: 2
973.3848
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2950.5752 - val_loss: 2
949.5757
Epoch 14/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2898.8779 - val_loss: 2
847.2585
Epoch 15/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2846.3289 - val_loss: 2
758.5303
Epoch 16/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2797.2104 - val_loss: 2
766.0891
Epoch 17/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2758.6436 - val_loss: 2
769.8650
Epoch 18/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2720.8823 - val_loss: 2
828.3940
Epoch 19/20
1125/1125 [==============================] - 6s 6ms/step - loss: 2693.6855 - val_loss: 2
719.2419
Epoch 20/20
1125/1125 [==============================] - 5s 5ms/step - loss: 2678.4634 - val_loss: 2
701.8008
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 3ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
MSE: 2840.0396666666666
Epoch 1/20
563/563 [==============================] - 6s 3ms/step - loss: 16234.3486 - val_loss: 33
01.6831
Epoch 2/20
563/563 [==============================] - 2s 4ms/step - loss: 3294.8154 - val_loss: 303
9.7170
Epoch 3/20
563/563 [==============================] - 2s 4ms/step - loss: 3149.8467 - val_loss: 296
4.9854
Epoch 4/20
```

```
563/563 [==============================] - 2s 4ms/step - loss: 3070.6306 - val_loss: 290
6.0496
Epoch 5/20
563/563 [==============================] - 3s 5ms/step - loss: 3023.3574 - val_loss: 293
7.4578
Epoch 6/20
563/563 [==============================] - 3s 5ms/step - loss: 2970.1511 - val_loss: 286
8.7346
Epoch 7/20
563/563 [==============================] - 3s 5ms/step - loss: 2925.2358 - val_loss: 277
5.7668
Epoch 8/20
563/563 [==============================] - 2s 4ms/step - loss: 2907.1582 - val_loss: 281
6.8357
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2857.1746 - val_loss: 282
5.4473
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2832.9541 - val_loss: 274
1.4260
Epoch 11/20
563/563 [==============================] - 8s 14ms/step - loss: 2821.4358 - val_loss: 27
44.0706
Epoch 12/20
563/563 [==============================] - 3s 5ms/step - loss: 2788.4231 - val_loss: 270
6.5364
Epoch 13/20
563/563 [==============================] - 3s 5ms/step - loss: 2766.6565 - val_loss: 268
3.5859
Epoch 14/20
563/563 [==============================] - 5s 9ms/step - loss: 2754.4568 - val_loss: 274
4.2368
Epoch 15/20
563/563 [==============================] - 3s 6ms/step - loss: 2725.8740 - val_loss: 271
4.7844
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2712.4255 - val_loss: 265
2.9443
Epoch 17/20
563/563 [==============================] - 2s 4ms/step - loss: 2689.7993 - val_loss: 263
7.6309
Epoch 18/20
563/563 [==============================] - 2s 4ms/step - loss: 2686.2671 - val_loss: 281
9.4700
Epoch 19/20
563/563 [==============================] - 2s 4ms/step - loss: 2669.0403 - val_loss: 265
0.7129
Epoch 20/20
563/563 [==============================] - 2s 4ms/step - loss: 2639.6340 - val_loss: 262
3.0806
Epoch 1/20
1125/1125 [==============================] - 5s 3ms/step - loss: 63613.5234 - val_loss:
42637.1055
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 31047.8965 - val_loss:
20526.3418
Epoch 3/20
1125/1125 [==============================] - 3s 2ms/step - loss: 15786.2188 - val_loss:
10737.6436
Epoch 4/20
```

```
1125/1125 [==============================] - 3s 2ms/step - loss: 8575.2236 - val_loss: 6
256.4331
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 5453.5586 - val_loss: 4
428.6177
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4250.5527 - val_loss: 3
718.5066
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3733.4539 - val_loss: 3
404.4971
Epoch 8/20
1125/1125 [==============================] - 4s 4ms/step - loss: 3455.3027 - val_loss: 3
252.9097
Epoch 9/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3292.2998 - val_loss: 3
153.7886
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3169.3196 - val_loss: 3
030.5603
Epoch 11/20
1125/1125 [==============================] - 12s 11ms/step - loss: 3049.5737 - val_loss:
2974.1443
Epoch 12/20
1125/1125 [==============================] - 7s 6ms/step - loss: 2976.6416 - val_loss: 2
903.0071
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2918.4983 - val_loss: 2
894.6982
Epoch 14/20
1125/1125 [==============================] - 7s 6ms/step - loss: 2871.5422 - val_loss: 2
844.1667
Epoch 15/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2821.7063 - val_loss: 2
822.2900
Epoch 16/20
1125/1125 [==============================] - 6s 5ms/step - loss: 2791.4656 - val_loss: 2
832.5339
Epoch 17/20
1125/1125 [==============================] - 4s 4ms/step - loss: 2747.1624 - val_loss: 2
755.4551
Epoch 18/20
1125/1125 [==============================] - 4s 4ms/step - loss: 2705.4121 - val_loss: 2
764.3818
Epoch 19/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2691.6272 - val_loss: 2
762.7161
Epoch 20/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2658.9902 - val_loss: 2
741.1724
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
MSE: 2869.9486666666667
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 10155.0674 - val_loss: 31
15.7097
```

