Machine Learning on Polutions from Transportation

In the following program, we would guide you through using Pandas to process the emission data for Tensorflow Machine Learning. Then we would teach you how to create and train your Tensorflow model. Answer the questions when you see Q; follow the steps in **To-do**. When you see something like ^{D1} or ^{M1} next to problems, you should refer to the rubrics to see how the the problems will be graded as those problems are worth points.

Note: Hit the "Run" button to run the program block by block. We don't recommend you to use "Run All" in "Cell" because the first few blocks only need to be run once and they take some time to run.

Import Libraries

The following block is used in Python to import necessary libraries. You might encounter error while trying to import tensorflow. This is becuase Tensorflow is not a default library that comes with the Python package you installed. Go to this link https://www.tensorflow.org/install/pip#system-install and follow the instructions on installing Tensorflow. If you encounter problems while trying to install Tensorflow you can add `--user` after `pip install`. This is because you did not create a virtual environment for your python packages. You can follow Step 2 on the website to create a virtual environment (recommended) or you can just install the package in your HOME environment. You might encounter error while trying to import other libraries. Please use the same `pip` method described above.

- `pandas` is used to process our data.
- `numpy` is a great tool for mathematical processing and array creations.
- `sklearn` is used to split the data into Training, Testing, and Validation set.

In [1]:

```
# Import Libraries
import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow.keras import layers
from sklearn.model_selection import train_test_split
import seaborn as sns
from matplotlib import pyplot as plt
```

Import Tensorboard

In [2]:

```
# Load the TensorBoard notebook extension.
%load_ext tensorboard
from datetime import datetime
from packaging import version

print("TensorFlow version: ", tf.__version__)
assert version.parse(tf.__version__).release[0] >= 2, \
    "This notebook requires TensorFlow 2.0 or above."
import tensorboard
tensorboard.__version__
```

```
TensorFlow version:  2.6.1
```

Out[2]:

```
'2.7.0'
```

Load and Clean up the Dataset

Load the Dataset

To process the data, save the .csv file you downloaded from the Google Drive to the same directory where this Notebook is at.

- `pd.read_csv("file path")` reads the data into emission_train
    - Note that we call `pd` directly becuase we import `pandas as pd`
- `.head()` returns the first 100 rows of data. Note that when displaying, some rows are truncated. It is normal since the rows are too long.
- `.describe()` shows statistical data for our data frame.

In [3]:

```
# loading the large data set, it may takes a while.
emission_train = pd.read_csv("UC-Emission.csv", delimiter=",", quoting = 3)
```

Here is a link that contains information about meaning of the columns in "emission.csv": https://sumo.dlr.de/docs/Simulation/Output/EmissionOutput.html

In [4]:

```
display(emission_train.head(100))
display(emission_train.describe())
```

	timestep_time	vehicle_CO	vehicle_CO2	vehicle_HC	vehicle_NOx	vehicle_PMx	vehicle_a
0	0.0	15.20	7380.56	0.00	84.89	2.21	5
1	0.0	0.00	2416.04	0.01	0.72	0.01	4
2	1.0	17.92	9898.93	0.00	103.38	2.49	5
3	1.0	0.00	0.00	0.00	0.00	0.00	4
4	1.0	164.78	2624.72	0.81	1.20	0.07	35
...	...	...	...	...	...	...	
95	7.0	23.44	2578.06	0.15	0.64	0.05	
96	7.0	732.32	18759.70	3.34	3.79	1.19	17
97	7.0	294.68	6949.38	1.29	1.47	0.43	17
98	7.0	236.07	4292.19	0.97	0.93	0.30	
99	7.0	179.19	1228.61	0.64	0.31	0.17	18

100 rows × 20 columns

	timestep_time	vehicle_CO	vehicle_CO2	vehicle_HC	vehicle_NOx	vehicle_PM
count	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+0
mean	4.112561e+03	5.764304e+01	4.919050e+03	7.284125e-01	1.769589e+01	4.227491e-0
std	2.168986e+03	8.854365e+01	7.959043e+03	1.589816e+00	5.993168e+01	1.164065e+0
min	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+0
25%	2.291000e+03	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+0
50%	4.133000e+03	2.017000e+01	2.624720e+03	1.500000e-01	1.200000e+00	6.000000e-0
75%	5.903000e+03	1.034400e+02	6.161010e+03	7.600000e-01	2.710000e+00	1.500000e-0
max	1.441800e+04	3.932950e+03	1.153026e+05	1.729000e+01	8.864200e+02	1.432000e+0

Visualize the Dataset

Below we use `sns.pairplot()` to show you the 2D plots between datasets. We only use 0.5% of the randomly extracted data from `emission_train` to make plots becuase using too many data might crash the program. `.sample(frac=0.01)` takes a fraction of sample from DataFrame randomly.

- `del` frees up memory for Python. However, it won't release memory back to the computer.

From the pair plots you can visualize the relationships between the data in the dataset. For example, `vehicle_CO2` and `vehicle_fuel` have a linear relationship. `vehicle_CO2` and `vehicle_pos` have a parabolic or exponential like relationship. Some data might have a relationship that is not easily identified from pair plots.

^{D1}Q: What do you find from the Pairplot? Find three pairs of data and list what you observe from their pair plots.

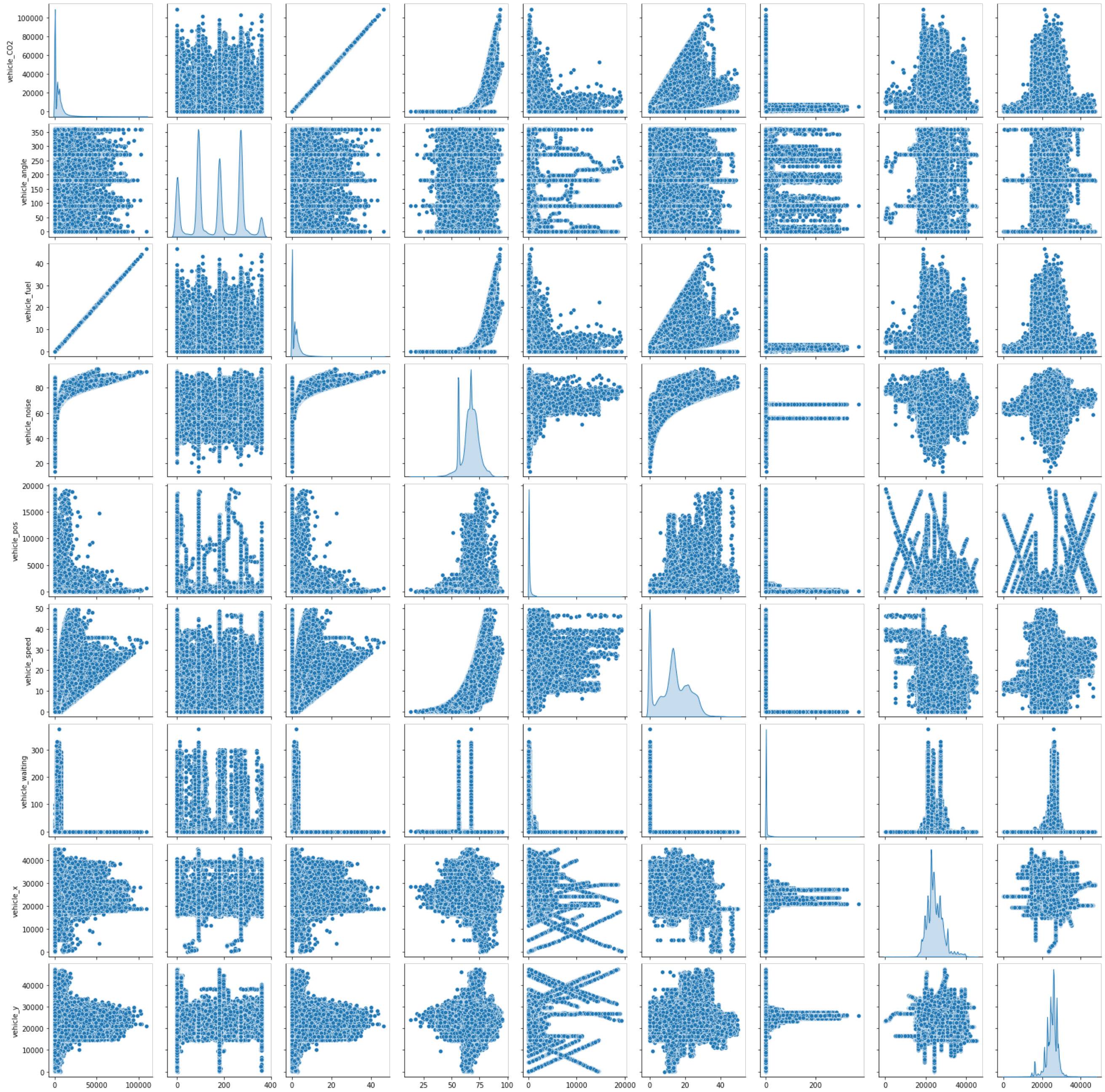
Type your questions to Q: Upon observating the various plots generated below, we observed trends between the data. Three observations include:

- We observed a directly proportional linear relationship between vehicle fuel and vehicle CO2, where vehicle fuel increased by 20 for every 50,000 increase in vehicle CO2.
- Vehicle noise generally tends to increase with vehicle fuel, and vehicle noise also tends to increase with vehicle CO2.
- A majority of vehicle waiting tends to occur in a certain cross-section (near the center of the city), where x-coordinates range from 20,000 to 30,000 and y-coordinates range from 20,000 to 30,000.

In [5]:

```
correlation_graph_data = emission_train.sample(frac=0.05).reset_index(drop=Tr
print(len(emission_train), 'emission_train')
print(len(correlation_graph_data), 'correlation_graph_data')
sns.pairplot(correlation_graph_data[['vehicle_CO2', 'vehicle_angle', 'vehicle_

#Free up memory for Python
del correlation_graph_data
```

16331008 emission_train
816550 correlation_graph_data



Clean up the Dataset

Note that there are emission data like `vehicle_CO`, `vehicle_CO2`, `vehicle_HC`, `vehicle_NOx`, `vehicle_PMx` in the dataset. In this lab, we only want to look at `vehicle_CO2`.

