NeuralNet

November 9, 2024

```
[47]: try:
          import os
          import glob
          import numpy as np
          import pandas as pd

          from sklearn.model_selection import train_test_split
          from sklearn.preprocessing import StandardScaler, OneHotEncoder
          from sklearn.compose import ColumnTransformer
          from sklearn.pipeline import Pipeline

          # Importing libraries for data visualization
          import seaborn as sns
          import matplotlib.pyplot as plt

          # Creating a model
          from tensorflow.keras.models import Sequential
          from tensorflow.keras.layers import Dense, Activation

          # Importing libraries for evaluation
          # evaluation on test data
          from sklearn.metrics import␣
      ↪mean_squared_error,mean_absolute_error,explained_variance_score
          from sklearn.metrics import classification_report,confusion_matrix

      except Exception as e:
          print(f"Error : {e}")
```

```
[48]: # Find the CSV file in the Datasets directory
      data_path = '../Datasets/*.csv'
      file_list = glob.glob(data_path)

      for file in file_list:
          print(f"Found file: {file}")

      # Ensure there is exactly one file
      if len(file_list) == 1:
```

```
    # Load the dataset
    df = pd.read_csv(file_list[0])
    print(f"Loaded dataset: {file_list[0]}")
else:
    raise FileNotFoundError("No CSV file found or multiple CSV files found in␣
 ↪the Datasets directory.")
```

```
Found file: ../Datasets/Dataset.csv
Loaded dataset: ../Datasets/Dataset.csv
```

```
[49]: # File path to save the trained model
     destination = '../Models/'
     os.makedirs(destination, exist_ok=True)
     print(f"Model will be saved to: {destination}")
```

```
Model will be saved to: ../Models/
```

```
[50]: categorical_cols_unified = ['partType', 'microstructure', 'seedLocation',␣
     ↪'castType']

     df = pd.get_dummies(df, columns=categorical_cols_unified, drop_first=False)
```
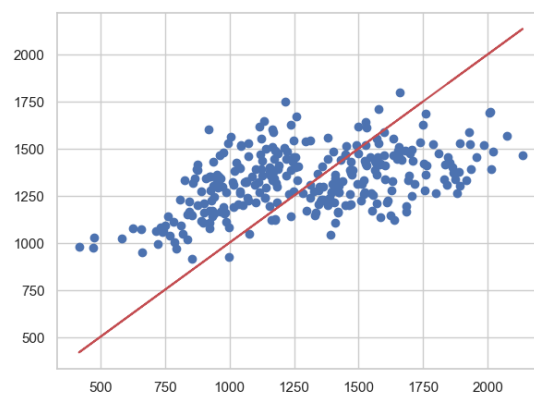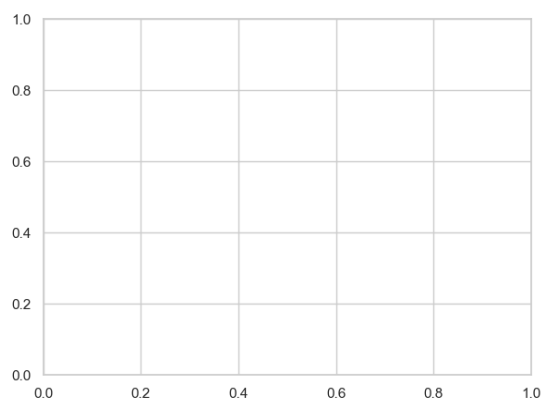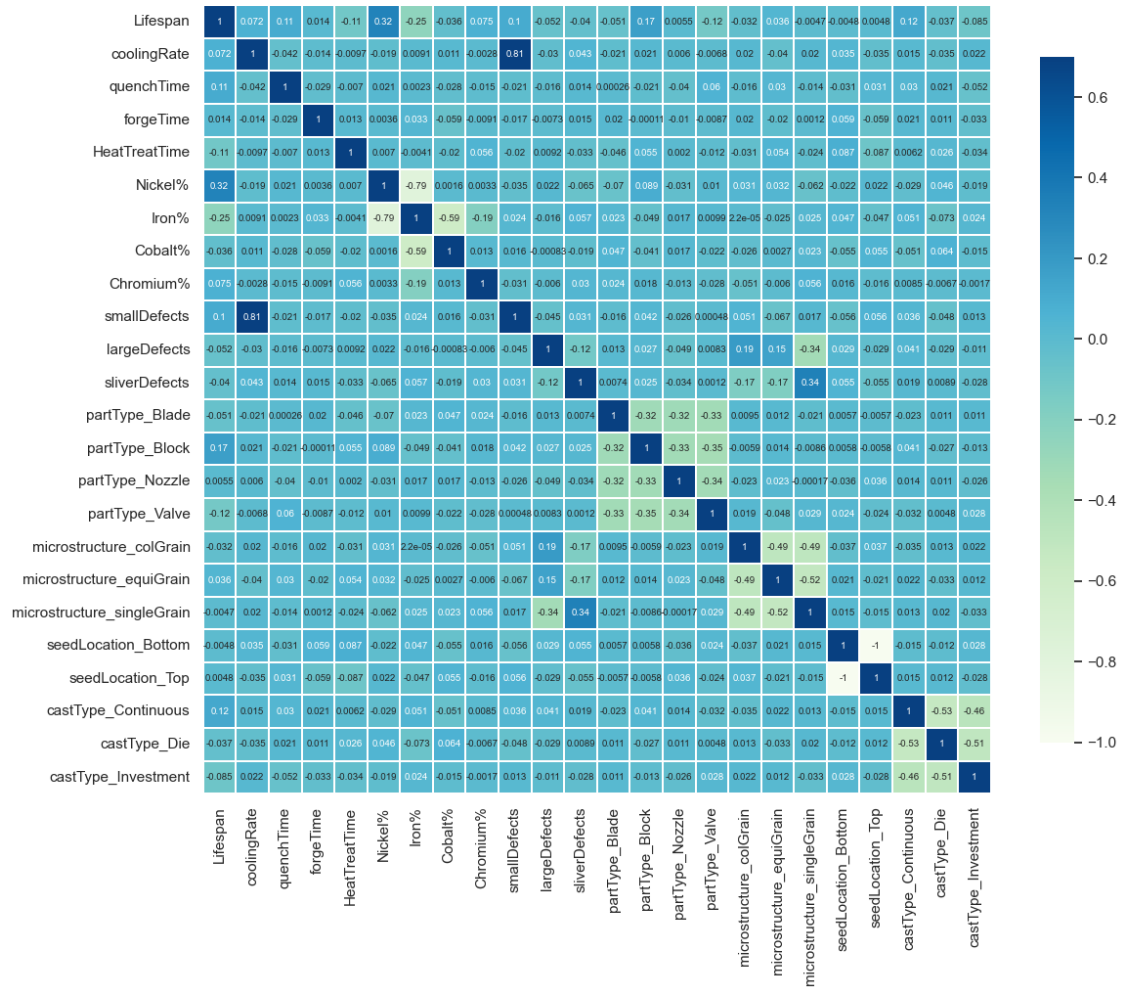
```
[51]: sns.set(style="whitegrid", font_scale=1)

     plt.figure(figsize=(13,13))
     plt.title('Pearson Correlation Matrix',fontsize=25)
     sns.heatmap(df.corr(),linewidths=0.25,vmax=0.
     ↪7,square=True,cmap="GnBu",linecolor='w',
               annot=True, annot_kws={"size":7}, cbar_kws={"shrink": .7})
     plt.show()
```