```
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3192.0403 - val_loss: 308
2.0037
Epoch 3/20
563/563 [==============================] - 2s 3ms/step - loss: 3105.3577 - val_loss: 294
2.6077
Epoch 4/20
563/563 [==============================] - 2s 3ms/step - loss: 3058.5413 - val_loss: 307
4.2207
Epoch 5/20
563/563 [==============================] - 1s 3ms/step - loss: 3013.6992 - val_loss: 285
2.1860
Epoch 6/20
563/563 [==============================] - 2s 3ms/step - loss: 2965.9578 - val_loss: 290
7.2908
Epoch 7/20
563/563 [==============================] - 2s 4ms/step - loss: 2936.5195 - val_loss: 303
4.4041
Epoch 8/20
563/563 [==============================] - 3s 5ms/step - loss: 2903.1523 - val_loss: 278
1.2263
Epoch 9/20
563/563 [==============================] - 2s 4ms/step - loss: 2855.8157 - val_loss: 276
2.6174
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2808.7222 - val_loss: 275
9.8567
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2786.1868 - val_loss: 271
4.1924
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2755.0386 - val_loss: 272
0.1736
Epoch 13/20
563/563 [==============================] - 1s 3ms/step - loss: 2743.4937 - val_loss: 270
6.6572
Epoch 14/20
563/563 [==============================] - 1s 2ms/step - loss: 2721.8325 - val_loss: 267
3.9666
Epoch 15/20
563/563 [==============================] - 1s 2ms/step - loss: 2710.2981 - val_loss: 268
5.3772
Epoch 16/20
563/563 [==============================] - 1s 3ms/step - loss: 2682.1938 - val_loss: 265
5.0132
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2664.9241 - val_loss: 267
0.3379
Epoch 18/20
563/563 [==============================] - 1s 2ms/step - loss: 2642.8123 - val_loss: 263
9.6577
Epoch 19/20
563/563 [==============================] - 1s 3ms/step - loss: 2638.7175 - val_loss: 262
3.9912
Epoch 20/20
563/563 [==============================] - 1s 3ms/step - loss: 2629.7935 - val_loss: 260
0.4131
Epoch 1/20
1125/1125 [==============================] - 4s 2ms/step - loss: 88622.5781 - val_loss:
87336.4844
```

```
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5938 - val_loss:
87336.4844
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5391 - val_loss:
87336.4844
Epoch 4/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 5/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5234 - val_loss:
87336.4844
Epoch 6/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5391 - val_loss:
87336.4844
Epoch 7/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5391 - val_loss:
87336.4844
Epoch 8/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5781 - val_loss:
87336.4844
Epoch 9/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5625 - val_loss:
87336.4844
Epoch 10/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.6016 - val_loss:
87336.4844
Epoch 11/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5859 - val_loss:
87336.4844
Epoch 12/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 13/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 14/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.4688 - val_loss:
87336.4844
Epoch 15/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 16/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5078 - val_loss:
87336.4844
Epoch 17/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 18/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.6016 - val_loss:
87336.4844
Epoch 19/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5938 - val_loss:
87336.4844
Epoch 20/20
1125/1125 [==============================] - 3s 2ms/step - loss: 88622.5859 - val_loss:
87336.4844
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 2ms/step
```