After looking at the data, you might notice there are a lot of data we don't want for our machine learning. For example, all the `vehicle_electricity` are zeros, and `vehicle_route` data are only used to keep track of the unique route each vehicle goes through.

Below, unwanted data are dropped. `vehicle_id` data are dropped because they are only used to keep track of different vehicles. `vehicle_lane` data are the name of the road. We dropped `vehicle_lane` data becuase we believed the data might not affect vehicle emissions. In practice, you should only drop the data if you have clear reasonings. For example `vehicle_electricity` are all zeros, so you can drop them. Even if you do not drop them, the machine learning program might be able to figure the relationship out. `vehicle_route` data are dropped due to the reasoning above. `timestep_time` data are dropped becuase they are the simulation time.

To-do:

1. ^{D2}Drop the data we mentioned above. Also, drop the data that you think might not affect the machine learning. Q: Provide your reasonings.

Type your questions to Q: In addition to dropping columns `vehicle_CO`, `vehicle_HC`, `vehicle_NOx`, `vehicle_PMx`, `timestep_time`, and `vehicle_id`, we decided to drop `vehicle_route`, `vehicle_lane`, and `vehicle_electricity` since these values were respectively used to keep track of each vehicle's unique routes, the name of the road, and `vehicle_electricity` data were all zeros. Dropping these data fields will not affect `vehicle_CO2` output, and thus will not affect the machine learning.

In [6]:

```
emission_train = emission_train.drop(columns=["vehicle_CO", "vehicle_HC", "ve
                                              "timestep_time", "vehicle_id",
                                              "vehicle_electricity"])
```

We seperated the block above from the block below becuase we don't want you to run `pd.read_csv` and `emission_train.drop()` twice. Reading a large csv file as you might have experienced a few minutes ago take up quite some RAM and CPU, and running `.drop()` twice will cause an error message to be printed out.

To-do:

1. ^{D3}Display the **last** 100 rows of your new `emission_train` data. It is okay if the displayed rows are truncated in the middle.

In [7]:

```
display(emission_train.head(100))
display(emission_train.describe())

### Insert your code below ###
display(emission_train.tail(100))
```

	vehicle_CO2	vehicle_angle	vehicle_eclass	vehicle_fuel	vehicle_noise	vehicle_pos	v
0	7380.56	50.28	HBEFA3/HDV	3.13	67.11	7.20	
1	2416.04	42.25	HBEFA3/PC_G_EU4	1.04	65.15	5.10	
2	9898.93	50.28	HBEFA3/HDV	4.20	73.20	8.21	
3	0.00	42.25	HBEFA3/PC_G_EU4	0.00	62.72	18.85	
4	2624.72	357.00	HBEFA3/PC_G_EU4	1.13	55.94	5.10	
...	...	...	...	...	...	...	
95	2578.06	0.13	HBEFA3/LDV_G_EU6	1.11	63.24	35.78	
96	18759.70	179.93	HBEFA3/LDV_G_EU6	8.07	81.67	30.96	
97	6949.38	179.93	HBEFA3/LDV_G_EU6	2.99	72.45	11.88	
98	4292.19	1.91	HBEFA3/LDV_G_EU6	1.85	71.73	5.60	
99	1228.61	180.06	HBEFA3/LDV_G_EU6	0.53	55.94	2.30	

100 rows × 11 columns

	vehicle_CO2	vehicle_angle	vehicle_fuel	vehicle_noise	vehicle_pos	vehicle_speed
count	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07
mean	4.919050e+03	1.633698e+02	2.105266e+00	6.636207e+01	2.162082e+02	1.331140e+01
std	7.959043e+03	1.051232e+02	3.389028e+00	7.389330e+00	6.034189e+02	8.833069e+00
min	0.000000e+00	0.000000e+00	0.000000e+00	1.258000e+01	0.000000e+00	0.000000e+00
25%	0.000000e+00	9.031000e+01	0.000000e+00	6.249000e+01	2.383000e+01	6.550000e+00
50%	2.624720e+03	1.799600e+02	1.130000e+00	6.711000e+01	7.199000e+01	1.337000e+01
75%	6.161010e+03	2.703500e+02	2.650000e+00	7.112000e+01	1.780600e+02	1.999000e+01
max	1.153026e+05	3.600000e+02	4.888000e+01	1.019600e+02	1.943554e+04	5.013000e+01

	vehicle_CO2	vehicle_angle	vehicle_eclass	vehicle_fuel	vehicle_noise	vehicle_pos
16330908	5293.91	1.98	HBEFA3/Bus	2.26	67.19	77.83
16330909	6541.73	2.07	HBEFA3/Bus	2.79	71.21	0.69
16330910	10387.44	2.06	HBEFA3/Bus	4.43	74.53	2.58
16330911	12058.39	1.62	HBEFA3/Bus	5.14	73.88	5.45
16330912	13307.66	1.06	HBEFA3/Bus	5.67	73.64	9.19
...	...	...	...	...	...	...
16331003	19817.16	0.45	HBEFA3/Bus	8.45	76.56	185.84
16331004	0.00	0.45	HBEFA3/Bus	0.00	74.14	199.17
16331005	23192.37	0.45	HBEFA3/Bus	9.89	77.18	212.90
16331006	0.00	0.45	HBEFA3/Bus	0.00	74.10	226.29
16331007	NaN	NaN	NaN	NaN	NaN	NaN

100 rows × 11 columns

By now, you would have already done some cleanups by dropping unwanted data. Below we used a `for` loop to cast the data in `vehicle_eclass` and `vehicle_type` to string. As you might notice that the values in both columns are texts. However, we found that the data in our csv file cannot be read correctly into Tensorflow so we added the for loop.

- `.dropna().reset_index(drop=True)` drops the rows that contain NaN in any columns and reset the row index.

To-do:

1. ^{D4}Shuffle `emission_train` and save a new copy to `emission_train_shuffle`. *Hint: Look at the function we used to extract data for the correlation graph.*
2. ^{D5}Display the first 100 rows of the shuffled data. It is okay if the displayed rows are truncated in the middle.
3. ^{D6}Display the statistic (count, mean, std...) on the shuffled data. ^{D7}Q: Does anything change?

Type your answers to Q: After comparing the statistics like count, mean, std, min, 25%, 50%, 75%, and max for both the unshuffled and shuffled data, we observed no changes; the statistics remained the same when frac=1. However, if frac is set to another value, say 0.5, certain statistics like count, mean, and std change.

In [8]:

```
for header in ["vehicle_eclass", "vehicle_type"]:
    emission_train[header] = emission_train[header].astype(str)

emission_train = emission_train.dropna().reset_index(drop=True)

# Shuffle the dataset
emission_train_shuffle = emission_train.sample(frac=1) #FILL IN THE CODE

### Insert your code below ###

# Display the data pre- and post- shuffle
display(emission_train.head(100))
###FILL IN THE CODE
display(emission_train_shuffle.head(100))

# Get info of the dataframe
###FILL IN THE CODE
display(emission_train_shuffle.describe())
```

	vehicle_CO2	vehicle_angle	vehicle_eclass	vehicle_fuel	vehicle_noise	vehicle_pos	v
0	7380.56	50.28	HBEFA3/HDV	3.13	67.11	7.20	
1	2416.04	42.25	HBEFA3/PC_G_EU4	1.04	65.15	5.10	
2	9898.93	50.28	HBEFA3/HDV	4.20	73.20	8.21	
3	0.00	42.25	HBEFA3/PC_G_EU4	0.00	62.72	18.85	

4	2624.72	357.00	HBEFA3/PC_G_EU4	1.13	55.94	5.10
...	...	...	...	...	...	...
95	2578.06	0.13	HBEFA3/LDV_G_EU6	1.11	63.24	35.78
96	18759.70	179.93	HBEFA3/LDV_G_EU6	8.07	81.67	30.96
97	6949.38	179.93	HBEFA3/LDV_G_EU6	2.99	72.45	11.88
98	4292.19	1.91	HBEFA3/LDV_G_EU6	1.85	71.73	5.60
99	1228.61	180.06	HBEFA3/LDV_G_EU6	0.53	55.94	2.30

100 rows × 11 columns

	vehicle_CO2	vehicle_angle	vehicle_eclass	vehicle_fuel	vehicle_noise	vehicle_
15886555	2709.26	272.11	HBEFA3/PC_G_EU4	1.16	60.01	8
9005659	7645.30	180.42	HBEFA3/PC_G_EU4	3.29	69.02	3
13455892	0.00	272.16	HBEFA3/PC_G_EU4	0.00	60.22	160
8736385	2544.18	308.17	HBEFA3/PC_G_EU4	1.09	63.65	44
6900660	2397.80	302.55	HBEFA3/PC_G_EU4	1.03	64.85	80
...	...	...	...	...	...	
13204731	2457.83	0.88	HBEFA3/PC_G_EU4	1.06	60.54	4
7337242	2624.72	89.84	HBEFA3/PC_G_EU4	1.13	55.94	64
10371264	0.00	90.15	HBEFA3/PC_G_EU4	0.00	63.65	1
1334692	0.00	0.08	HBEFA3/PC_G_EU4	0.00	67.21	5
4381848	0.00	120.44	HBEFA3/PC_G_EU4	0.00	55.92	13

100 rows × 11 columns

	vehicle_CO2	vehicle_angle	vehicle_fuel	vehicle_noise	vehicle_pos	vehicle_speed
count	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07
mean	4.919050e+03	1.633698e+02	2.105266e+00	6.636207e+01	2.162082e+02	1.331140e+01
std	7.959043e+03	1.051232e+02	3.389028e+00	7.389330e+00	6.034189e+02	8.833069e+00
min	0.000000e+00	0.000000e+00	0.000000e+00	1.258000e+01	0.000000e+00	0.000000e+00
25%	0.000000e+00	9.031000e+01	0.000000e+00	6.249000e+01	2.383000e+01	6.550000e+00
50%	2.624720e+03	1.799600e+02	1.130000e+00	6.711000e+01	7.199000e+01	1.337000e+01
75%	6.161010e+03	2.703500e+02	2.650000e+00	7.112000e+01	1.780600e+02	1.999000e+01
max	1.153026e+05	3.600000e+02	4.888000e+01	1.019600e+02	1.943554e+04	5.013000e+01