Pearson Correlation Matrix


```
[ ]:  # Features
      X = df.drop('Lifespan',axis=1)

      # Target
      y = df['Lifespan']

      # Split
      X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.
       ↪3,random_state=101)
```

```
[53]: print(X_train.shape)
      print(X_test.shape)
      print(y_train.shape)
      print(y_test.shape)
```

```
(700, 23)
```

```
(300, 23)
(700,)
(300,)
```

[54]:
```python
from sklearn.preprocessing import MinMaxScaler

# Create the scaler
scaler = MinMaxScaler()

# fit and transfrom
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# everything has been scaled between 1 and 0
print('Max: ',X_train.max())
print('Min: ', X_train.min())
```

```
Max:  1.0
Min:  0.0
```

[55]:
```python
model = Sequential()

# input layer
model.add(Dense(19,activation='relu'))

# hidden layers
model.add(Dense(19,activation='relu'))
model.add(Dense(19,activation='relu'))
model.add(Dense(19,activation='relu'))

# output layer
model.add(Dense(1))

model.compile(optimizer='adam',loss='mse')
```

[56]:
```python
model.fit(x=X_train,y=y_train.values,
          validation_data=(X_test,y_test.values),
          batch_size=128,epochs=400)
```

```
Epoch 1/400

6/6              1s 12ms/step - loss:
1797721.2500 - val_loss: 1775813.3750
Epoch 2/400
6/6              0s 3ms/step - loss:
1793231.7500 - val_loss: 1775288.5000
Epoch 3/400
6/6              0s 3ms/step - loss:
1817473.1250 - val_loss: 1774588.6250
```