```
282/282 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
MSE: 2919.423
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 11693.5791 - val_loss: 32
17.0916
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3208.3096 - val_loss: 301
0.4141
Epoch 3/20
563/563 [==============================] - 1s 3ms/step - loss: 3114.4141 - val_loss: 297
9.7646
Epoch 4/20
563/563 [==============================] - 1s 3ms/step - loss: 3047.9873 - val_loss: 291
8.3823
Epoch 5/20
563/563 [==============================] - 1s 3ms/step - loss: 2996.9380 - val_loss: 287
3.3201
Epoch 6/20
563/563 [==============================] - 1s 2ms/step - loss: 2969.4021 - val_loss: 284
0.1990
Epoch 7/20
563/563 [==============================] - 1s 3ms/step - loss: 2936.6921 - val_loss: 285
4.3684
Epoch 8/20
563/563 [==============================] - 1s 3ms/step - loss: 2896.2205 - val_loss: 282
6.0823
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2864.5544 - val_loss: 284
3.4463
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2832.6643 - val_loss: 278
8.5557
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2811.7690 - val_loss: 276
5.3506
Epoch 12/20
563/563 [==============================] - 1s 3ms/step - loss: 2785.8740 - val_loss: 283
0.4287
Epoch 13/20
563/563 [==============================] - 1s 2ms/step - loss: 2770.6323 - val_loss: 290
7.0083
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2756.5510 - val_loss: 273
8.8372
Epoch 15/20
563/563 [==============================] - 1s 3ms/step - loss: 2735.0076 - val_loss: 273
1.1765
Epoch 16/20
563/563 [==============================] - 1s 2ms/step - loss: 2711.2439 - val_loss: 268
4.1938
Epoch 17/20
563/563 [==============================] - 1s 2ms/step - loss: 2699.9734 - val_loss: 269
3.0208
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2685.6018 - val_loss: 267
3.4648
Epoch 19/20
563/563 [==============================] - 1s 2ms/step - loss: 2662.8306 - val_loss: 266
```

```
7.9634
Epoch 20/20
563/563 [==============================] - 1s 2ms/step - loss: 2649.5525 - val_loss: 272
7.2178
Epoch 1/20
1125/1125 [==============================] - 4s 2ms/step - loss: 65831.5312 - val_loss:
46309.5234
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 34939.7422 - val_loss:
24107.1582
Epoch 3/20
1125/1125 [==============================] - 3s 2ms/step - loss: 18665.1270 - val_loss:
13370.1377
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 10669.3604 - val_loss:
7599.3828
Epoch 5/20
1125/1125 [==============================] - 4s 3ms/step - loss: 6482.1733 - val_loss: 5
082.8848
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4697.3584 - val_loss: 3
989.8762
Epoch 7/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3947.5845 - val_loss: 3
577.7024
Epoch 8/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3551.7629 - val_loss: 3
350.4854
Epoch 9/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3361.1418 - val_loss: 3
198.1641
Epoch 10/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3205.3928 - val_loss: 3
061.4373
Epoch 11/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3089.3694 - val_loss: 2
961.3354
Epoch 12/20
1125/1125 [==============================] - 3s 2ms/step - loss: 3011.0334 - val_loss: 2
947.3132
Epoch 13/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2969.7507 - val_loss: 2
867.0073
Epoch 14/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2896.2349 - val_loss: 3
020.6851
Epoch 15/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2849.9617 - val_loss: 2
816.6604
Epoch 16/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2812.3018 - val_loss: 2
822.6982
Epoch 17/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2764.7776 - val_loss: 2
827.4006
Epoch 18/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2725.8523 - val_loss: 2
799.6377
Epoch 19/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2695.2754 - val_loss: 2
```

```
779.2388
Epoch 20/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2662.9104 - val_loss: 2
798.0347
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 2ms/step
MSE: 2875.5796666666665
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 9950.3594 - val_loss: 326
5.0298
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3198.4580 - val_loss: 297
7.3196
Epoch 3/20
563/563 [==============================] - 2s 3ms/step - loss: 3095.7271 - val_loss: 291
4.1152
Epoch 4/20
563/563 [==============================] - 2s 3ms/step - loss: 3040.0273 - val_loss: 290
7.2114
Epoch 5/20
563/563 [==============================] - 2s 3ms/step - loss: 3000.9170 - val_loss: 288
4.9131
Epoch 6/20
563/563 [==============================] - 1s 3ms/step - loss: 2953.2166 - val_loss: 280
3.5000
Epoch 7/20
563/563 [==============================] - 2s 3ms/step - loss: 2909.9568 - val_loss: 288
3.4526
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2900.8342 - val_loss: 278
8.7957
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2859.6875 - val_loss: 276
7.4260
Epoch 10/20
563/563 [==============================] - 3s 5ms/step - loss: 2821.5962 - val_loss: 274
0.7043
Epoch 11/20
563/563 [==============================] - 4s 7ms/step - loss: 2813.9905 - val_loss: 281
5.7546
Epoch 12/20
563/563 [==============================] - 4s 6ms/step - loss: 2796.8345 - val_loss: 274
8.8145
Epoch 13/20
563/563 [==============================] - 2s 3ms/step - loss: 2767.1997 - val_loss: 280
4.5229
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2753.5371 - val_loss: 277
9.4802
Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2724.9199 - val_loss: 269
9.0454
Epoch 16/20
563/563 [==============================] - 2s 4ms/step - loss: 2723.6230 - val_loss: 264
5.9275
Epoch 17/20
```