In [9]:

```
emission_train_shuffle = emission_train.sample(frac=0.5) #Re-set frac value
display(emission_train.describe())
display(emission_train_shuffle.describe())
```

	vehicle_CO2	vehicle_angle	vehicle_fuel	vehicle_noise	vehicle_pos	vehicle_speed
count	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07	1.633101e+07
mean	4.919050e+03	1.633698e+02	2.105266e+00	6.636207e+01	2.162082e+02	1.331140e+01
std	7.959043e+03	1.051232e+02	3.389028e+00	7.389330e+00	6.034189e+02	8.833069e+00
min	0.000000e+00	0.000000e+00	0.000000e+00	1.258000e+01	0.000000e+00	0.000000e+00
25%	0.000000e+00	9.031000e+01	0.000000e+00	6.249000e+01	2.383000e+01	6.550000e+00
50%	2.624720e+03	1.799600e+02	1.130000e+00	6.711000e+01	7.199000e+01	1.337000e+01
75%	6.161010e+03	2.703500e+02	2.650000e+00	7.112000e+01	1.780600e+02	1.999000e+01
max	1.153026e+05	3.600000e+02	4.888000e+01	1.019600e+02	1.943554e+04	5.013000e+01

	vehicle_CO2	vehicle_angle	vehicle_fuel	vehicle_noise	vehicle_pos	vehicle_speed
count	8.165504e+06	8.165504e+06	8.165504e+06	8.165504e+06	8.165504e+06	8.165504e+06
mean	4.923362e+03	1.634167e+02	2.107105e+00	6.636414e+01	2.160551e+02	1.331269e+01
std	7.965866e+03	1.051208e+02	3.391924e+00	7.389251e+00	6.030814e+02	8.831753e+00
min	0.000000e+00	0.000000e+00	0.000000e+00	1.258000e+01	0.000000e+00	0.000000e+00
25%	0.000000e+00	9.031000e+01	0.000000e+00	6.249000e+01	2.381000e+01	6.560000e+00
50%	2.624720e+03	1.799600e+02	1.130000e+00	6.711000e+01	7.195000e+01	1.338000e+01
75%	6.168073e+03	2.703500e+02	2.650000e+00	7.112000e+01	1.780400e+02	1.999000e+01
max	1.121178e+05	3.600000e+02	4.753000e+01	9.794000e+01	1.943053e+04	5.002000e+01

Stop

Before you proceed, make sure you finish reading "Machine Learning Introduction" in Step 3 of the lab. You should complete the Tensorflow playground exercise and take a screenshot of your results.

Split Data for Machine Learning

In machine learning, we often want to split our data into Training Set, Validation Set, and Test Set.

- **Training Set**: Training Set is used to train our machine learning model while the Validation and Test Set aren't.
- **Validation Set**: Having a Validation Set prevents overfitting of our machine learning model. Overfitting is when our model is tuned perfectly for a specific set of data, but is fitted poorly for other set of data. Take our traffic emission data for example. If the data predicts CO_2 emission data within 10 mse (mean squared error) from Training Set, but predicts emission data over 50 mse from Validation data. Then we could see that the model is overfitted.
- **Test Set**: Test set is used to evaluate the final model.

A typical workflow will be:

1. Train your model using *Training Set*.
2. Validate your model using *Validation Set*.
3. Adjust your model using results from *Validation Set*.
4. Pick the model that produces best results from using *Validation Set*.
5. Confirm your model with *Test Set*.

To-Do:

1. Don't change the `test_size=0.99` in the first split.
2. Tweak the `test_size=` values for spilitting `train_df`, `test_df`, and `val_df`.
3. You will come back and change some codes after you finish your first training. Instructions will be provided in the "Train the Model" section.

In [204…

```
train_df, backup_df = train_test_split(emission_train_shuffle, test_size=0.99
# Edit the test_size below.

# train_df, test_df = train_test_split(emission_train_shuffle, test_size=0.1)
train_df, test_df = train_test_split(train_df, test_size=0.1) # Comment for l
train_df, val_df = train_test_split(train_df, test_size=0.2)

print(len(backup_df), 'backup data')
print(len(train_df), 'train examples')
print(len(val_df), 'validation examples')
print(len(test_df), 'test examples')

# del emission_train
```

```
8083849 backup data
58791 train examples
14698 validation examples
8166 test examples
```

Normalize the Input Data (Optional)

Sometimes when there are huge value differences between input features, we want to scale them to get a better training result. In this lab you are not required to use normalization. But if you cannot get a nice machine learning result, you can try normalizing the data. Below, we used Z normalization. It is just a normalization method. If you normalize your trainning data, make sure to also **normalize the validation and test data**. Note that `train_df_norm = train_df` won't copy `train_df` to `train_df_norm`. Changing the values in `train_df_norm` will affect the values in `train_df`. So if you decide to revert the normalization after you run the code block below, run the code block under "Split Data for Machine Learning" again and run only the `train_df_norm = train_df` below. (Comment out the code using `#` sign.)

Z Normalization Equation:

$$z = \frac{x - \mu}{\sigma}$$
$$z : \text{Normalized Data}$$
$$x : \text{Original Data}$$
$$\mu : \text{Mean of } x$$
$$\sigma : \text{Standard Deviation of } x$$

In [205…

```
# Z-Score Normalizing
# train_df_norm = train_df

# for header in ["vehicle_electricity", "vehicle_fuel", "vehicle_noise", "veh

#     train_df_norm[header] = (train_df[header] - train_df[header].mean()) /
#     train_df_norm[header] = train_df_norm[header].fillna(0)

### Insert your code below (optional) ###
# Normalize the validation data


# Normalize the test data


# print(train_df_norm.head())
```

Organize Features

Classify Features

We need to define our feature columns so that the program knows what type of features are used in the training. In emission data, there are two types of features: numeric (floating point, int, etc.) and categorical/indicator (for example, 'color', 'gender'; 'color' column can contain 'red', 'blue', etc.).

To Do:

1. ^{M1}Organize the numeric columns. Also fill in the numeric columns' names in your dataset. Remember that you dropped some values already. Only put the names of the columns that are still in your dataset. Refer to "Classify structured data with feature columns" under "Tensorflow Tutorials" section on the Tensorflow website. Link: https://www.tensorflow.org/tutorials/structured_data/feature_columns

In [206…

```
# Create an empty list
feature_cols = []


# Numeric Columns
numeric_col_names = ["vehicle_fuel", "vehicle_speed"]
for header in numeric_col_names: ### Finish the list on the left
    ### Insert your code ###
    numeric_column = tf.feature_column.numeric_column(header)
    feature_cols.append(numeric_column)

# Indicator Columns
indicator_col_names = ["vehicle_type"] # removed "vehicle_eclass"
for col_name in indicator_col_names:
    categorical_column = tf.feature_column.categorical_column_with_vocabulary_

    indicator_column = tf.feature_column.indicator_column(categorical_column)
    feature_cols.append(indicator_column)

print("Feature columns: ", feature_cols, "\n")
```

```
Feature columns:  [NumericColumn(key='vehicle_fuel', shape=(1,), default_value
=None, dtype=tf.float32, normalizer_fn=None), NumericColumn(key='vehicle_speed
', shape=(1,), default_value=None, dtype=tf.float32, normalizer_fn=None), Indi
catorColumn(categorical_column=VocabularyListCategoricalColumn(key='vehicle_ty
pe', vocabulary_list=('pt_bus', 'veh_passenger', 'moto_motorcycle', 'bus_bus',
'truck_truck'), dtype=tf.string, default_value=-1, num_oov_buckets=0))]
```

Create a Feature Layer

Feature layer will the input to our machine learning. We need to create a feature layer to be added into the machine learning model.

In [207…

```
# Create a feature layer for tf
feature_layer = tf.keras.layers.DenseFeatures(feature_cols, name='Features')
```

Create and Train the Model

Create Model

- `model.add()` : add layer to model
- In `tf.keras.layers.Dense()`
  - `units` : number of nodes in that layer
  - `activation` : activation function used in that layer
  - `kernel_regularizer` : regularization function used in that layer
  - `name` : is just for us to keep track and debug
- In `model.compile()`
  - `optimizer=tf.keras.optimizers.Adam(lr=learning_rate)` : Used to improve performance of the training
  - `Adam` : stochastic gradient descent method
  - `loss` : update the model according to specified loss function
  - `metrics` : evaluate the model according specified metrics

Train the Model

- We first split our Pandas dataframe into features and labels.
- Then `model.fit()` trains our model.
- `logdir` , `tensorboard_callback` is to save training logs to be used in Tensorboard.
- Notice that there are 2 `model.fit()` function calls with one being commented out. The one without `callbacks=[tensorboard_callback]` is used in this program for large dataset training.

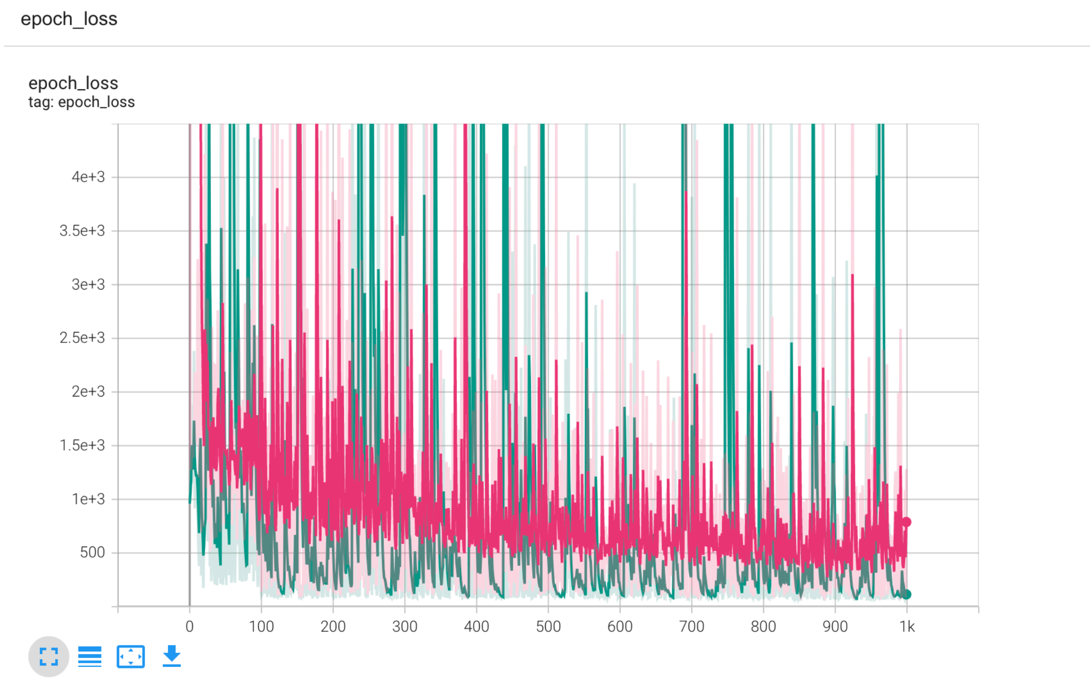
Instructions for Training Small and Large Data

As we mentioned in the lab document, hyperparameters affect the performance of your model. In the following blocks, you would be training your model. We also want you to experience training both a small dataset and a large dataset.