4

```
Epoch 4/400
6/6              0s 3ms/step - loss:
1822381.8750 - val_loss: 1773656.5000
Epoch 5/400
6/6              0s 3ms/step - loss:
1826836.5000 - val_loss: 1772410.5000
Epoch 6/400
6/6              0s 3ms/step - loss:
1790828.5000 - val_loss: 1770721.5000
Epoch 7/400
6/6              0s 2ms/step - loss:
1808824.0000 - val_loss: 1768413.6250
Epoch 8/400
6/6              0s 3ms/step - loss:
1804260.6250 - val_loss: 1765243.8750
Epoch 9/400
6/6              0s 3ms/step - loss:
1764122.0000 - val_loss: 1760881.2500
Epoch 10/400
6/6              0s 3ms/step - loss:
1791976.5000 - val_loss: 1754855.6250
Epoch 11/400
6/6              0s 3ms/step - loss:
1752319.0000 - val_loss: 1746553.1250
Epoch 12/400
6/6              0s 3ms/step - loss:
1807547.7500 - val_loss: 1735084.0000
Epoch 13/400
6/6              0s 3ms/step - loss:
1763974.0000 - val_loss: 1719277.3750
Epoch 14/400
6/6              0s 3ms/step - loss:
1772107.8750 - val_loss: 1697566.1250
Epoch 15/400
6/6              0s 3ms/step - loss:
1719963.6250 - val_loss: 1668211.8750
Epoch 16/400
6/6              0s 3ms/step - loss:
1719741.6250 - val_loss: 1629153.8750
Epoch 17/400
6/6              0s 3ms/step - loss:
1665076.1250 - val_loss: 1578160.5000
Epoch 18/400
6/6              0s 3ms/step - loss:
1635941.2500 - val_loss: 1512678.1250
Epoch 19/400
6/6              0s 3ms/step - loss:
1531142.7500 - val_loss: 1430265.8750
```

```
Epoch 20/400
6/6              0s 3ms/step - loss:
1414623.8750 - val_loss: 1328729.3750
Epoch 21/400
6/6              0s 3ms/step - loss:
1305290.6250 - val_loss: 1206434.5000
Epoch 22/400
6/6              0s 3ms/step - loss:
1205106.5000 - val_loss: 1063273.6250
Epoch 23/400
6/6              0s 3ms/step - loss:
1053224.8750 - val_loss: 901776.5625
Epoch 24/400
6/6              0s 3ms/step - loss:
908826.1250 - val_loss: 727606.6875
Epoch 25/400
6/6              0s 6ms/step - loss:
711660.8750 - val_loss: 550621.3750
Epoch 26/400
6/6              0s 3ms/step - loss:
547584.2500 - val_loss: 385246.6562
Epoch 27/400
6/6              0s 3ms/step - loss:
372656.6562 - val_loss: 250606.9531
Epoch 28/400
6/6              0s 3ms/step - loss:
233305.9844 - val_loss: 161809.1406
Epoch 29/400
6/6              0s 2ms/step - loss:
153371.3438 - val_loss: 123356.7578
Epoch 30/400
6/6              0s 3ms/step - loss:
120915.5391 - val_loss: 120787.5469
Epoch 31/400
6/6              0s 3ms/step - loss:
113584.1875 - val_loss: 128492.7344
Epoch 32/400
6/6              0s 3ms/step - loss:
115598.0391 - val_loss: 130817.2422
Epoch 33/400
6/6              0s 3ms/step - loss:
118443.1562 - val_loss: 127040.2422
Epoch 34/400
6/6              0s 3ms/step - loss:
117684.8203 - val_loss: 122212.8281
Epoch 35/400
6/6              0s 3ms/step - loss:
111273.4688 - val_loss: 119332.4375
```

```
Epoch 36/400
6/6              0s 2ms/step - loss:
114278.7031 - val_loss: 118155.3984
Epoch 37/400
6/6              0s 2ms/step - loss:
111139.3516 - val_loss: 117724.0156
Epoch 38/400
6/6              0s 3ms/step - loss:
114500.0000 - val_loss: 117674.0156
Epoch 39/400
6/6              0s 3ms/step - loss:
107943.2969 - val_loss: 117863.1562
Epoch 40/400
6/6              0s 3ms/step - loss:
106610.6562 - val_loss: 117700.6562
Epoch 41/400
6/6              0s 4ms/step - loss:
107124.2578 - val_loss: 117566.3828
Epoch 42/400
6/6              0s 3ms/step - loss:
111582.2734 - val_loss: 117579.0781
Epoch 43/400
6/6              0s 3ms/step - loss:
104796.0000 - val_loss: 117510.8828
Epoch 44/400
6/6              0s 3ms/step - loss:
110872.8984 - val_loss: 117191.8125
Epoch 45/400
6/6              0s 3ms/step - loss:
105052.1250 - val_loss: 117238.4375
Epoch 46/400
6/6              0s 3ms/step - loss:
110840.6328 - val_loss: 117085.3438
Epoch 47/400
6/6              0s 3ms/step - loss:
107110.0391 - val_loss: 117047.3047
Epoch 48/400
6/6              0s 3ms/step - loss:
106432.8516 - val_loss: 116604.4297
Epoch 49/400
6/6              0s 3ms/step - loss:
104760.8203 - val_loss: 116289.7578
Epoch 50/400
6/6              0s 2ms/step - loss:
109206.1562 - val_loss: 116088.7188
Epoch 51/400
6/6              0s 3ms/step - loss:
103697.6406 - val_loss: 116192.3438
```

```
Epoch 52/400
6/6              0s 3ms/step - loss:
108936.9453 - val_loss: 116503.9453
Epoch 53/400
6/6              0s 3ms/step - loss:
105067.4688 - val_loss: 116023.6172
Epoch 54/400
6/6              0s 3ms/step - loss:
110836.3906 - val_loss: 115784.0391
Epoch 55/400
6/6              0s 7ms/step - loss:
106502.3828 - val_loss: 115701.6953
Epoch 56/400
6/6              0s 3ms/step - loss:
102138.6328 - val_loss: 115667.1172
Epoch 57/400
6/6              0s 3ms/step - loss:
106173.0781 - val_loss: 115630.8906
Epoch 58/400
6/6              0s 3ms/step - loss:
104738.2578 - val_loss: 115572.9453
Epoch 59/400
6/6              0s 3ms/step - loss:
106850.0938 - val_loss: 115233.7578
Epoch 60/400
6/6              0s 3ms/step - loss:
102399.3125 - val_loss: 115036.9297
Epoch 61/400
6/6              0s 2ms/step - loss:
105483.9766 - val_loss: 114654.6953
Epoch 62/400
6/6              0s 3ms/step - loss:
104297.2344 - val_loss: 114710.3750
Epoch 63/400
6/6              0s 3ms/step - loss:
99108.6406 - val_loss: 114836.6797
Epoch 64/400
6/6              0s 3ms/step - loss:
98812.9062 - val_loss: 114629.5703
Epoch 65/400
6/6              0s 3ms/step - loss:
104802.1562 - val_loss: 114648.6953
Epoch 66/400
6/6              0s 2ms/step - loss:
101293.5703 - val_loss: 114455.1484
Epoch 67/400
6/6              0s 2ms/step - loss:
106293.8594 - val_loss: 114307.4141
```

```
Epoch 68/400
6/6              0s 2ms/step - loss:
105356.1250 - val_loss: 113978.9609
Epoch 69/400
6/6              0s 2ms/step - loss:
103904.9609 - val_loss: 113985.2266
Epoch 70/400
6/6              0s 7ms/step - loss:
101193.2891 - val_loss: 113960.7344
Epoch 71/400
6/6              0s 3ms/step - loss:
100685.5156 - val_loss: 113831.1719
Epoch 72/400
6/6              0s 3ms/step - loss:
101077.9141 - val_loss: 113510.2109
Epoch 73/400
6/6              0s 2ms/step - loss:
101430.8281 - val_loss: 113775.7188
Epoch 74/400
6/6              0s 2ms/step - loss:
107048.1875 - val_loss: 113596.6406
Epoch 75/400
6/6              0s 3ms/step - loss:
100271.9609 - val_loss: 113503.8438
Epoch 76/400
6/6              0s 3ms/step - loss:
105212.8125 - val_loss: 113281.0000
Epoch 77/400
6/6              0s 2ms/step - loss:
97958.9219 - val_loss: 113191.0781
Epoch 78/400
6/6              0s 2ms/step - loss:
101316.8594 - val_loss: 112998.3203
Epoch 79/400
6/6              0s 2ms/step - loss:
102297.7109 - val_loss: 112811.5234
Epoch 80/400
6/6              0s 2ms/step - loss:
100130.8594 - val_loss: 112605.7969
Epoch 81/400
6/6              0s 2ms/step - loss:
98177.4297 - val_loss: 112755.3047
Epoch 82/400
6/6              0s 3ms/step - loss:
98812.0000 - val_loss: 112593.4766
Epoch 83/400
6/6              0s 2ms/step - loss:
101736.9688 - val_loss: 112632.1328
```

```
Epoch 84/400
6/6              0s 3ms/step - loss:
99972.5469 - val_loss: 112543.4688
Epoch 85/400
6/6              0s 2ms/step - loss:
103594.8828 - val_loss: 112298.2969
Epoch 86/400
6/6              0s 2ms/step - loss:
101418.0938 - val_loss: 112552.2500
Epoch 87/400
6/6              0s 2ms/step - loss:
99518.3438 - val_loss: 112585.6641
Epoch 88/400
6/6              0s 2ms/step - loss:
96317.5156 - val_loss: 112212.3047
Epoch 89/400
6/6              0s 2ms/step - loss:
97904.5234 - val_loss: 111657.2500
Epoch 90/400
6/6              0s 2ms/step - loss:
101029.6406 - val_loss: 111750.1406
Epoch 91/400
6/6              0s 2ms/step - loss:
100108.1484 - val_loss: 112074.5859
Epoch 92/400
6/6              0s 2ms/step - loss:
100821.3516 - val_loss: 112095.4922
Epoch 93/400
6/6              0s 3ms/step - loss:
100942.6406 - val_loss: 112109.6562
Epoch 94/400
6/6              0s 3ms/step - loss:
99578.4453 - val_loss: 112189.0938
Epoch 95/400
6/6              0s 3ms/step - loss:
97179.1328 - val_loss: 111833.0000
Epoch 96/400
6/6              0s 2ms/step - loss:
91307.8906 - val_loss: 111353.4766
Epoch 97/400
6/6              0s 7ms/step - loss:
103153.9609 - val_loss: 111188.5859
Epoch 98/400
6/6              0s 2ms/step - loss:
92734.7734 - val_loss: 111293.4297
Epoch 99/400
6/6              0s 2ms/step - loss:
96233.8672 - val_loss: 111674.5078
```

```
Epoch 100/400
6/6              0s 2ms/step - loss:
97161.6094 - val_loss: 111392.6641
Epoch 101/400
6/6              0s 3ms/step - loss:
95064.5938 - val_loss: 111098.8984
Epoch 102/400
6/6              0s 2ms/step - loss:
98323.6719 - val_loss: 110700.2422
Epoch 103/400
6/6              0s 3ms/step - loss:
95936.0625 - val_loss: 110623.1562
Epoch 104/400
6/6              0s 3ms/step - loss:
97562.5000 - val_loss: 110560.1875
Epoch 105/400
6/6              0s 3ms/step - loss:
99401.7031 - val_loss: 110711.8438
Epoch 106/400
6/6              0s 2ms/step - loss:
95295.4453 - val_loss: 111253.0234
Epoch 107/400
6/6              0s 3ms/step - loss:
102398.4453 - val_loss: 111347.3828
Epoch 108/400
6/6              0s 6ms/step - loss:
93851.4766 - val_loss: 111426.3594
Epoch 109/400
6/6              0s 3ms/step - loss:
100982.5781 - val_loss: 110839.3438
Epoch 110/400
6/6              0s 3ms/step - loss:
98044.6875 - val_loss: 110702.6406
Epoch 111/400
6/6              0s 2ms/step - loss:
101910.3359 - val_loss: 110602.5703
Epoch 112/400
6/6              0s 2ms/step - loss:
95795.2891 - val_loss: 110442.7031
Epoch 113/400
6/6              0s 2ms/step - loss:
93526.5234 - val_loss: 110134.4062
Epoch 114/400
6/6              0s 2ms/step - loss:
93757.3359 - val_loss: 110017.7422
Epoch 115/400
6/6              0s 2ms/step - loss:
94942.3906 - val_loss: 109938.3438
```

```
Epoch 116/400
6/6              0s 3ms/step - loss:
97274.5000 - val_loss: 110183.5391
Epoch 117/400
6/6              0s 2ms/step - loss:
95426.4297 - val_loss: 110436.2422
Epoch 118/400
6/6              0s 2ms/step - loss:
88340.5156 - val_loss: 110021.8438
Epoch 119/400
6/6              0s 2ms/step - loss:
94667.1797 - val_loss: 109458.5078
Epoch 120/400
6/6              0s 2ms/step - loss:
93300.6094 - val_loss: 109498.8438
Epoch 121/400
6/6              0s 2ms/step - loss:
96824.7344 - val_loss: 109549.4531
Epoch 122/400
6/6              0s 7ms/step - loss:
94339.7031 - val_loss: 109993.9531
Epoch 123/400
6/6              0s 2ms/step - loss:
96003.0703 - val_loss: 110043.1641
Epoch 124/400
6/6              0s 3ms/step - loss:
94693.0469 - val_loss: 109685.7969
Epoch 125/400
6/6              0s 3ms/step - loss:
89819.1719 - val_loss: 109575.7969
Epoch 126/400
6/6              0s 3ms/step - loss:
91817.7500 - val_loss: 109155.9141
Epoch 127/400
6/6              0s 2ms/step - loss:
94918.4375 - val_loss: 109390.4375
Epoch 128/400
6/6              0s 2ms/step - loss:
91948.4688 - val_loss: 109791.1562
Epoch 129/400
6/6              0s 2ms/step - loss:
94831.5938 - val_loss: 109746.0234
Epoch 130/400
6/6              0s 2ms/step - loss:
92348.1250 - val_loss: 109143.5703
Epoch 131/400
6/6              0s 2ms/step - loss:
97739.9531 - val_loss: 109126.6172
```

```
Epoch 132/400
6/6              0s 2ms/step - loss:
93170.8906 - val_loss: 108923.5859
Epoch 133/400
6/6              0s 2ms/step - loss:
95027.2969 - val_loss: 108962.4766
Epoch 134/400
6/6              0s 2ms/step - loss:
97395.9531 - val_loss: 108864.0234
Epoch 135/400
6/6              0s 3ms/step - loss:
95406.4375 - val_loss: 109460.3984
Epoch 136/400
6/6              0s 2ms/step - loss:
92080.0938 - val_loss: 108749.1094
Epoch 137/400
6/6              0s 2ms/step - loss:
90146.5000 - val_loss: 108798.6328
Epoch 138/400
6/6              0s 3ms/step - loss:
97867.4453 - val_loss: 108807.3828
Epoch 139/400
6/6              0s 2ms/step - loss:
93317.4922 - val_loss: 109059.6875
Epoch 140/400
6/6              0s 2ms/step - loss:
92631.1016 - val_loss: 109000.3125
Epoch 141/400
6/6              0s 2ms/step - loss:
93470.0781 - val_loss: 108886.4766
Epoch 142/400
6/6              0s 2ms/step - loss:
92791.7969 - val_loss: 108572.6562
Epoch 143/400
6/6              0s 2ms/step - loss:
93845.9141 - val_loss: 108338.2500
Epoch 144/400
6/6              0s 2ms/step - loss:
93843.6875 - val_loss: 108340.0547
Epoch 145/400
6/6              0s 2ms/step - loss:
92812.9453 - val_loss: 108411.1484
Epoch 146/400
6/6              0s 3ms/step - loss:
90534.5391 - val_loss: 108987.2109
Epoch 147/400
6/6              0s 2ms/step - loss:
89224.2656 - val_loss: 108561.2500
```

```
Epoch 148/400
6/6              0s 3ms/step - loss:
97404.3984 - val_loss: 107757.2266
Epoch 149/400
6/6              0s 2ms/step - loss:
91255.8516 - val_loss: 107954.0156
Epoch 150/400
6/6              0s 2ms/step - loss:
93032.6172 - val_loss: 108772.4453
Epoch 151/400
6/6              0s 2ms/step - loss:
95074.0391 - val_loss: 108795.8984
Epoch 152/400
6/6              0s 2ms/step - loss:
92868.7031 - val_loss: 108750.4062
Epoch 153/400
6/6              0s 3ms/step - loss:
89781.8359 - val_loss: 108507.6875
Epoch 154/400
6/6              0s 2ms/step - loss:
96933.7422 - val_loss: 108124.0078
Epoch 155/400
6/6              0s 2ms/step - loss:
92353.6094 - val_loss: 107422.1172
Epoch 156/400
6/6              0s 3ms/step - loss:
93219.1484 - val_loss: 107604.8672
Epoch 157/400
6/6              0s 2ms/step - loss:
93197.2422 - val_loss: 107680.7500
Epoch 158/400
6/6              0s 3ms/step - loss:
90941.0391 - val_loss: 107587.7969
Epoch 159/400
6/6              0s 2ms/step - loss:
92118.8438 - val_loss: 108656.3359
Epoch 160/400
6/6              0s 3ms/step - loss:
92200.1875 - val_loss: 108448.0938
Epoch 161/400
6/6              0s 2ms/step - loss:
89882.9688 - val_loss: 108137.9062
Epoch 162/400
6/6              0s 2ms/step - loss:
86845.3672 - val_loss: 107737.6016
Epoch 163/400
6/6              0s 2ms/step - loss:
96489.6562 - val_loss: 107600.6172
```

```
Epoch 164/400
6/6              0s 2ms/step - loss:
91119.9062 - val_loss: 107774.5938
Epoch 165/400
6/6              0s 2ms/step - loss:
86084.5547 - val_loss: 107816.6250
Epoch 166/400
6/6              0s 2ms/step - loss:
88998.3750 - val_loss: 108135.4375
Epoch 167/400
6/6              0s 2ms/step - loss:
93416.5234 - val_loss: 107726.2031
Epoch 168/400
6/6              0s 2ms/step - loss:
91821.3047 - val_loss: 107256.1250
Epoch 169/400
6/6              0s 6ms/step - loss:
90638.4844 - val_loss: 107182.5781
Epoch 170/400
6/6              0s 2ms/step - loss:
88634.5391 - val_loss: 107023.0000
Epoch 171/400
6/6              0s 2ms/step - loss:
92926.1953 - val_loss: 107837.7500
Epoch 172/400
6/6              0s 2ms/step - loss:
91858.4688 - val_loss: 107401.4531
Epoch 173/400
6/6              0s 2ms/step - loss:
89935.2344 - val_loss: 107047.3594
Epoch 174/400
6/6              0s 2ms/step - loss:
89440.0078 - val_loss: 107344.9297
Epoch 175/400
6/6              0s 2ms/step - loss:
92093.7891 - val_loss: 108247.8438
Epoch 176/400
6/6              0s 2ms/step - loss:
90809.6484 - val_loss: 108109.1172
Epoch 177/400
6/6              0s 2ms/step - loss:
95674.5391 - val_loss: 107214.7266
Epoch 178/400
6/6              0s 2ms/step - loss:
87530.2656 - val_loss: 107013.6875
Epoch 179/400
6/6              0s 2ms/step - loss:
91959.2422 - val_loss: 106795.7969
```

```
Epoch 180/400
6/6              0s 3ms/step - loss:
90642.5156 - val_loss: 106719.7969
Epoch 181/400
6/6              0s 2ms/step - loss:
94325.5703 - val_loss: 106990.6562
Epoch 182/400
6/6              0s 2ms/step - loss:
90067.0000 - val_loss: 107023.9062
Epoch 183/400
6/6              0s 2ms/step - loss:
89668.5703 - val_loss: 107378.9297
Epoch 184/400
6/6              0s 2ms/step - loss:
91002.8203 - val_loss: 107172.1719
Epoch 185/400
6/6              0s 2ms/step - loss:
92590.6484 - val_loss: 106965.7188
Epoch 186/400
6/6              0s 2ms/step - loss:
90534.6562 - val_loss: 107225.7031
Epoch 187/400
6/6              0s 2ms/step - loss:
93303.1953 - val_loss: 107269.9062
Epoch 188/400
6/6              0s 2ms/step - loss:
86817.9297 - val_loss: 107262.8750
Epoch 189/400
6/6              0s 2ms/step - loss:
89633.8359 - val_loss: 107542.9453
Epoch 190/400
6/6              0s 2ms/step - loss:
89983.8594 - val_loss: 107600.6719
Epoch 191/400
6/6              0s 2ms/step - loss:
88239.7109 - val_loss: 106478.9609
Epoch 192/400
6/6              0s 3ms/step - loss:
91285.9844 - val_loss: 106534.0859
Epoch 193/400
6/6              0s 7ms/step - loss:
88935.4062 - val_loss: 107199.7500
Epoch 194/400
6/6              0s 3ms/step - loss:
90536.5703 - val_loss: 107667.4297
Epoch 195/400
6/6              0s 2ms/step - loss:
90788.6172 - val_loss: 106972.6484
```

```
Epoch 196/400
6/6              0s 2ms/step - loss:
92469.5469 - val_loss: 106716.2266
Epoch 197/400
6/6              0s 3ms/step - loss:
87597.0000 - val_loss: 106414.1016
Epoch 198/400
6/6              0s 2ms/step - loss:
89159.0625 - val_loss: 106573.7969
Epoch 199/400
6/6              0s 3ms/step - loss:
89547.6797 - val_loss: 106238.8516
Epoch 200/400
6/6              0s 2ms/step - loss:
89192.8438 - val_loss: 106603.5938
Epoch 201/400
6/6              0s 2ms/step - loss:
87509.3672 - val_loss: 106337.8984
Epoch 202/400
6/6              0s 2ms/step - loss:
89817.4062 - val_loss: 106585.3125
Epoch 203/400
6/6              0s 2ms/step - loss:
88505.1406 - val_loss: 106518.7031
Epoch 204/400
6/6              0s 6ms/step - loss:
90583.3203 - val_loss: 106018.4922
Epoch 205/400
6/6              0s 2ms/step - loss:
88101.7891 - val_loss: 106297.4062
Epoch 206/400
6/6              0s 2ms/step - loss:
89472.6016 - val_loss: 107365.7031
Epoch 207/400
6/6              0s 2ms/step - loss:
88990.2188 - val_loss: 107425.6094
Epoch 208/400
6/6              0s 2ms/step - loss:
87777.1719 - val_loss: 106660.2031
Epoch 209/400
6/6              0s 2ms/step - loss:
88701.9922 - val_loss: 105803.8359
Epoch 210/400
6/6              0s 2ms/step - loss:
85499.5391 - val_loss: 106051.4688
Epoch 211/400
6/6              0s 2ms/step - loss:
88376.0938 - val_loss: 106668.7969
```

```
Epoch 212/400
6/6              0s 2ms/step - loss:
90027.7969 - val_loss: 107092.4766
Epoch 213/400
6/6              0s 2ms/step - loss:
89023.3438 - val_loss: 106767.3906
Epoch 214/400
6/6              0s 3ms/step - loss:
92418.4922 - val_loss: 106336.7031
Epoch 215/400
6/6              0s 3ms/step - loss:
88059.7812 - val_loss: 106351.2812
Epoch 216/400
6/6              0s 2ms/step - loss:
88150.7734 - val_loss: 106155.6953
Epoch 217/400
6/6              0s 3ms/step - loss:
85868.5938 - val_loss: 106931.6875
Epoch 218/400
6/6              0s 2ms/step - loss:
87874.5000 - val_loss: 106806.3047
Epoch 219/400
6/6              0s 2ms/step - loss:
88514.2578 - val_loss: 106207.1875
Epoch 220/400
6/6              0s 2ms/step - loss:
91389.7812 - val_loss: 106316.7812
Epoch 221/400
6/6              0s 2ms/step - loss:
92232.7656 - val_loss: 107193.7109
Epoch 222/400
6/6              0s 2ms/step - loss:
90357.8438 - val_loss: 106185.3906
Epoch 223/400
6/6              0s 2ms/step - loss:
88758.5156 - val_loss: 106157.9922
Epoch 224/400
6/6              0s 2ms/step - loss:
88037.3984 - val_loss: 106640.9219
Epoch 225/400
6/6              0s 2ms/step - loss:
88011.7891 - val_loss: 106724.4062
Epoch 226/400
6/6              0s 2ms/step - loss:
89935.6641 - val_loss: 106300.0156
Epoch 227/400
6/6              0s 3ms/step - loss:
90145.3906 - val_loss: 106234.2969
```

```
Epoch 228/400
6/6             0s 2ms/step - loss:
90352.5078 - val_loss: 105965.2500
Epoch 229/400
6/6             0s 2ms/step - loss:
90101.0000 - val_loss: 106208.2031
Epoch 230/400
6/6             0s 2ms/step - loss:
90381.8828 - val_loss: 106299.7891
Epoch 231/400
6/6             0s 2ms/step - loss:
88495.3906 - val_loss: 105591.8516
Epoch 232/400
6/6             0s 2ms/step - loss:
85050.0469 - val_loss: 105682.6250
Epoch 233/400
6/6             0s 2ms/step - loss:
85136.0469 - val_loss: 107090.7500
Epoch 234/400
6/6             0s 2ms/step - loss:
85503.6328 - val_loss: 107187.9844
Epoch 235/400
6/6             0s 2ms/step - loss:
87969.0234 - val_loss: 105958.9688
Epoch 236/400
6/6             0s 5ms/step - loss:
88056.2812 - val_loss: 105296.9844
Epoch 237/400
6/6             0s 2ms/step - loss:
88730.8516 - val_loss: 106234.7500
Epoch 238/400
6/6             0s 2ms/step - loss:
87123.8750 - val_loss: 105890.0703
Epoch 239/400
6/6             0s 2ms/step - loss:
88610.9531 - val_loss: 105895.2656
Epoch 240/400
6/6             0s 2ms/step - loss:
89898.7969 - val_loss: 105728.5234
Epoch 241/400
6/6             0s 2ms/step - loss:
88488.2578 - val_loss: 105937.8438
Epoch 242/400
6/6             0s 2ms/step - loss:
89599.2812 - val_loss: 106146.6562
Epoch 243/400
6/6             0s 2ms/step - loss:
90119.2422 - val_loss: 105798.2891
```

```
Epoch 244/400
6/6            0s 2ms/step - loss:
85537.2734 - val_loss: 105482.0000
Epoch 245/400
6/6            0s 2ms/step - loss:
88516.4766 - val_loss: 106020.7891
Epoch 246/400
6/6            0s 5ms/step - loss:
88248.7031 - val_loss: 105804.9531
Epoch 247/400
6/6            0s 2ms/step - loss:
83636.2812 - val_loss: 106149.4844
Epoch 248/400
6/6            0s 2ms/step - loss:
88670.6094 - val_loss: 105576.5234
Epoch 249/400
6/6            0s 2ms/step - loss:
86249.7812 - val_loss: 105857.4531
Epoch 250/400
6/6            0s 2ms/step - loss:
90295.8359 - val_loss: 106380.3359
Epoch 251/400
6/6            0s 2ms/step - loss:
87396.7266 - val_loss: 105928.8359
Epoch 252/400
6/6            0s 2ms/step - loss:
90117.9844 - val_loss: 104853.6562
Epoch 253/400
6/6            0s 2ms/step - loss:
89430.9219 - val_loss: 105257.2656
Epoch 254/400
6/6            0s 2ms/step - loss:
86742.4688 - val_loss: 105174.5547
Epoch 255/400
6/6            0s 2ms/step - loss:
83379.2344 - val_loss: 106138.8750
Epoch 256/400
6/6            0s 2ms/step - loss:
85900.0078 - val_loss: 107037.4766
Epoch 257/400
6/6            0s 5ms/step - loss:
86500.5312 - val_loss: 106124.4453
Epoch 258/400
6/6            0s 2ms/step - loss:
88281.2500 - val_loss: 104638.1484
Epoch 259/400
6/6            0s 2ms/step - loss:
82872.6172 - val_loss: 104592.3438
```

```
Epoch 260/400
6/6              0s 2ms/step - loss:
85750.4766 - val_loss: 106154.7969
Epoch 261/400
6/6              0s 2ms/step - loss:
83477.0000 - val_loss: 106115.3828
Epoch 262/400
6/6              0s 2ms/step - loss:
81602.6406 - val_loss: 105189.0156
Epoch 263/400
6/6              0s 2ms/step - loss:
87957.5078 - val_loss: 104965.5703
Epoch 264/400
6/6              0s 2ms/step - loss:
85774.0547 - val_loss: 104583.6875
Epoch 265/400
6/6              0s 2ms/step - loss:
87150.8281 - val_loss: 104554.1875
Epoch 266/400
6/6              0s 2ms/step - loss:
88210.0625 - val_loss: 104586.2812
Epoch 267/400
6/6              0s 5ms/step - loss:
84195.1953 - val_loss: 105464.9453
Epoch 268/400
6/6              0s 2ms/step - loss:
88352.0625 - val_loss: 106017.2969
Epoch 269/400
6/6              0s 2ms/step - loss:
85808.4844 - val_loss: 103827.0547
Epoch 270/400
6/6              0s 2ms/step - loss:
86619.4219 - val_loss: 104125.3750
Epoch 271/400
6/6              0s 2ms/step - loss:
87910.5703 - val_loss: 104987.4141
Epoch 272/400
6/6              0s 2ms/step - loss:
88181.5625 - val_loss: 104925.1484
Epoch 273/400
6/6              0s 2ms/step - loss:
89449.6328 - val_loss: 104745.7188
Epoch 274/400
6/6              0s 2ms/step - loss:
88473.3438 - val_loss: 104017.1406
Epoch 275/400
6/6              0s 2ms/step - loss:
86475.2422 - val_loss: 103648.6484
```