```
563/563 [==============================] - 2s 4ms/step - loss: 2710.1877 - val_loss: 264
6.0601
Epoch 18/20
563/563 [==============================] - 2s 4ms/step - loss: 2694.1050 - val_loss: 279
1.4763
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2672.9614 - val_loss: 265
2.4824
Epoch 20/20
563/563 [==============================] - 2s 3ms/step - loss: 2677.8799 - val_loss: 267
4.2805
Epoch 1/20
1125/1125 [==============================] - 4s 3ms/step - loss: 66581.0781 - val_loss:
46533.6367
Epoch 2/20
1125/1125 [==============================] - 3s 3ms/step - loss: 34912.9648 - val_loss:
23986.9902
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 18551.7715 - val_loss:
13303.3682
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 10647.3389 - val_loss:
7537.4219
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 6471.6792 - val_loss: 5
193.8081
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4694.0054 - val_loss: 4
076.9893
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3900.3528 - val_loss: 3
533.1426
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3504.4492 - val_loss: 3
321.0791
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3290.6106 - val_loss: 3
166.3474
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3150.4270 - val_loss: 3
030.4473
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3046.0669 - val_loss: 2
970.6677
Epoch 12/20
1125/1125 [==============================] - 3s 2ms/step - loss: 2972.0688 - val_loss: 2
945.1526
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2912.4834 - val_loss: 2
870.8040
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2865.7837 - val_loss: 2
861.6777
Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2818.5405 - val_loss: 2
817.0906
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2777.8372 - val_loss: 2
759.7041
Epoch 17/20
```

```
1125/1125 [==============================] - 3s 3ms/step - loss: 2735.1196 - val_loss: 2
748.5825
Epoch 18/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2694.7485 - val_loss: 2
769.0605
Epoch 19/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2669.6250 - val_loss: 2
780.4387
Epoch 20/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2643.8733 - val_loss: 2
694.2515
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
282/282 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
MSE: 2820.6633333333334
Average MSE: 2865.130866666667
```

In [16]:

```
# Extract the deep features from Model-1 (from 2nd layer) and Model- 2 (from 2nd layer)

from sklearn.decomposition import PCA

count = 5
avg_mse = 0
for i in range(count):
    x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_s
    x_train, x_val, y_train, y_val = train_test_split(x_train, y_train, test_size = 0.2
    model_1 = model1(x_train, x_val, y_train, y_val)
    model_2 = model2(x_train, x_val, y_train, y_val)
    model_1 = Model(inputs = model_1.input, outputs = model_1.get_layer(index = 2).outp
    model_2 = Model(inputs = model_2.input, outputs = model_2.get_layer(index = 2).outp
    x_train1 = model_1.predict(x_train)
    x_val1 = model_1.predict(x_val)
    x_test1 = model_1.predict(x_test)
    x_train2 = model_2.predict(x_train)
    x_val2 = model_2.predict(x_val)
    x_test2 = model_2.predict(x_test)
    x_train = np.hstack((x_train1, x_train2))
    x_val = np.hstack((x_val1, x_val2))
    x_test = np.hstack((x_test1, x_test2))
    mse = []

    pca = PCA(n_components = 8)
    pca.fit(x_train)
    x_train_pca = pca.transform(x_train)
    x_val_pca = pca.transform(x_val)
    x_test_pca = pca.transform(x_test)
    model = SVR()
    model.fit(x_train_pca, y_train)
    y_pred = model.predict(x_test_pca)
    y_pred = np.round(y_pred)
    mse.append(mean_squared_error(y_test, y_pred))

print('MSE for 8 components:', mse)
```

```
Epoch 1/20
563/563 [==============================] - 2s 2ms/step - loss: 11557.3418 - val_loss: 31
29.8757
Epoch 2/20
563/563 [==============================] - 2s 3ms/step - loss: 3202.1028 - val_loss: 299
5.5012
Epoch 3/20
563/563 [==============================] - 3s 5ms/step - loss: 3114.5168 - val_loss: 293
5.2224
Epoch 4/20
563/563 [==============================] - 4s 7ms/step - loss: 3056.4973 - val_loss: 293
9.1846
Epoch 5/20
563/563 [==============================] - 3s 4ms/step - loss: 3016.3855 - val_loss: 284
4.3613
Epoch 6/20
563/563 [==============================] - 2s 4ms/step - loss: 2972.4043 - val_loss: 300
5.7170
Epoch 7/20
563/563 [==============================] - 2s 3ms/step - loss: 2954.4871 - val_loss: 293
9.2092
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2928.2166 - val_loss: 290
7.1870
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2894.1660 - val_loss: 280
7.6816
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2858.2661 - val_loss: 274
3.0334
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2834.8867 - val_loss: 273
3.6438
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2815.6545 - val_loss: 281
3.6799
Epoch 13/20
563/563 [==============================] - 2s 3ms/step - loss: 2803.9807 - val_loss: 271
8.1621
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2783.2729 - val_loss: 281
6.6042
Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2763.3127 - val_loss: 268
7.4451
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2733.6519 - val_loss: 269
2.1758
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2722.6992 - val_loss: 269
1.0723
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2707.8887 - val_loss: 272
9.4424
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2713.2310 - val_loss: 267
6.2637
Epoch 20/20
563/563 [==============================] - 2s 3ms/step - loss: 2669.4846 - val_loss: 267
1.5098
```