To-do:

- **Small Dataset:**

    1. The program cells you ran until now prepare you for small dataset training. You don't need to adjust the `test_size=0.99` in "Split Data for Machine Learning".
    2. Adjust the Hyperparameters (learning rate, batch size, epochs, hidden layer number, node number). Add in additional hidden layers as needed. Remember, a large learning rate might cause the model to never converge, but a very small learning rate would cause the model to converge very slow. If your mse (mean squared error) is decreasing but your program finishes before the mse reaches a small number, increase your epochs. Lastly, start with a small batch size. Smaller batch size often gives a better training result. A large batch size often causes poor convergence, and it might also lead to poor generalization and slow training speed. Try batch sizes of 100, 500, 1000.
    3. In the function definitions (previous code block):
        - Press the stop button (**interrupt the kernal**) next to Run before you change the values in the functions above.
        - Add or reduce Hidden layers if your model turns our poorly.
        - Adjust the amount of nodes in each Hidden layer.
        - Try out different activation functions.
        - Try different regularizers.
        - You should aim to get an **mse < 100**. **Note, we will grade your results based on mse.**
    4. ^{M2}Once you get a result with nice mse, run the block `%tensorboard --logdir logs` . Then take screenshots that show your **epoch_loss** and your **epoch_mse**.
        - **Screenshot showing Epoch Loss**



- **Screenshot showing Epoch MSE**

- **Large Dataset:**

  1. Adjust the codes in "Split Data for Machine Learning" so that no data go to `backup_df` .

  2. Go to previous code block and use the `model.fit()` without `callbacks=[tensorboard_callback]` . Remember to comment out the one with `callbacks=[tensorboard_callback]` .

  3. Adjust the Hyperparameters (learning rate, batch size, epochs, hidden layer number, node number). Remember, a large learning rate might cause the model to never converge, but a very small learning rate would cause the model to converge very slow. If your mse (mean squared error) is decreasing but your program finishes before the mse reaches a small number, increase your epochs. Smaller batch size often gives a better training result. A large batch size often causes poor convergence, and it might also lead to poor generalization and slow training speed. Try batch sizes of 1000, 10000, 200000. ^{M3}Q: Do you notice any difference

between using batch sizes of 1000, 10000, 200000?

4. In the function definitions:

    - Press the stop button (**interrupt the kernal**) next to Run before you change the values in the functions above.
    - Add or reduce Hidden layers if your model turns our poorly.
    - Adjust the amount of nodes in each Hidden layer.
    - Try out different activation functions.
    - Try different regularizers.
    - You should aim to get an **mse < 200**. **Note, we will grade your results based on mse.**

5. ^{M4}The program will run for a longer time with large dataset input. Once you get a result with nice mse, you don't have to run `%tensorboard --logdir logs` . Move on to sections below. We would have you save a PDF once you reach the end of this Notebook. We will look at your training for the large dataset based on the logs printed out during each epoch.

Note: Ignore the warnings at the beginning and at the end.

Type your answers to Q: While adjusting the hyperparameters, including learning rate, epochs, batch size, the number of hidden layers and the node numbers, we observed that training with smaller batch sizes took much longer to train. For instance, a batch size of 1000 takes around 400-500 seconds per epoch during training. Training with larger batch sizes like 20,000 was much faster, averaging ~28 seconds per epoch. Meanwhile, training with a batch size of 200,000 took 3-4 seconds per epoch. The batch size I settled on (10,000) took ~50 seconds per epoch. Each test with these varying batch sizes had a parameter value of 50 epochs, and we observe that larger batch sizes (20,000 and 200,000) yielded test mse of 793.2882 and 4994.9922 respectively. Larger batch sizes require more epochs to converge and reach the desired mse.