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Epoch 276/400
6/6              0s 2ms/step - loss:
86042.0938 - val_loss: 104528.6250
Epoch 277/400
6/6              0s 5ms/step - loss:
87710.3516 - val_loss: 105595.1953
Epoch 278/400
6/6              0s 2ms/step - loss:
82974.0547 - val_loss: 104386.5000
Epoch 279/400
6/6              0s 2ms/step - loss:
85695.7109 - val_loss: 103414.4922
Epoch 280/400
6/6              0s 2ms/step - loss:
82982.6484 - val_loss: 104173.1875
Epoch 281/400
6/6              0s 2ms/step - loss:
85182.2500 - val_loss: 104089.0703
Epoch 282/400
6/6              0s 2ms/step - loss:
85277.1406 - val_loss: 104746.7578
Epoch 283/400
6/6              0s 2ms/step - loss:
82810.4922 - val_loss: 103689.2422
Epoch 284/400
6/6              0s 2ms/step - loss:
83776.0703 - val_loss: 103362.9766
Epoch 285/400
6/6              0s 2ms/step - loss:
88933.8281 - val_loss: 104795.6172
Epoch 286/400
6/6              0s 2ms/step - loss:
83765.7344 - val_loss: 103357.7188
Epoch 287/400
6/6              0s 5ms/step - loss:
84113.7656 - val_loss: 103585.4141
Epoch 288/400
6/6              0s 2ms/step - loss:
86360.8359 - val_loss: 103286.7969
Epoch 289/400
6/6              0s 2ms/step - loss:
83865.7734 - val_loss: 103266.3125
Epoch 290/400
6/6              0s 2ms/step - loss:
84417.5547 - val_loss: 102964.0938
Epoch 291/400
6/6              0s 2ms/step - loss:
86212.3984 - val_loss: 103062.6641
```