```
Epoch 1/20
1125/1125 [==============================] - 3s 2ms/step - loss: 72639.4375 - val_loss:
55767.7383
Epoch 2/20
1125/1125 [==============================] - 2s 2ms/step - loss: 44835.0234 - val_loss:
33730.2070
Epoch 3/20
1125/1125 [==============================] - 2s 2ms/step - loss: 27246.3828 - val_loss:
20332.0449
Epoch 4/20
1125/1125 [==============================] - 2s 2ms/step - loss: 16871.5879 - val_loss:
12980.3320
Epoch 5/20
1125/1125 [==============================] - 2s 2ms/step - loss: 10759.5537 - val_loss:
8014.5767
Epoch 6/20
1125/1125 [==============================] - 2s 2ms/step - loss: 7022.9595 - val_loss: 5
538.8364
Epoch 7/20
1125/1125 [==============================] - 2s 2ms/step - loss: 5126.4351 - val_loss: 4
350.5479
Epoch 8/20
1125/1125 [==============================] - 2s 2ms/step - loss: 4214.0889 - val_loss: 3
748.3669
Epoch 9/20
1125/1125 [==============================] - 2s 2ms/step - loss: 3748.1582 - val_loss: 3
508.8459
Epoch 10/20
1125/1125 [==============================] - 2s 2ms/step - loss: 3470.2751 - val_loss: 3
230.0811
Epoch 11/20
1125/1125 [==============================] - 2s 2ms/step - loss: 3257.7229 - val_loss: 3
098.3623
Epoch 12/20
1125/1125 [==============================] - 2s 2ms/step - loss: 3106.6648 - val_loss: 3
010.2346
Epoch 13/20
1125/1125 [==============================] - 2s 2ms/step - loss: 3004.3352 - val_loss: 2
949.6387
Epoch 14/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2931.7363 - val_loss: 2
903.2646
Epoch 15/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2864.8696 - val_loss: 2
927.9819
Epoch 16/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2817.3330 - val_loss: 2
833.6243
Epoch 17/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2765.1260 - val_loss: 2
849.8396
Epoch 18/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2738.2017 - val_loss: 2
768.7876
Epoch 19/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2709.3618 - val_loss: 2
741.6062
Epoch 20/20
1125/1125 [==============================] - 2s 2ms/step - loss: 2666.2283 - val_loss: 2
762.8892
```

```
282/282 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
282/282 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
94/94 [==============================] - 0s 1ms/step
Epoch 1/20
563/563 [==============================] - 2s 3ms/step - loss: 10939.0488 - val_loss: 31
72.1624
Epoch 2/20
563/563 [==============================] - 1s 2ms/step - loss: 3192.1885 - val_loss: 299
5.4351
Epoch 3/20
563/563 [==============================] - 1s 3ms/step - loss: 3107.3428 - val_loss: 295
6.1333
Epoch 4/20
563/563 [==============================] - 1s 3ms/step - loss: 3052.4121 - val_loss: 290
0.6506
Epoch 5/20
563/563 [==============================] - 2s 3ms/step - loss: 2998.3320 - val_loss: 286
4.8887
Epoch 6/20
563/563 [==============================] - 1s 3ms/step - loss: 2961.7136 - val_loss: 283
2.9463
Epoch 7/20
563/563 [==============================] - 1s 3ms/step - loss: 2916.2346 - val_loss: 277
6.4238
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2899.7222 - val_loss: 277
2.5300
Epoch 9/20
563/563 [==============================] - 1s 3ms/step - loss: 2862.4512 - val_loss: 280
0.3047
Epoch 10/20
563/563 [==============================] - 1s 3ms/step - loss: 2855.2734 - val_loss: 292
1.9727
Epoch 11/20
563/563 [==============================] - 1s 3ms/step - loss: 2813.1169 - val_loss: 277
3.1165
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2803.0811 - val_loss: 273
8.5432
Epoch 13/20
563/563 [==============================] - 1s 3ms/step - loss: 2787.9468 - val_loss: 270
3.9263
Epoch 14/20
563/563 [==============================] - 1s 3ms/step - loss: 2761.1052 - val_loss: 280
2.0667
Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2738.2546 - val_loss: 270
8.5674
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2737.4756 - val_loss: 272
1.5762
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2724.9529 - val_loss: 271
1.9497
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2701.5508 - val_loss: 278
0.6140
```