In [208…

```
# Hyperparameters
learning_rate = 0.03 ### FILL IN A NUMBER
epochs = 1000 ### FILL IN A NUMBER
batch_size = 128 ### FILL IN A NUMBER

# Label
label_name = "vehicle_CO2"
shuffle = True

#---Create a sequential model---#
model = tf.keras.models.Sequential([
    # Add the feature layer
    feature_layer,

    # First hidden layer with 10 nodes
    tf.keras.layers.Dense(units=10,
```

```
                              activation='relu',
                              kernel_regularizer=tf.keras.regularizers.l1(l=0.3),
                              name='Hidden1'),

    # Additional hidden layers
    tf.keras.layers.Dense(units=7,
                              activation='relu',
                              kernel_regularizer=tf.keras.regularizers.l1(l=0.3),
                              name='Hidden2'),

    tf.keras.layers.Dense(units=4,
                              activation='relu',
                              kernel_regularizer=tf.keras.regularizers.l1(l=0.3),
                              name='Hidden3'),

    # Output layer
    tf.keras.layers.Dense(units=1,
                              activation='linear',
                              name='Output')

])


model.compile(optimizer=tf.keras.optimizers.Adam(lr=learning_rate),
              loss=tf.keras.losses.MeanSquaredError(),
              metrics=['mse'])


#---Train the Model---#
# Keras TensorBoard callback.
logdir = "logs/fit/" + datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
print(logdir)
train_lbl = np.array(train_df["vehicle_CO2"])
train_df = train_df.drop(columns=["vehicle_CO2"])
# Split the datasets into features and label.
train_ft = {name:np.array(value) for name, value in train_df.items()}
# train_lbl = np.array(train_ft.pop(label_name))

val_lbl =  np.array(val_df["vehicle_CO2"])
val_df = val_df.drop(columns=["vehicle_CO2"])
val_ft = {name:np.array(value) for name, value in val_df.items()}


# Keras TensorBoard callback.
logdir = "logs/fit/" + datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
print(logdir)
model.fit(x=train_ft, y=train_lbl, batch_size=batch_size,
          epochs=epochs, callbacks=[tensorboard_callback], validation_data=(v

# Training function for large training set
# model.fit(x=train_ft, y=train_lbl, batch_size=batch_size,
#           epochs=epochs, verbose=2, validation_data=(val_ft, val_lbl), shuf
```

```
logs/fit/20211120-012155
logs/fit/20211120-012155
```

```
Epoch 1/1000
WARNING:tensorflow:Layers in a Sequential model should only have a single inpu
t tensor, but we receive a <class 'dict'> input: {'vehicle_angle': <tf.Tensor
'ExpandDims:0' shape=(None, 1) dtype=float32>, 'vehicle_eclass': <tf.Tensor 'E
xpandDims_1:0' shape=(None, 1) dtype=string>, 'vehicle_fuel': <tf.Tensor 'Expa
ndDims_2:0' shape=(None, 1) dtype=float32>, 'vehicle_noise': <tf.Tensor 'Expan
dDims_3:0' shape=(None, 1) dtype=float32>, 'vehicle_pos': <tf.Tensor 'ExpandDi
ms_4:0' shape=(None, 1) dtype=float32>, 'vehicle_speed': <tf.Tensor 'ExpandDim
s_5:0' shape=(None, 1) dtype=float32>, 'vehicle_type': <tf.Tensor 'ExpandDims_
6:0' shape=(None, 1) dtype=string>, 'vehicle_waiting': <tf.Tensor 'ExpandDims_
7:0' shape=(None, 1) dtype=float32>, 'vehicle_x': <tf.Tensor 'ExpandDims_8:0'
shape=(None, 1) dtype=float32>, 'vehicle_y': <tf.Tensor 'ExpandDims_9:0' shape
=(None, 1) dtype=float32>}
Consider rewriting this model with the Functional API.
WARNING:tensorflow:Layers in a Sequential model should only have a single inpu
t tensor, but we receive a <class 'dict'> input: {'vehicle_angle': <tf.Tensor
'ExpandDims:0' shape=(None, 1) dtype=float32>, 'vehicle_eclass': <tf.Tensor 'E
xpandDims_1:0' shape=(None, 1) dtype=string>, 'vehicle_fuel': <tf.Tensor 'Expa
ndDims_2:0' shape=(None, 1) dtype=float32>, 'vehicle_noise': <tf.Tensor 'Expan
dDims_3:0' shape=(None, 1) dtype=float32>, 'vehicle_pos': <tf.Tensor 'ExpandDi
ms_4:0' shape=(None, 1) dtype=float32>, 'vehicle_speed': <tf.Tensor 'ExpandDim
s_5:0' shape=(None, 1) dtype=float32>, 'vehicle_type': <tf.Tensor 'ExpandDims_
6:0' shape=(None, 1) dtype=string>, 'vehicle_waiting': <tf.Tensor 'ExpandDims_
7:0' shape=(None, 1) dtype=float32>, 'vehicle_x': <tf.Tensor 'ExpandDims_8:0'
shape=(None, 1) dtype=float32>, 'vehicle_y': <tf.Tensor 'ExpandDims_9:0' shape
=(None, 1) dtype=float32>}
Consider rewriting this model with the Functional API.
424/460 [==========================>...] - ETA: 0s - loss: 15588345.0000 - mse
: 15588300.0000WARNING:tensorflow:Layers in a Sequential model should only hav
e a single input tensor, but we receive a <class 'dict'> input: {'vehicle_angl
e': <tf.Tensor 'ExpandDims:0' shape=(None, 1) dtype=float32>, 'vehicle_eclass'
: <tf.Tensor 'ExpandDims_1:0' shape=(None, 1) dtype=string>, 'vehicle_fuel': <
tf.Tensor 'ExpandDims_2:0' shape=(None, 1) dtype=float32>, 'vehicle_noise': <t
f.Tensor 'ExpandDims_3:0' shape=(None, 1) dtype=float32>, 'vehicle_pos': <tf.T
ensor 'ExpandDims_4:0' shape=(None, 1) dtype=float32>, 'vehicle_speed': <tf.Te
nsor 'ExpandDims_5:0' shape=(None, 1) dtype=float32>, 'vehicle_type': <tf.Tens
or 'ExpandDims_6:0' shape=(None, 1) dtype=string>, 'vehicle_waiting': <tf.Tens
or 'ExpandDims_7:0' shape=(None, 1) dtype=float32>, 'vehicle_x': <tf.Tensor 'E
xpandDims_8:0' shape=(None, 1) dtype=float32>, 'vehicle_y': <tf.Tensor 'Expand
Dims_9:0' shape=(None, 1) dtype=float32>}
Consider rewriting this model with the Functional API.
460/460 [==============================] - 1s 2ms/step - loss: 14390220.0000 -
mse: 14390173.0000 - val_loss: 960.7873 - val_mse: 896.9650
Epoch 2/1000
460/460 [==============================] - 1s 1ms/step - loss: 1294.2542 - mse
: 1230.7958 - val_loss: 1123.5656 - val_mse: 1060.4581
Epoch 3/1000
460/460 [==============================] - 1s 1ms/step - loss: 1288.4664 - mse
: 1225.7668 - val_loss: 1311.1069 - val_mse: 1248.7766
Epoch 4/1000
460/460 [==============================] - 1s 1ms/step - loss: 1463.9661 - mse
: 1401.7129 - val_loss: 1876.9619 - val_mse: 1813.3413
Epoch 5/1000
460/460 [==============================] - 1s 1ms/step - loss: 1514.6885 - mse
: 1452.0614 - val_loss: 1152.3872 - val_mse: 1090.7985
Epoch 6/1000
460/460 [==============================] - 1s 1ms/step - loss: 1386.9001 - mse
: 1326.1233 - val_loss: 1177.6323 - val_mse: 1117.3474
Epoch 7/1000
460/460 [==============================] - 1s 1ms/step - loss: 1612.9814 - mse
: 1553.1210 - val_loss: 2383.4263 - val_mse: 2324.0308
```

```
Epoch 8/1000
460/460 [==============================] - 1s 1ms/step - loss: 2181.9800 - mse
: 2123.1831 - val_loss: 916.6105 - val_mse: 858.4507
Epoch 9/1000
460/460 [==============================] - 1s 1ms/step - loss: 1714.3367 - mse
: 1656.6272 - val_loss: 1067.9589 - val_mse: 1010.7408
Epoch 10/1000
460/460 [==============================] - 1s 1ms/step - loss: 1751.2753 - mse
: 1694.5151 - val_loss: 1135.1104 - val_mse: 1078.8667
Epoch 11/1000
460/460 [==============================] - 1s 2ms/step - loss: 1511.1981 - mse
: 1455.2994 - val_loss: 1255.6201 - val_mse: 1200.1117
Epoch 12/1000
460/460 [==============================] - 1s 2ms/step - loss: 3238.3662 - mse
: 3183.3303 - val_loss: 919.7274 - val_mse: 863.6814
Epoch 13/1000
460/460 [==============================] - 1s 1ms/step - loss: 1666.7347 - mse
: 1610.0166 - val_loss: 568.8065 - val_mse: 511.1476
Epoch 14/1000
460/460 [==============================] - 1s 1ms/step - loss: 1204.0687 - mse
: 1147.1099 - val_loss: 378.3917 - val_mse: 322.1206
Epoch 15/1000
460/460 [==============================] - 1s 1ms/step - loss: 1712.2361 - mse
: 1656.3112 - val_loss: 2361.5061 - val_mse: 2306.5371
Epoch 16/1000
460/460 [==============================] - 1s 1ms/step - loss: 3894.8364 - mse
: 3840.8374 - val_loss: 1893.3291 - val_mse: 1840.0050
Epoch 17/1000
460/460 [==============================] - 1s 1ms/step - loss: 691.5209 - mse:
638.2205 - val_loss: 289.6559 - val_mse: 235.8215
Epoch 18/1000
460/460 [==============================] - 1s 1ms/step - loss: 1477.3539 - mse
: 1424.2133 - val_loss: 484.1295 - val_mse: 432.0246
Epoch 19/1000
460/460 [==============================] - 1s 1ms/step - loss: 1875.7386 - mse
: 1823.4003 - val_loss: 448.2324 - val_mse: 395.8971
Epoch 20/1000
460/460 [==============================] - 1s 1ms/step - loss: 741.3167 - mse:
689.2108 - val_loss: 174.5670 - val_mse: 122.6398
Epoch 21/1000
460/460 [==============================] - 1s 1ms/step - loss: 1185.5190 - mse
: 1133.0519 - val_loss: 713.9376 - val_mse: 660.7907
Epoch 22/1000
460/460 [==============================] - 1s 1ms/step - loss: 4215.9565 - mse
: 4163.3896 - val_loss: 1013.4846 - val_mse: 961.7798
Epoch 23/1000
460/460 [==============================] - 1s 1ms/step - loss: 1750.4709 - mse
: 1698.9542 - val_loss: 934.5901 - val_mse: 883.2675
Epoch 24/1000
460/460 [==============================] - 1s 1ms/step - loss: 2747.9924 - mse
: 2696.9097 - val_loss: 7222.8096 - val_mse: 7171.9258
Epoch 25/1000
460/460 [==============================] - 0s 1ms/step - loss: 1105.9773 - mse
: 1054.3271 - val_loss: 961.4768 - val_mse: 909.2204
Epoch 26/1000
460/460 [==============================] - 0s 1ms/step - loss: 2863.0178 - mse
: 2811.6987 - val_loss: 610.2139 - val_mse: 557.6967