```
Epoch 292/400
6/6              0s 2ms/step - loss:
84351.9297 - val_loss: 102984.7500
Epoch 293/400
6/6              0s 2ms/step - loss:
85149.5625 - val_loss: 103731.2500
Epoch 294/400
6/6              0s 2ms/step - loss:
82969.1172 - val_loss: 102891.1719
Epoch 295/400
6/6              0s 2ms/step - loss:
82135.2891 - val_loss: 102329.4297
Epoch 296/400
6/6              0s 5ms/step - loss:
84182.0469 - val_loss: 101539.0000
Epoch 297/400
6/6              0s 2ms/step - loss:
81470.7969 - val_loss: 102677.3438
Epoch 298/400
6/6              0s 2ms/step - loss:
84816.4141 - val_loss: 104056.6172
Epoch 299/400
6/6              0s 2ms/step - loss:
83057.0469 - val_loss: 102733.8125
Epoch 300/400
6/6              0s 2ms/step - loss:
80283.3906 - val_loss: 101864.1406
Epoch 301/400
6/6              0s 2ms/step - loss:
83718.4766 - val_loss: 101935.1250
Epoch 302/400
6/6              0s 2ms/step - loss:
80819.1797 - val_loss: 101469.5625
Epoch 303/400
6/6              0s 2ms/step - loss:
82382.1562 - val_loss: 101666.8672
Epoch 304/400
6/6              0s 2ms/step - loss:
82424.9609 - val_loss: 102014.4766
Epoch 305/400
6/6              0s 3ms/step - loss:
80123.1016 - val_loss: 101454.1172
Epoch 306/400
6/6              0s 2ms/step - loss:
83009.2734 - val_loss: 101288.7500
Epoch 307/400
6/6              0s 2ms/step - loss:
80603.3516 - val_loss: 101799.4766
```

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Epoch 308/400
6/6              0s 2ms/step - loss:
81865.7188 - val_loss: 101046.5312
Epoch 309/400
6/6              0s 2ms/step - loss:
81988.5234 - val_loss: 101225.0859
Epoch 310/400
6/6              0s 2ms/step - loss:
81733.2422 - val_loss: 101700.4531
Epoch 311/400
6/6              0s 2ms/step - loss:
84653.2812 - val_loss: 100754.5391
Epoch 312/400
6/6              0s 2ms/step - loss:
79676.4375 - val_loss: 100227.2188
Epoch 313/400
6/6              0s 2ms/step - loss:
82172.1719 - val_loss: 100711.0391
Epoch 314/400
6/6              0s 3ms/step - loss:
84352.0859 - val_loss: 100292.8125
Epoch 315/400
6/6              0s 2ms/step - loss:
81949.8906 - val_loss: 100244.2812
Epoch 316/400
6/6              0s 2ms/step - loss:
81471.5859 - val_loss: 100616.4688
Epoch 317/400
6/6              0s 2ms/step - loss:
84023.9062 - val_loss: 100032.7344
Epoch 318/400
6/6              0s 2ms/step - loss:
80514.3750 - val_loss: 99432.1875
Epoch 319/400
6/6              0s 2ms/step - loss:
81235.0469 - val_loss: 99729.0469
Epoch 320/400
6/6              0s 2ms/step - loss:
82509.7422 - val_loss: 99906.8672
Epoch 321/400
6/6              0s 2ms/step - loss:
79846.1328 - val_loss: 100049.0859
Epoch 322/400
6/6              0s 4ms/step - loss:
81784.3438 - val_loss: 99584.7500
Epoch 323/400
6/6              0s 2ms/step - loss:
83593.5547 - val_loss: 98826.5312
```