```
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2692.3655 - val_loss: 268
5.0562
Epoch 20/20
563/563 [==============================] - 3s 5ms/step - loss: 2684.5496 - val_loss: 267
9.8953
Epoch 1/20
1125/1125 [==============================] - 6s 4ms/step - loss: 65814.8750 - val_loss:
46645.7773
Epoch 2/20
1125/1125 [==============================] - 3s 2ms/step - loss: 35204.9453 - val_loss:
24315.4727
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 18804.1934 - val_loss:
13474.3652
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 10821.6572 - val_loss:
7652.5371
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 6536.8110 - val_loss: 5
130.5205
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4751.0479 - val_loss: 4
028.8154
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3998.9810 - val_loss: 3
623.7336
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3652.9465 - val_loss: 3
398.1074
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3398.0947 - val_loss: 3
174.8022
Epoch 10/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3199.1655 - val_loss: 3
070.0427
Epoch 11/20
1125/1125 [==============================] - 4s 3ms/step - loss: 3068.9600 - val_loss: 3
016.9480
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2988.9082 - val_loss: 3
030.9163
Epoch 13/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2915.8484 - val_loss: 2
865.9043
Epoch 14/20
1125/1125 [==============================] - 4s 3ms/step - loss: 2875.2849 - val_loss: 2
842.9380
Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2824.7908 - val_loss: 2
828.6106
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2781.9841 - val_loss: 2
879.3540
Epoch 17/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2753.3164 - val_loss: 2
784.2910
Epoch 18/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2711.4333 - val_loss: 2
742.8259
```

```
Epoch 19/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2676.7749 - val_loss: 2
760.0767
Epoch 20/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2659.5769 - val_loss: 2
854.3057
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
Epoch 1/20
563/563 [==============================] - 2s 3ms/step - loss: 10781.7822 - val_loss: 33
03.7708
Epoch 2/20
563/563 [==============================] - 2s 3ms/step - loss: 3202.1790 - val_loss: 306
0.8459
Epoch 3/20
563/563 [==============================] - 2s 3ms/step - loss: 3118.4502 - val_loss: 297
0.2644
Epoch 4/20
563/563 [==============================] - 2s 3ms/step - loss: 3063.0496 - val_loss: 289
4.6689
Epoch 5/20
563/563 [==============================] - 2s 3ms/step - loss: 3016.3823 - val_loss: 290
7.6768
Epoch 6/20
563/563 [==============================] - 2s 3ms/step - loss: 2984.9617 - val_loss: 283
0.8369
Epoch 7/20
563/563 [==============================] - 2s 3ms/step - loss: 2951.2434 - val_loss: 284
1.3516
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2909.4124 - val_loss: 279
8.7214
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2880.1414 - val_loss: 276
4.2766
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2826.8640 - val_loss: 272
9.1484
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2817.5444 - val_loss: 271
1.8650
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2772.0820 - val_loss: 271
7.2009
Epoch 13/20
563/563 [==============================] - 2s 3ms/step - loss: 2736.8572 - val_loss: 272
8.1479
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2742.3384 - val_loss: 270
4.0088
Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2711.8896 - val_loss: 265
9.0186
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2685.2410 - val_loss: 263
6.7603
```

```
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2680.7156 - val_loss: 263
9.4846
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2662.1626 - val_loss: 262
6.1956
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2641.1707 - val_loss: 262
5.4048
Epoch 20/20
563/563 [==============================] - 2s 3ms/step - loss: 2637.1367 - val_loss: 273
6.3943
Epoch 1/20
1125/1125 [==============================] - 4s 3ms/step - loss: 70294.6953 - val_loss:
52806.8281
Epoch 2/20
1125/1125 [==============================] - 3s 3ms/step - loss: 40022.0000 - val_loss:
28430.0449
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 22304.3066 - val_loss:
16118.9307
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 13321.0283 - val_loss:
9609.5166
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 8044.0420 - val_loss: 6
150.6899
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 5495.6201 - val_loss: 4
497.0005
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 4297.2871 - val_loss: 3
792.8979
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3776.4019 - val_loss: 3
478.3047
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3472.5854 - val_loss: 3
241.9934
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3238.5984 - val_loss: 3
095.3406
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 3088.8330 - val_loss: 2
991.7507
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2983.6807 - val_loss: 2
896.9036
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2906.0740 - val_loss: 2
862.7734
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2843.5950 - val_loss: 2
804.3186
Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2786.4507 - val_loss: 2
774.5906
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2740.5554 - val_loss: 2
728.1887
```