Epoch 27/1000
460/460 [==============================] - 1s 1ms/step - loss: 787.5295 - mse:
734.7916 - val_loss: 627.4996 - val_mse: 575.1221
Epoch 28/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 1564.3864 - mse
: 1512.9224 - val_loss: 10536.7598 - val_mse: 10485.6084
Epoch 29/1000
460/460 [==============================] - 1s 1ms/step - loss: 1735.1354 - mse
: 1684.3579 - val_loss: 375.4037 - val_mse: 324.8468
Epoch 30/1000
460/460 [==============================] - 1s 1ms/step - loss: 523.2108 - mse:
472.8238 - val_loss: 1941.9749 - val_mse: 1891.8575
Epoch 31/1000
460/460 [==============================] - 1s 1ms/step - loss: 1014.5718 - mse
: 964.6384 - val_loss: 237.5023 - val_mse: 187.7878
Epoch 32/1000
460/460 [==============================] - 1s 1ms/step - loss: 2606.5125 - mse
: 2556.9282 - val_loss: 661.1423 - val_mse: 611.5719
Epoch 33/1000
460/460 [==============================] - 1s 1ms/step - loss: 976.7448 - mse:
925.9935 - val_loss: 391.1174 - val_mse: 340.3965
Epoch 34/1000
460/460 [==============================] - 0s 1ms/step - loss: 2273.3289 - mse
: 2222.5825 - val_loss: 1578.4456 - val_mse: 1527.7898
Epoch 35/1000
460/460 [==============================] - 1s 2ms/step - loss: 627.1928 - mse:
576.9225 - val_loss: 301.7124 - val_mse: 251.8843
Epoch 36/1000
460/460 [==============================] - 0s 1ms/step - loss: 1247.1887 - mse
: 1197.5847 - val_loss: 208.9788 - val_mse: 159.2604
Epoch 37/1000
460/460 [==============================] - 0s 1ms/step - loss: 2260.6301 - mse
: 2208.1606 - val_loss: 798.9533 - val_mse: 745.7689
Epoch 38/1000
460/460 [==============================] - 0s 1ms/step - loss: 644.4957 - mse:
592.0671 - val_loss: 941.6177 - val_mse: 889.5788
Epoch 39/1000
460/460 [==============================] - 0s 1ms/step - loss: 1515.6472 - mse
: 1463.8884 - val_loss: 198.4297 - val_mse: 147.0544
Epoch 40/1000
460/460 [==============================] - 0s 1ms/step - loss: 2761.7192 - mse
: 2710.7290 - val_loss: 1741.1089 - val_mse: 1690.4199
Epoch 41/1000
460/460 [==============================] - 0s 1ms/step - loss: 2209.1123 - mse
: 2158.3601 - val_loss: 514.5925 - val_mse: 463.8033
Epoch 42/1000
460/460 [==============================] - 0s 1ms/step - loss: 1674.7032 - mse
: 1624.1238 - val_loss: 271.2199 - val_mse: 220.8976
Epoch 43/1000
460/460 [==============================] - 0s 1ms/step - loss: 692.0458 - mse:
642.1431 - val_loss: 339.6877 - val_mse: 289.9935
Epoch 44/1000
460/460 [==============================] - 1s 1ms/step - loss: 1072.9009 - mse
: 1023.8126 - val_loss: 214.4813 - val_mse: 165.6025
Epoch 45/1000
460/460 [==============================] - 0s 1ms/step - loss: 744.0613 - mse:
695.4609 - val_loss: 8245.6104 - val_mse: 8196.0703
Epoch 46/1000
460/460 [==============================] - 0s 1ms/step - loss: 1958.7676 - mse
: 1908.8632 - val_loss: 400.2506 - val_mse: 350.8480
Epoch 47/1000
460/460 [==============================] - 0s 998us/step - loss: 4944.8032 - m
se: 4892.5947 - val_loss: 203.6978 - val_mse: 151.4023
Epoch 48/1000
460/460 [==============================] - 0s 1ms/step - loss: 1086.4852 - mse
```

```
: 1034.1498 - val_loss: 296.7823 - val_mse: 244.8236
Epoch 49/1000
460/460 [==============================] - 1s 1ms/step - loss: 771.5824 - mse:
720.0629 - val_loss: 3995.5208 - val_mse: 3944.3279
Epoch 50/1000
460/460 [==============================] - 1s 1ms/step - loss: 1255.5358 - mse
: 1204.2615 - val_loss: 275.8482 - val_mse: 225.1096
Epoch 51/1000
460/460 [==============================] - 1s 1ms/step - loss: 1394.7828 - mse
: 1344.7786 - val_loss: 546.5143 - val_mse: 497.0962
Epoch 52/1000
460/460 [==============================] - 0s 1ms/step - loss: 1459.4854 - mse
: 1409.8949 - val_loss: 201.6817 - val_mse: 152.0665
Epoch 53/1000
460/460 [==============================] - 1s 1ms/step - loss: 1459.8560 - mse
: 1408.4475 - val_loss: 1060.0891 - val_mse: 1008.6887
Epoch 54/1000
460/460 [==============================] - 0s 1ms/step - loss: 1024.0051 - mse
: 973.1761 - val_loss: 667.6844 - val_mse: 617.1738
Epoch 55/1000
460/460 [==============================] - 0s 1ms/step - loss: 1320.8633 - mse
: 1270.0144 - val_loss: 748.1354 - val_mse: 697.8074
Epoch 56/1000
460/460 [==============================] - 0s 1ms/step - loss: 879.2988 - mse:
828.8986 - val_loss: 292.3968 - val_mse: 241.7715
Epoch 57/1000
460/460 [==============================] - 0s 1ms/step - loss: 1272.2909 - mse
: 1220.9498 - val_loss: 2945.2275 - val_mse: 2895.2854
Epoch 58/1000
460/460 [==============================] - 1s 1ms/step - loss: 2376.1338 - mse
: 2326.5557 - val_loss: 59981.6289 - val_mse: 59930.5117
Epoch 59/1000
460/460 [==============================] - 1s 1ms/step - loss: 2319.2261 - mse
: 2266.6943 - val_loss: 223.3981 - val_mse: 171.1778
Epoch 60/1000
460/460 [==============================] - 1s 1ms/step - loss: 762.0746 - mse:
710.0620 - val_loss: 256.7050 - val_mse: 204.9143
Epoch 61/1000
460/460 [==============================] - 1s 1ms/step - loss: 1218.0142 - mse
: 1166.1620 - val_loss: 6922.7910 - val_mse: 6871.4819
Epoch 62/1000
460/460 [==============================] - 1s 1ms/step - loss: 1600.0977 - mse
: 1548.9817 - val_loss: 2425.6064 - val_mse: 2374.1289
Epoch 63/1000
460/460 [==============================] - 1s 1ms/step - loss: 1407.8799 - mse
: 1356.8448 - val_loss: 548.9406 - val_mse: 497.8929
Epoch 64/1000
460/460 [==============================] - 1s 1ms/step - loss: 1061.8575 - mse
: 1010.6998 - val_loss: 222.9275 - val_mse: 169.8481
Epoch 65/1000
460/460 [==============================] - 1s 1ms/step - loss: 1128.1322 - mse
: 1075.6151 - val_loss: 622.9378 - val_mse: 570.9710
Epoch 66/1000
460/460 [==============================] - 1s 1ms/step - loss: 1712.1713 - mse
: 1661.2683 - val_loss: 2009.3076 - val_mse: 1959.4753
Epoch 67/1000
460/460 [==============================] - 0s 974us/step - loss: 624.8170 - ms
e: 575.4349 - val_loss: 576.8279 - val_mse: 527.7664
Epoch 68/1000
460/460 [==============================] - 1s 1ms/step - loss: 1445.9102 - mse
: 1396.5839 - val_loss: 5891.9438 - val_mse: 5840.5200
```

```
Epoch 69/1000
460/460 [==============================] - 0s 1ms/step - loss: 1796.8555 - mse
: 1747.2133 - val_loss: 1611.8829 - val_mse: 1563.2845
Epoch 70/1000
460/460 [==============================] - 0s 1ms/step - loss: 2492.3157 - mse
: 2442.8552 - val_loss: 779.2023 - val_mse: 730.0289
Epoch 71/1000
460/460 [==============================] - 0s 987us/step - loss: 911.7769 - ms
e: 862.1813 - val_loss: 242.9234 - val_mse: 193.4585
Epoch 72/1000
460/460 [==============================] - 0s 1ms/step - loss: 1586.8657 - mse
: 1537.1934 - val_loss: 1851.2977 - val_mse: 1800.1724
Epoch 73/1000
460/460 [==============================] - 0s 1ms/step - loss: 1835.1266 - mse
: 1784.9506 - val_loss: 1059.1156 - val_mse: 1009.6906
Epoch 74/1000
460/460 [==============================] - 0s 961us/step - loss: 1234.8743 - m
se: 1185.7045 - val_loss: 233.3353 - val_mse: 184.2990
Epoch 75/1000
460/460 [==============================] - 0s 960us/step - loss: 1928.9265 - m
se: 1879.8883 - val_loss: 922.9743 - val_mse: 873.6453
Epoch 76/1000
460/460 [==============================] - 0s 987us/step - loss: 1192.6028 - m
se: 1143.7738 - val_loss: 1079.3337 - val_mse: 1029.8055
Epoch 77/1000
460/460 [==============================] - 0s 960us/step - loss: 617.1443 - ms
e: 568.4607 - val_loss: 572.2305 - val_mse: 523.8123
Epoch 78/1000
460/460 [==============================] - 0s 978us/step - loss: 2827.6089 - m
se: 2778.0940 - val_loss: 238.0903 - val_mse: 188.8351
Epoch 79/1000
460/460 [==============================] - 0s 973us/step - loss: 947.5010 - ms
e: 898.1538 - val_loss: 329.2023 - val_mse: 280.0887
Epoch 80/1000
460/460 [==============================] - 1s 1ms/step - loss: 873.7864 - mse:
823.8572 - val_loss: 245.7016 - val_mse: 196.2513
Epoch 81/1000
460/460 [==============================] - 0s 1ms/step - loss: 1064.9003 - mse
: 1015.3140 - val_loss: 403.2919 - val_mse: 353.9266
Epoch 82/1000
460/460 [==============================] - 1s 1ms/step - loss: 3067.5769 - mse
: 3017.3577 - val_loss: 12777.2695 - val_mse: 12725.7002
Epoch 83/1000
460/460 [==============================] - 1s 1ms/step - loss: 979.8632 - mse:
929.1993 - val_loss: 1579.8522 - val_mse: 1529.6796
Epoch 84/1000
460/460 [==============================] - 1s 1ms/step - loss: 2172.7415 - mse
: 2122.3394 - val_loss: 312.4846 - val_mse: 262.6520
Epoch 85/1000
460/460 [==============================] - 0s 1ms/step - loss: 726.5920 - mse:
676.9226 - val_loss: 707.5283 - val_mse: 658.2956
Epoch 86/1000
460/460 [==============================] - 1s 1ms/step - loss: 661.2540 - mse:
611.9364 - val_loss: 1029.7213 - val_mse: 980.0208
Epoch 87/1000
460/460 [==============================] - 1s 1ms/step - loss: 2767.8132 - mse
: 2716.1318 - val_loss: 394.0341 - val_mse: 342.5018
Epoch 88/1000
460/460 [==============================] - 0s 1ms/step - loss: 659.8021 - mse:
609.2512 - val_loss: 1865.2859 - val_mse: 1815.5050
Epoch 89/1000
```

```
460/460 [==============================] - 0s 1ms/step - loss: 1322.0189 - mse