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Epoch 324/400
6/6              0s 2ms/step - loss:
80155.9297 - val_loss: 99234.8125
Epoch 325/400
6/6              0s 2ms/step - loss:
78801.8359 - val_loss: 99344.3750
Epoch 326/400
6/6              0s 2ms/step - loss:
83436.4609 - val_loss: 98027.1172
Epoch 327/400
6/6              0s 2ms/step - loss:
81803.5312 - val_loss: 98800.0781
Epoch 328/400
6/6              0s 2ms/step - loss:
81209.8984 - val_loss: 98092.3281
Epoch 329/400
6/6              0s 2ms/step - loss:
77972.0312 - val_loss: 97763.7500
Epoch 330/400
6/6              0s 2ms/step - loss:
80649.8906 - val_loss: 97206.6562
Epoch 331/400
6/6              0s 2ms/step - loss:
80210.4219 - val_loss: 97671.7969
Epoch 332/400
6/6              0s 2ms/step - loss:
82133.4453 - val_loss: 98130.0391
Epoch 333/400
6/6              0s 3ms/step - loss:
79252.8281 - val_loss: 97073.0391
Epoch 334/400
6/6              0s 2ms/step - loss:
81599.2500 - val_loss: 97309.5156
Epoch 335/400
6/6              0s 2ms/step - loss:
78423.5156 - val_loss: 97636.0703
Epoch 336/400
6/6              0s 2ms/step - loss:
77344.8516 - val_loss: 96521.8906
Epoch 337/400
6/6              0s 2ms/step - loss:
76687.1641 - val_loss: 96598.4297
Epoch 338/400
6/6              0s 2ms/step - loss:
77167.9141 - val_loss: 96177.2656
Epoch 339/400
6/6              0s 2ms/step - loss:
75558.3281 - val_loss: 96347.2109
```

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Epoch 340/400
6/6              0s 2ms/step - loss:
80296.3594 - val_loss: 95972.2969
Epoch 341/400
6/6              0s 2ms/step - loss:
76895.0625 - val_loss: 95796.6641
Epoch 342/400
6/6              0s 2ms/step - loss:
79765.4531 - val_loss: 95745.1484
Epoch 343/400
6/6              0s 7ms/step - loss:
76988.1797 - val_loss: 95469.1719
Epoch 344/400
6/6              0s 2ms/step - loss:
72690.7656 - val_loss: 94374.2734
Epoch 345/400
6/6              0s 2ms/step - loss:
78163.6250 - val_loss: 94567.8125
Epoch 346/400
6/6              0s 2ms/step - loss:
79701.8438 - val_loss: 94870.5703
Epoch 347/400
6/6              0s 2ms/step - loss:
75034.9922 - val_loss: 94777.6328
Epoch 348/400
6/6              0s 2ms/step - loss:
80341.7344 - val_loss: 93849.0156
Epoch 349/400
6/6              0s 2ms/step - loss:
73664.5781 - val_loss: 92920.8359
Epoch 350/400
6/6              0s 2ms/step - loss:
71984.5938 - val_loss: 95186.6797
Epoch 351/400
6/6              0s 2ms/step - loss:
78532.0938 - val_loss: 93537.7500
Epoch 352/400
6/6              0s 2ms/step - loss:
76018.6406 - val_loss: 92466.7344
Epoch 353/400
6/6              0s 6ms/step - loss:
70966.1484 - val_loss: 91961.9766
Epoch 354/400
6/6              0s 2ms/step - loss:
73343.1328 - val_loss: 92410.6641
Epoch 355/400
6/6              0s 2ms/step - loss:
70015.5312 - val_loss: 92471.7969
```