```
Epoch 17/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2704.3684 - val_loss: 2
713.1819
Epoch 18/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2674.8513 - val_loss: 2
735.7505
Epoch 19/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2635.1685 - val_loss: 2
667.7285
Epoch 20/20
1125/1125 [==============================] - 3s 3ms/step - loss: 2599.9814 - val_loss: 2
662.4702
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 1ms/step
Epoch 1/20
563/563 [==============================] - 2s 3ms/step - loss: 12420.7090 - val_loss: 31
65.1987
Epoch 2/20
563/563 [==============================] - 2s 3ms/step - loss: 3217.2363 - val_loss: 302
8.2544
Epoch 3/20
563/563 [==============================] - 2s 3ms/step - loss: 3114.7598 - val_loss: 301
9.4382
Epoch 4/20
563/563 [==============================] - 2s 3ms/step - loss: 3056.6995 - val_loss: 301
8.3701
Epoch 5/20
563/563 [==============================] - 2s 3ms/step - loss: 3003.2009 - val_loss: 285
6.9973
Epoch 6/20
563/563 [==============================] - 2s 3ms/step - loss: 2956.6594 - val_loss: 286
1.9573
Epoch 7/20
563/563 [==============================] - 2s 3ms/step - loss: 2936.1472 - val_loss: 286
7.4802
Epoch 8/20
563/563 [==============================] - 2s 3ms/step - loss: 2902.6907 - val_loss: 277
7.4089
Epoch 9/20
563/563 [==============================] - 2s 3ms/step - loss: 2860.1377 - val_loss: 284
2.8904
Epoch 10/20
563/563 [==============================] - 2s 3ms/step - loss: 2835.4868 - val_loss: 275
2.7810
Epoch 11/20
563/563 [==============================] - 2s 3ms/step - loss: 2808.4436 - val_loss: 273
8.9800
Epoch 12/20
563/563 [==============================] - 2s 3ms/step - loss: 2800.9988 - val_loss: 275
2.4199
Epoch 13/20
563/563 [==============================] - 2s 3ms/step - loss: 2762.4636 - val_loss: 276
5.1028
Epoch 14/20
563/563 [==============================] - 2s 3ms/step - loss: 2746.0344 - val_loss: 271
6.3879
```

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Epoch 15/20
563/563 [==============================] - 2s 3ms/step - loss: 2735.0334 - val_loss: 271
8.7227
Epoch 16/20
563/563 [==============================] - 2s 3ms/step - loss: 2726.6023 - val_loss: 267
8.3274
Epoch 17/20
563/563 [==============================] - 2s 3ms/step - loss: 2695.7759 - val_loss: 270
5.3335
Epoch 18/20
563/563 [==============================] - 2s 3ms/step - loss: 2688.7983 - val_loss: 267
7.4910
Epoch 19/20
563/563 [==============================] - 2s 3ms/step - loss: 2677.0051 - val_loss: 269
1.8997
Epoch 20/20
563/563 [==============================] - 2s 3ms/step - loss: 2660.3296 - val_loss: 272
8.8745
Epoch 1/20
1125/1125 [==============================] - 4s 3ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 2/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6172 - val_loss:
87336.4844
Epoch 3/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5469 - val_loss:
87336.4844
Epoch 4/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 5/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5000 - val_loss:
87336.4844
Epoch 6/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 7/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6172 - val_loss:
87336.4844
Epoch 8/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5391 - val_loss:
87336.4844
Epoch 9/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6328 - val_loss:
87336.4844
Epoch 10/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5859 - val_loss:
87336.4844
Epoch 11/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6562 - val_loss:
87336.4844
Epoch 12/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5312 - val_loss:
87336.4844
Epoch 13/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6328 - val_loss:
87336.4844
Epoch 14/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5469 - val_loss:
87336.4844
```

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Epoch 15/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6016 - val_loss:
87336.4844
Epoch 16/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 17/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5625 - val_loss:
87336.4844
Epoch 18/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5234 - val_loss:
87336.4844
Epoch 19/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.5547 - val_loss:
87336.4844
Epoch 20/20
1125/1125 [==============================] - 3s 3ms/step - loss: 88622.6172 - val_loss:
87336.4844
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
Epoch 1/20
563/563 [==============================] - 7s 7ms/step - loss: 13338.7236 - val_loss: 31
72.3904
Epoch 2/20
563/563 [==============================] - 3s 6ms/step - loss: 3194.4954 - val_loss: 302
2.5969
Epoch 3/20
563/563 [==============================] - 3s 6ms/step - loss: 3127.9700 - val_loss: 300
7.9236
Epoch 4/20
563/563 [==============================] - 3s 6ms/step - loss: 3044.9612 - val_loss: 287
9.7576
Epoch 5/20
563/563 [==============================] - 3s 5ms/step - loss: 3004.2278 - val_loss: 290
6.0623
Epoch 6/20
563/563 [==============================] - 2s 4ms/step - loss: 2958.6125 - val_loss: 287
8.4106
Epoch 7/20
563/563 [==============================] - 3s 6ms/step - loss: 2926.0432 - val_loss: 291
5.6038
Epoch 8/20
563/563 [==============================] - 3s 6ms/step - loss: 2894.3455 - val_loss: 283
6.7476
Epoch 9/20
563/563 [==============================] - 3s 6ms/step - loss: 2872.4270 - val_loss: 275
1.4663
Epoch 10/20
563/563 [==============================] - 3s 5ms/step - loss: 2844.7922 - val_loss: 277
5.2534
Epoch 11/20
563/563 [==============================] - 3s 6ms/step - loss: 2821.8948 - val_loss: 273
5.2561
Epoch 12/20
563/563 [==============================] - 4s 7ms/step - loss: 2794.2639 - val_loss: 270
7.6079
```