: 1272.3318 - val_loss: 3637.9617 - val_mse: 3588.3979
Epoch 90/1000
460/460 [==============================] - 0s 1ms/step - loss: 1630.9987 - mse
: 1581.4272 - val_loss: 235.1797 - val_mse: 184.6083
Epoch 91/1000
460/460 [==============================] - 1s 1ms/step - loss: 3258.1262 - mse
: 3208.4763 - val_loss: 4370.0347 - val_mse: 4319.2852
Epoch 92/1000
460/460 [==============================] - 1s 1ms/step - loss: 594.2405 - mse:
544.0009 - val_loss: 640.8410 - val_mse: 590.7892
Epoch 93/1000
460/460 [==============================] - 1s 1ms/step - loss: 1037.5887 - mse
: 985.6686 - val_loss: 875.0453 - val_mse: 822.9418
Epoch 94/1000
460/460 [==============================] - 1s 1ms/step - loss: 1217.2643 - mse
: 1165.6509 - val_loss: 335.7108 - val_mse: 284.8501
Epoch 95/1000
460/460 [==============================] - 1s 1ms/step - loss: 2526.9373 - mse
: 2476.5271 - val_loss: 371.6035 - val_mse: 322.1002
Epoch 96/1000
460/460 [==============================] - 1s 1ms/step - loss: 375.1328 - mse:
326.3900 - val_loss: 184.5673 - val_mse: 136.7040
Epoch 97/1000
460/460 [==============================] - 1s 1ms/step - loss: 480.1567 - mse:
432.3899 - val_loss: 650.1774 - val_mse: 602.3512
Epoch 98/1000
460/460 [==============================] - 1s 1ms/step - loss: 615.3884 - mse:
567.2964 - val_loss: 337.1521 - val_mse: 288.4509
Epoch 99/1000
460/460 [==============================] - 1s 1ms/step - loss: 985.6642 - mse:
937.3680 - val_loss: 10170.5625 - val_mse: 10122.3701
Epoch 100/1000
460/460 [==============================] - 1s 1ms/step - loss: 10696.2510 - ms
e: 10645.9541 - val_loss: 224.8307 - val_mse: 173.3170
Epoch 101/1000
460/460 [==============================] - 1s 1ms/step - loss: 139.8476 - mse:
88.4757 - val_loss: 101.8801 - val_mse: 50.5226
Epoch 102/1000
460/460 [==============================] - 1s 1ms/step - loss: 244.6726 - mse:
190.5260 - val_loss: 114.2101 - val_mse: 58.3109
Epoch 103/1000
460/460 [==============================] - 1s 1ms/step - loss: 190.4823 - mse:
135.0211 - val_loss: 151.0190 - val_mse: 96.0117
Epoch 104/1000
460/460 [==============================] - 1s 1ms/step - loss: 658.3762 - mse:
603.7629 - val_loss: 208.1917 - val_mse: 154.0405
Epoch 105/1000
460/460 [==============================] - 1s 1ms/step - loss: 684.5677 - mse:
630.9188 - val_loss: 1188.9437 - val_mse: 1135.6766
Epoch 106/1000
460/460 [==============================] - 1s 1ms/step - loss: 3570.7004 - mse
: 3517.1331 - val_loss: 122.5677 - val_mse: 69.2304
Epoch 107/1000
460/460 [==============================] - 1s 1ms/step - loss: 544.9863 - mse:
491.7803 - val_loss: 284.6560 - val_mse: 231.5450
Epoch 108/1000
460/460 [==============================] - 1s 1ms/step - loss: 156.8515 - mse:
103.8660 - val_loss: 1213.0405 - val_mse: 1160.3528
Epoch 109/1000
460/460 [==============================] - 1s 1ms/step - loss: 368.7523 - mse:
```

```
314.6303 - val_loss: 90.3454 - val_mse: 36.0994
Epoch 110/1000
460/460 [==============================] - 1s 1ms/step - loss: 1679.7371 - mse
: 1625.8530 - val_loss: 135.6545 - val_mse: 82.8500
Epoch 111/1000
460/460 [==============================] - 1s 1ms/step - loss: 267.6522 - mse:
215.3907 - val_loss: 353.6375 - val_mse: 301.8412
Epoch 112/1000
460/460 [==============================] - 1s 1ms/step - loss: 1806.3469 - mse
: 1754.3085 - val_loss: 1608.2721 - val_mse: 1556.8375
Epoch 113/1000
460/460 [==============================] - 1s 1ms/step - loss: 819.5314 - mse:
768.8496 - val_loss: 126.2044 - val_mse: 75.7999
Epoch 114/1000
460/460 [==============================] - 1s 1ms/step - loss: 2228.7908 - mse
: 2178.1035 - val_loss: 111.8483 - val_mse: 60.6931
Epoch 115/1000
460/460 [==============================] - 1s 1ms/step - loss: 182.9695 - mse:
132.4662 - val_loss: 90.3904 - val_mse: 40.1322
Epoch 116/1000
460/460 [==============================] - 1s 1ms/step - loss: 1756.7379 - mse
: 1706.2161 - val_loss: 6187.2720 - val_mse: 6134.7500
Epoch 117/1000
460/460 [==============================] - 1s 1ms/step - loss: 4613.0825 - mse
: 4560.6777 - val_loss: 91.9943 - val_mse: 39.9335
Epoch 118/1000
460/460 [==============================] - 1s 1ms/step - loss: 231.6175 - mse:
179.5363 - val_loss: 152.2725 - val_mse: 100.2121
Epoch 119/1000
460/460 [==============================] - 1s 1ms/step - loss: 364.6110 - mse:
312.4240 - val_loss: 79.5733 - val_mse: 27.5114
Epoch 120/1000
460/460 [==============================] - 1s 1ms/step - loss: 236.1810 - mse:
184.1289 - val_loss: 267.1060 - val_mse: 215.1384
Epoch 121/1000
460/460 [==============================] - 1s 1ms/step - loss: 585.1184 - mse:
533.5479 - val_loss: 80.6053 - val_mse: 29.0933
Epoch 122/1000
460/460 [==============================] - 1s 1ms/step - loss: 1420.2031 - mse
: 1368.6241 - val_loss: 1005.1153 - val_mse: 953.2596
Epoch 123/1000
460/460 [==============================] - 1s 1ms/step - loss: 8261.2549 - mse
: 8207.4248 - val_loss: 94.9780 - val_mse: 41.0368
Epoch 124/1000
460/460 [==============================] - 1s 1ms/step - loss: 120.4440 - mse:
66.2456 - val_loss: 86.6216 - val_mse: 32.4577
Epoch 125/1000
460/460 [==============================] - 1s 1ms/step - loss: 120.8872 - mse:
66.7550 - val_loss: 111.8060 - val_mse: 57.7925
Epoch 126/1000
460/460 [==============================] - 1s 1ms/step - loss: 273.4607 - mse:
219.7029 - val_loss: 113.9387 - val_mse: 60.3424
Epoch 127/1000
460/460 [==============================] - 1s 1ms/step - loss: 721.5933 - mse:
668.1927 - val_loss: 242.8870 - val_mse: 189.8576
Epoch 128/1000
460/460 [==============================] - 1s 1ms/step - loss: 2276.4717 - mse
: 2223.5061 - val_loss: 86.5145 - val_mse: 33.8581
Epoch 129/1000
460/460 [==============================] - 1s 1ms/step - loss: 197.8883 - mse:
145.7237 - val_loss: 112.3299 - val_mse: 60.4779
```

```
Epoch 130/1000
460/460 [==============================] - 1s 1ms/step - loss: 4355.0723 - mse
: 4303.4888 - val_loss: 107.5920 - val_mse: 56.2971
Epoch 131/1000
460/460 [==============================] - 1s 1ms/step - loss: 179.4480 - mse:
128.1729 - val_loss: 146.3504 - val_mse: 95.4134
Epoch 132/1000
460/460 [==============================] - 1s 1ms/step - loss: 491.0961 - mse:
440.7247 - val_loss: 119.8533 - val_mse: 70.3921
Epoch 133/1000
460/460 [==============================] - 1s 1ms/step - loss: 325.1794 - mse:
275.6212 - val_loss: 465.4424 - val_mse: 416.1082
Epoch 134/1000
460/460 [==============================] - 1s 1ms/step - loss: 1141.8171 - mse
: 1092.4138 - val_loss: 3484.6392 - val_mse: 3434.7612
Epoch 135/1000
460/460 [==============================] - 1s 1ms/step - loss: 1654.9816 - mse
: 1605.5233 - val_loss: 346.0750 - val_mse: 296.3015
Epoch 136/1000
460/460 [==============================] - 1s 1ms/step - loss: 222.6660 - mse:
173.4433 - val_loss: 80.9882 - val_mse: 32.1956
Epoch 137/1000
460/460 [==============================] - 1s 2ms/step - loss: 3543.4790 - mse
: 3493.8113 - val_loss: 235.1815 - val_mse: 183.3550
Epoch 138/1000
460/460 [==============================] - 1s 2ms/step - loss: 218.3462 - mse:
167.8754 - val_loss: 81.7970 - val_mse: 32.0637
Epoch 139/1000
460/460 [==============================] - 1s 1ms/step - loss: 855.5894 - mse:
806.4368 - val_loss: 456.4990 - val_mse: 407.4980
Epoch 140/1000
460/460 [==============================] - 1s 1ms/step - loss: 193.5499 - mse:
144.7291 - val_loss: 271.2065 - val_mse: 222.4369
Epoch 141/1000
460/460 [==============================] - 1s 1ms/step - loss: 5126.9287 - mse
: 5076.2939 - val_loss: 134.1582 - val_mse: 83.0288
Epoch 142/1000
460/460 [==============================] - 1s 1ms/step - loss: 159.0587 - mse:
109.4488 - val_loss: 120.4715 - val_mse: 71.7835
Epoch 143/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.2421 - mse:
84.5941 - val_loss: 226.3530 - val_mse: 177.8814
Epoch 144/1000
460/460 [==============================] - 1s 1ms/step - loss: 974.2279 - mse:
925.6999 - val_loss: 121.7869 - val_mse: 73.2763
Epoch 145/1000
460/460 [==============================] - 1s 1ms/step - loss: 1152.0637 - mse
: 1103.3726 - val_loss: 144.9227 - val_mse: 95.8952
Epoch 146/1000
460/460 [==============================] - 1s 1ms/step - loss: 658.9187 - mse:
610.3392 - val_loss: 479.6227 - val_mse: 429.9487
Epoch 147/1000
460/460 [==============================] - 1s 1ms/step - loss: 2052.2798 - mse
: 2003.4163 - val_loss: 166.0742 - val_mse: 117.5289
Epoch 148/1000
460/460 [==============================] - 1s 1ms/step - loss: 250.5314 - mse:
202.0186 - val_loss: 1310.6703 - val_mse: 1262.0022
Epoch 149/1000
460/460 [==============================] - 1s 1ms/step - loss: 2368.1533 - mse
: 2319.2520 - val_loss: 290.2663 - val_mse: 239.8308
Epoch 150/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 178.5998 - mse:
129.6281 - val_loss: 270.9373 - val_mse: 222.4954
Epoch 151/1000
460/460 [==============================] - 1s 1ms/step - loss: 889.1599 - mse:
840.3101 - val_loss: 149.1367 - val_mse: 100.4426
Epoch 152/1000
460/460 [==============================] - 1s 1ms/step - loss: 3394.2905 - mse
: 3345.6682 - val_loss: 39396.9336 - val_mse: 39345.6172