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Epoch 356/400
6/6            0s 2ms/step - loss:
74840.8281 - val_loss: 90898.8594
Epoch 357/400
6/6            0s 2ms/step - loss:
72732.4062 - val_loss: 91220.2891
Epoch 358/400
6/6            0s 2ms/step - loss:
74162.2344 - val_loss: 91583.9688
Epoch 359/400
6/6            0s 2ms/step - loss:
74259.5547 - val_loss: 92931.6406
Epoch 360/400
6/6            0s 2ms/step - loss:
72754.9844 - val_loss: 90316.5703
Epoch 361/400
6/6            0s 2ms/step - loss:
73274.7266 - val_loss: 88906.4375
Epoch 362/400
6/6            0s 2ms/step - loss:
69126.5625 - val_loss: 89997.2031
Epoch 363/400
6/6            0s 2ms/step - loss:
72972.4531 - val_loss: 90069.8516
Epoch 364/400
6/6            0s 2ms/step - loss:
73014.9531 - val_loss: 89685.9062
Epoch 365/400
6/6            0s 2ms/step - loss:
71111.5156 - val_loss: 89399.3984
Epoch 366/400
6/6            0s 3ms/step - loss:
72579.8672 - val_loss: 87798.2734
Epoch 367/400
6/6            0s 2ms/step - loss:
71627.7891 - val_loss: 88554.5938
Epoch 368/400
6/6            0s 2ms/step - loss:
73145.5156 - val_loss: 86894.6797
Epoch 369/400
6/6            0s 2ms/step - loss:
68474.8594 - val_loss: 87037.6875
Epoch 370/400
6/6            0s 2ms/step - loss:
72591.8594 - val_loss: 87081.8828
Epoch 371/400
6/6            0s 2ms/step - loss:
71517.3828 - val_loss: 86352.2500
```

```
Epoch 372/400
6/6             0s 2ms/step - loss:
71013.9453 - val_loss: 86361.1250
Epoch 373/400
6/6             0s 2ms/step - loss:
70105.1406 - val_loss: 86611.0391
Epoch 374/400
6/6             0s 2ms/step - loss:
69483.0234 - val_loss: 85847.1953
Epoch 375/400
6/6             0s 2ms/step - loss:
69408.4844 - val_loss: 85494.9766
Epoch 376/400
6/6             0s 3ms/step - loss:
68734.0234 - val_loss: 83787.6406
Epoch 377/400
6/6             0s 2ms/step - loss:
70863.0469 - val_loss: 84312.1094
Epoch 378/400
6/6             0s 2ms/step - loss:
65588.0312 - val_loss: 84586.6641
Epoch 379/400
6/6             0s 2ms/step - loss:
66461.0938 - val_loss: 83600.6016
Epoch 380/400
6/6             0s 2ms/step - loss:
63100.5820 - val_loss: 82329.1328
Epoch 381/400
6/6             0s 2ms/step - loss:
68481.3281 - val_loss: 82803.8438
Epoch 382/400
6/6             0s 2ms/step - loss:
66498.0312 - val_loss: 83072.6172
Epoch 383/400
6/6             0s 2ms/step - loss:
62005.3711 - val_loss: 81308.2969
Epoch 384/400
6/6             0s 2ms/step - loss:
64901.6992 - val_loss: 81178.8047
Epoch 385/400
6/6             0s 2ms/step - loss:
62851.8672 - val_loss: 81037.4375
Epoch 386/400
6/6             0s 2ms/step - loss:
63594.5742 - val_loss: 80369.5469
Epoch 387/400
6/6             0s 2ms/step - loss:
64317.8125 - val_loss: 81073.1797
```