```
Epoch 13/20
563/563 [==============================] - 3s 5ms/step - loss: 2780.1279 - val_loss: 273
5.6641
Epoch 14/20
563/563 [==============================] - 3s 6ms/step - loss: 2760.0181 - val_loss: 271
3.5813
Epoch 15/20
563/563 [==============================] - 3s 5ms/step - loss: 2749.9453 - val_loss: 267
7.9094
Epoch 16/20
563/563 [==============================] - 2s 4ms/step - loss: 2730.7231 - val_loss: 270
1.7388
Epoch 17/20
563/563 [==============================] - 2s 4ms/step - loss: 2713.7771 - val_loss: 281
9.0317
Epoch 18/20
563/563 [==============================] - 2s 4ms/step - loss: 2713.2019 - val_loss: 266
2.4094
Epoch 19/20
563/563 [==============================] - 2s 4ms/step - loss: 2702.5286 - val_loss: 268
2.1584
Epoch 20/20
563/563 [==============================] - 2s 4ms/step - loss: 2683.4395 - val_loss: 264
6.2744
Epoch 1/20
1125/1125 [==============================] - 7s 5ms/step - loss: 65794.6406 - val_loss:
46614.2461
Epoch 2/20
1125/1125 [==============================] - 6s 5ms/step - loss: 35278.9375 - val_loss:
24407.0488
Epoch 3/20
1125/1125 [==============================] - 7s 6ms/step - loss: 18869.7676 - val_loss:
13506.9482
Epoch 4/20
1125/1125 [==============================] - 5s 5ms/step - loss: 10822.3545 - val_loss:
7690.3521
Epoch 5/20
1125/1125 [==============================] - 6s 5ms/step - loss: 6557.6968 - val_loss: 5
086.7085
Epoch 6/20
1125/1125 [==============================] - 5s 5ms/step - loss: 4742.7988 - val_loss: 4
070.4006
Epoch 7/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3975.2097 - val_loss: 3
614.0610
Epoch 8/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3606.5085 - val_loss: 3
331.8704
Epoch 9/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3366.1694 - val_loss: 3
167.6968
Epoch 10/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3197.7361 - val_loss: 3
195.1526
Epoch 11/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3096.8467 - val_loss: 2
991.8018
Epoch 12/20
1125/1125 [==============================] - 5s 4ms/step - loss: 3013.9180 - val_loss: 2
926.5940
```

```
Epoch 13/20
1125/1125 [==============================] - 4s 4ms/step - loss: 2963.3772 - val_loss: 2
942.6768
Epoch 14/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2899.4263 - val_loss: 2
853.0276
Epoch 15/20
1125/1125 [==============================] - 5s 5ms/step - loss: 2839.7773 - val_loss: 2
828.3384
Epoch 16/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2800.5706 - val_loss: 2
851.3240
Epoch 17/20
1125/1125 [==============================] - 5s 4ms/step - loss: 2756.3140 - val_loss: 2
805.1057
Epoch 18/20
1125/1125 [==============================] - 4s 4ms/step - loss: 2721.6050 - val_loss: 2
729.4609
Epoch 19/20
1125/1125 [==============================] - 6s 5ms/step - loss: 2686.6519 - val_loss: 2
853.1448
Epoch 20/20
1125/1125 [==============================] - 6s 5ms/step - loss: 2669.8044 - val_loss: 2
782.6743
282/282 [==============================] - 1s 3ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
282/282 [==============================] - 1s 2ms/step
94/94 [==============================] - 0s 2ms/step
94/94 [==============================] - 0s 2ms/step
MSE for 8 components: [2963.6483333333335]
```

In [ ]:

```
# Draw conclusions on the best model among the above four models for predicting the Del
Average MSE for model 1 : 2833.979866666667
Average MSE for model 2 : 4231.987533333333
Average MSE for model 3 : 2865.130866666667
Average MSE for model 4 : 2963.6483333333335

The best model is Model 1.
```