```
Epoch 388/400
6/6                0s 2ms/step - loss:
65234.2109 - val_loss: 80148.2109
Epoch 389/400
6/6                0s 2ms/step - loss:
58065.9766 - val_loss: 77441.2891
Epoch 390/400
6/6                0s 2ms/step - loss:
59977.1992 - val_loss: 78456.6797
Epoch 391/400
6/6                0s 2ms/step - loss:
60832.8828 - val_loss: 80550.0156
Epoch 392/400
6/6                0s 2ms/step - loss:
63472.3320 - val_loss: 77411.4375
Epoch 393/400
6/6                0s 2ms/step - loss:
60556.0859 - val_loss: 76176.9766
Epoch 394/400
6/6                0s 2ms/step - loss:
59348.3359 - val_loss: 77165.4219
Epoch 395/400
6/6                0s 2ms/step - loss:
60392.1445 - val_loss: 77452.6875
Epoch 396/400
6/6                0s 6ms/step - loss:
58289.0000 - val_loss: 75554.1172
Epoch 397/400
6/6                0s 2ms/step - loss:
60689.7109 - val_loss: 75394.3281
Epoch 398/400
6/6                0s 2ms/step - loss:
59848.1406 - val_loss: 74862.2109
Epoch 399/400
6/6                0s 2ms/step - loss:
59722.2539 - val_loss: 74465.6172
Epoch 400/400
6/6                0s 2ms/step - loss:
60333.4375 - val_loss: 73995.6953
```
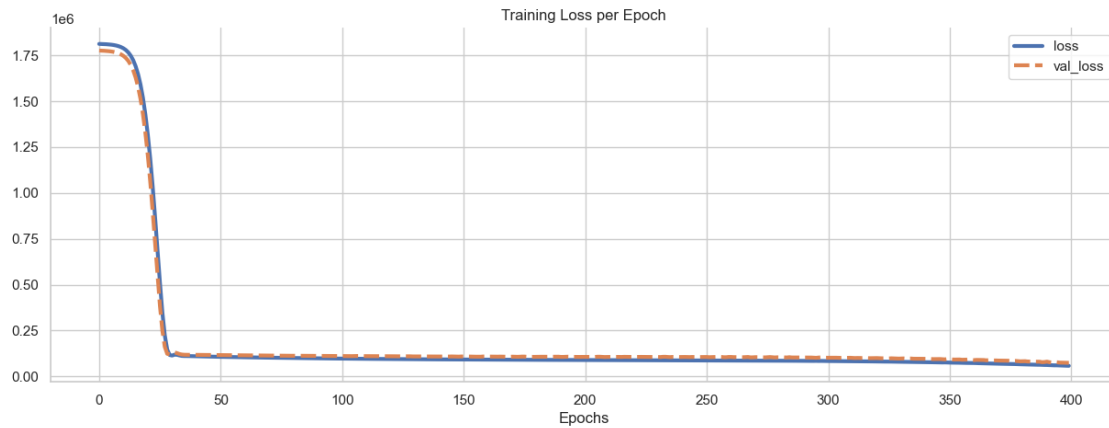
[56]: `<keras.src.callbacks.history.History at 0x1774efa30>`

[57]:
```python
losses = pd.DataFrame(model.history.history)

plt.figure(figsize=(15,5))
sns.lineplot(data=losses,lw=3)
plt.xlabel('Epochs')
```

```
plt.ylabel('')
plt.title('Training Loss per Epoch')
sns.despine()
plt.show()
```


[58]:
```
# predictions on the test set
predictions = model.predict(X_test)

print('MAE: ',mean_absolute_error(y_test,predictions))
print('MSE: ',mean_squared_error(y_test,predictions))
print('RMSE: ',np.sqrt(mean_squared_error(y_test,predictions)))
print('Variance Regression Score:␣
  ↪',explained_variance_score(y_test,predictions))

print('\n\nDescriptive Statistics:\n',df['Lifespan'].describe())
```

```
10/10                  0s 2ms/step
MAE:   228.2824228922526
MSE:   73995.69163243033
RMSE:   272.0214911223566
Variance Regression Score:  0.39795815640040744


Descriptive Statistics:
 count    1000.000000
mean     1298.556320
std       340.071434
min       417.990000
25%      1047.257500
50%      1266.040000
75%      1563.050000
max      2134.530000
```

```
Name: Lifespan, dtype: float64
```

[60]:
```python
f, axes = plt.subplots(1, 2, figsize=(15,5))

# Plot 1: Error Distribution
errors = y_test.values.reshape(300, 1) - predictions
sns.histplot(errors, ax=axes[0], kde=True)  # Using histplot instead of
 ↪distplot as distplot is deprecated
axes[0].set(xlabel='Error', ylabel='Count', title='Error Distribution')

# Plot 2: Predictions vs Actual
axes[1].scatter(y_test, predictions)
axes[1].plot(y_test, y_test, 'r')  # Perfect predictions line
axes[1].set(xlabel='Test True Y', ylabel='Model Predictions',
 ↪title='Predictions vs Actual')

sns.despine()
plt.tight_layout()
plt.show()
```
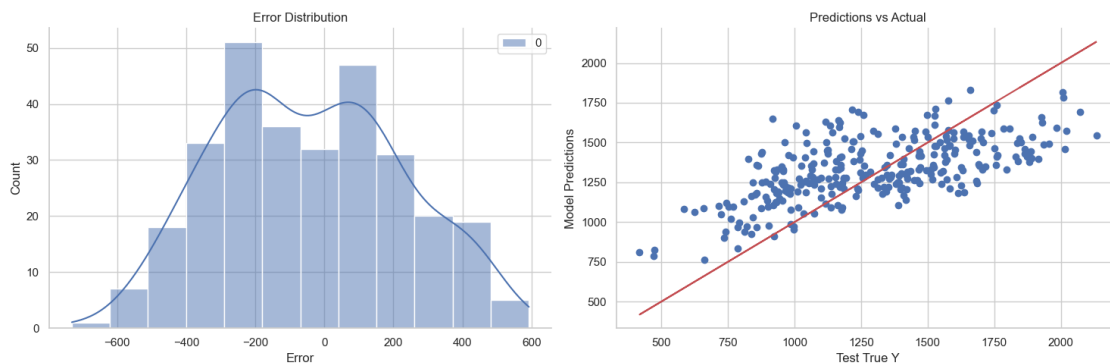

[62]:
```python
# Get features of new part type
single_partType = df.drop('Lifespan', axis=1).iloc[0]
print(f'Features of new part type:\n{single_partType}')

# Convert to DataFrame with feature names
single_partType_df = pd.DataFrame([single_partType.values],
 ↪columns=single_partType.index)

# Scale the features while preserving feature names
single_partType_scaled = scaler.transform(single_partType_df)

# Run the model and get the lifespan prediction
print('\nPrediction Lifespan:', model.predict(single_partType_scaled)[0,0])
```

```
# Print original lifespan
print('\nOriginal Lifespan:', df.iloc[0]['Lifespan'])
```

```
Features of new part type:
coolingRate                       13
quenchTime                      3.84
forgeTime                       6.47
HeatTreatTime                  46.87
Nickel%                        65.73
Iron%                          16.52
Cobalt%                        16.82
Chromium%                       0.93
smallDefects                      10
largeDefects                       0
sliverDefects                      0
partType_Blade                 False
partType_Block                 False
partType_Nozzle                 True
partType_Valve                 False
microstructure_colGrain        False
microstructure_equiGrain        True
microstructure_singleGrain     False
seedLocation_Bottom             True
seedLocation_Top               False
castType_Continuous            False
castType_Die                    True
castType_Investment            False
Name: 0, dtype: object
1/1                 0s 12ms/step

Prediction Lifespan: 1444.3018

Original Lifespan: 1469.17
1/1                 0s 12ms/step

Prediction Lifespan: 1444.3018

Original Lifespan: 1469.17
```