Epoch 153/1000
460/460 [==============================] - 1s 2ms/step - loss: 31455.3262 - ms
e: 31401.9883 - val_loss: 131.5951 - val_mse: 78.5730
Epoch 154/1000
460/460 [==============================] - 1s 1ms/step - loss: 106.6516 - mse:
54.0006 - val_loss: 87.0796 - val_mse: 34.4986
Epoch 155/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.4037 - mse:
46.8161 - val_loss: 92.8828 - val_mse: 40.3177
Epoch 156/1000
460/460 [==============================] - 1s 1ms/step - loss: 97.4339 - mse:
44.9782 - val_loss: 84.8533 - val_mse: 32.4248
Epoch 157/1000
460/460 [==============================] - 1s 2ms/step - loss: 100.1090 - mse:
47.4345 - val_loss: 204.5307 - val_mse: 151.9381
Epoch 158/1000
460/460 [==============================] - 1s 2ms/step - loss: 154.5478 - mse:
102.1365 - val_loss: 94.5660 - val_mse: 42.4814
Epoch 159/1000
460/460 [==============================] - 1s 1ms/step - loss: 222.0025 - mse:
170.2154 - val_loss: 80.9298 - val_mse: 29.2087
Epoch 160/1000
460/460 [==============================] - 1s 2ms/step - loss: 990.9495 - mse:
939.1592 - val_loss: 4517.5151 - val_mse: 4465.9058
Epoch 161/1000
460/460 [==============================] - 1s 1ms/step - loss: 5073.2969 - mse
: 5022.3999 - val_loss: 303.4742 - val_mse: 252.8883
Epoch 162/1000
460/460 [==============================] - 1s 1ms/step - loss: 209.9200 - mse:
159.6855 - val_loss: 175.6870 - val_mse: 125.5247
Epoch 163/1000
460/460 [==============================] - 1s 1ms/step - loss: 223.0748 - mse:
172.9256 - val_loss: 109.1469 - val_mse: 59.1763
Epoch 164/1000
460/460 [==============================] - 1s 1ms/step - loss: 455.2686 - mse:
405.6472 - val_loss: 96.8075 - val_mse: 47.5153
Epoch 165/1000
460/460 [==============================] - 1s 1ms/step - loss: 2777.3235 - mse
: 2727.5740 - val_loss: 1544.1398 - val_mse: 1493.4331
Epoch 166/1000
460/460 [==============================] - 1s 1ms/step - loss: 296.7280 - mse:
246.6080 - val_loss: 121.4065 - val_mse: 71.3503
Epoch 167/1000
460/460 [==============================] - 1s 1ms/step - loss: 551.7558 - mse:
500.6678 - val_loss: 138.0867 - val_mse: 86.9439
Epoch 168/1000
460/460 [==============================] - 1s 1ms/step - loss: 156.3928 - mse:
105.9029 - val_loss: 522.1022 - val_mse: 472.0273
Epoch 169/1000
460/460 [==============================] - 1s 1ms/step - loss: 1413.2665 - mse
: 1363.1448 - val_loss: 114.1958 - val_mse: 64.4539
Epoch 170/1000
460/460 [==============================] - 1s 1ms/step - loss: 1303.0535 - mse
```

```
: 1252.9497 - val_loss: 114.3895 - val_mse: 64.4871
Epoch 171/1000
460/460 [==============================] - 1s 1ms/step - loss: 428.5204 - mse:
379.4000 - val_loss: 1053.0092 - val_mse: 1004.0618
Epoch 172/1000
460/460 [==============================] - 1s 1ms/step - loss: 967.2920 - mse:
918.3471 - val_loss: 75.5755 - val_mse: 26.7300
Epoch 173/1000
460/460 [==============================] - 1s 1ms/step - loss: 1965.7314 - mse
: 1916.6366 - val_loss: 117.3198 - val_mse: 68.1308
Epoch 174/1000
460/460 [==============================] - 1s 1ms/step - loss: 152.3874 - mse:
103.4207 - val_loss: 146.3622 - val_mse: 97.4945
Epoch 175/1000
460/460 [==============================] - 1s 1ms/step - loss: 1011.3798 - mse
: 962.2739 - val_loss: 1773.2653 - val_mse: 1723.2142
Epoch 176/1000
460/460 [==============================] - 1s 1ms/step - loss: 1023.0380 - mse
: 973.8664 - val_loss: 94.0248 - val_mse: 45.2649
Epoch 177/1000
460/460 [==============================] - 1s 1ms/step - loss: 206.9139 - mse:
158.4399 - val_loss: 128.2240 - val_mse: 79.7501
Epoch 178/1000
460/460 [==============================] - 1s 1ms/step - loss: 13043.3965 - ms
e: 12993.4463 - val_loss: 138.5692 - val_mse: 85.7248
Epoch 179/1000
460/460 [==============================] - 1s 1ms/step - loss: 131.8483 - mse:
79.2120 - val_loss: 87.1552 - val_mse: 34.6626
Epoch 180/1000
460/460 [==============================] - 1s 1ms/step - loss: 107.6170 - mse:
54.9667 - val_loss: 90.6986 - val_mse: 38.0659
Epoch 181/1000
460/460 [==============================] - 1s 1ms/step - loss: 285.4867 - mse:
232.2970 - val_loss: 154.5736 - val_mse: 101.5708
Epoch 182/1000
460/460 [==============================] - 1s 1ms/step - loss: 168.3930 - mse:
115.3848 - val_loss: 693.8549 - val_mse: 640.9402
Epoch 183/1000
460/460 [==============================] - 1s 1ms/step - loss: 193.4111 - mse:
140.7975 - val_loss: 149.7393 - val_mse: 97.2895
Epoch 184/1000
460/460 [==============================] - 1s 1ms/step - loss: 4436.4272 - mse
: 4383.8633 - val_loss: 619.0811 - val_mse: 565.7881
Epoch 185/1000
460/460 [==============================] - 1s 1ms/step - loss: 217.9557 - mse:
165.1570 - val_loss: 88.7812 - val_mse: 36.4030
Epoch 186/1000
460/460 [==============================] - 1s 1ms/step - loss: 773.2144 - mse:
721.0225 - val_loss: 543.0204 - val_mse: 491.1728
Epoch 187/1000
460/460 [==============================] - 1s 1ms/step - loss: 193.3513 - mse:
141.7068 - val_loss: 85.8408 - val_mse: 34.2346
Epoch 188/1000
460/460 [==============================] - 1s 1ms/step - loss: 743.3425 - mse:
691.7120 - val_loss: 162.3410 - val_mse: 110.6719
Epoch 189/1000
460/460 [==============================] - 1s 1ms/step - loss: 1769.1996 - mse
: 1718.2266 - val_loss: 247.2819 - val_mse: 196.6505
Epoch 190/1000
460/460 [==============================] - 1s 1ms/step - loss: 224.2333 - mse:
174.0966 - val_loss: 174.8983 - val_mse: 124.8969
```

```
Epoch 191/1000
460/460 [==============================] - 1s 1ms/step - loss: 862.0751 - mse:
811.8827 - val_loss: 381.3926 - val_mse: 331.3649
Epoch 192/1000
460/460 [==============================] - 1s 1ms/step - loss: 428.6132 - mse:
378.7380 - val_loss: 93.1291 - val_mse: 43.6434
Epoch 193/1000
460/460 [==============================] - 1s 1ms/step - loss: 5225.5513 - mse
: 5175.0781 - val_loss: 1365.2506 - val_mse: 1315.4447
Epoch 194/1000
460/460 [==============================] - 1s 1ms/step - loss: 141.3616 - mse:
91.8636 - val_loss: 91.0764 - val_mse: 41.6199
Epoch 195/1000
460/460 [==============================] - 1s 1ms/step - loss: 187.8367 - mse:
138.4414 - val_loss: 2120.7441 - val_mse: 2071.4255
Epoch 196/1000
460/460 [==============================] - 1s 1ms/step - loss: 1944.2466 - mse
: 1894.0706 - val_loss: 478.1071 - val_mse: 426.0498
Epoch 197/1000
460/460 [==============================] - 1s 1ms/step - loss: 507.6989 - mse:
456.2489 - val_loss: 166.0968 - val_mse: 115.3593
Epoch 198/1000
460/460 [==============================] - 1s 1ms/step - loss: 276.2614 - mse:
225.9846 - val_loss: 505.8831 - val_mse: 455.8748
Epoch 199/1000
460/460 [==============================] - 1s 1ms/step - loss: 438.7343 - mse:
389.1852 - val_loss: 2323.1121 - val_mse: 2273.9307
Epoch 200/1000
460/460 [==============================] - 1s 1ms/step - loss: 3866.4570 - mse
: 3816.6169 - val_loss: 89.8965 - val_mse: 40.8314
Epoch 201/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.0838 - mse:
84.2307 - val_loss: 113.9126 - val_mse: 65.2040
Epoch 202/1000
460/460 [==============================] - 1s 1ms/step - loss: 340.7992 - mse:
292.1852 - val_loss: 83.3812 - val_mse: 34.8831
Epoch 203/1000
460/460 [==============================] - 1s 1ms/step - loss: 485.7730 - mse:
437.3228 - val_loss: 90.5196 - val_mse: 42.2835
Epoch 204/1000
460/460 [==============================] - 1s 1ms/step - loss: 3789.7729 - mse
: 3740.4265 - val_loss: 147.0137 - val_mse: 95.5386
Epoch 205/1000
460/460 [==============================] - 1s 1ms/step - loss: 116.5775 - mse:
66.2286 - val_loss: 78.7801 - val_mse: 29.5163
Epoch 206/1000
460/460 [==============================] - 1s 1ms/step - loss: 509.0663 - mse:
460.5147 - val_loss: 493.4564 - val_mse: 445.2609
Epoch 207/1000
460/460 [==============================] - 1s 1ms/step - loss: 169.6692 - mse:
121.6891 - val_loss: 938.5179 - val_mse: 890.6669
Epoch 208/1000
460/460 [==============================] - 1s 1ms/step - loss: 608.3502 - mse:
560.2742 - val_loss: 1428.4768 - val_mse: 1380.6475
Epoch 209/1000
460/460 [==============================] - 1s 1ms/step - loss: 8090.9653 - mse
: 8042.1069 - val_loss: 263.7880 - val_mse: 211.9897
Epoch 210/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.8138 - mse:
82.7505 - val_loss: 83.2956 - val_mse: 32.9416
Epoch 211/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 122.8695 - mse:
72.6992 - val_loss: 97.3515 - val_mse: 47.3030
Epoch 212/1000
460/460 [==============================] - 1s 1ms/step - loss: 263.4599 - mse:
212.9061 - val_loss: 103.0705 - val_mse: 52.4098
Epoch 213/1000
460/460 [==============================] - 1s 1ms/step - loss: 198.7965 - mse:
148.5231 - val_loss: 133.3314 - val_mse: 83.1245
Epoch 214/1000
460/460 [==============================] - 1s 1ms/step - loss: 4184.3584 - mse
: 4133.3154 - val_loss: 4022.2490 - val_mse: 3969.4951
Epoch 215/1000
460/460 [==============================] - 1s 1ms/step - loss: 350.7305 - mse:
297.3872 - val_loss: 384.0786 - val_mse: 331.3847
Epoch 216/1000
460/460 [==============================] - 1s 1ms/step - loss: 262.6461 - mse:
210.3789 - val_loss: 86.5394 - val_mse: 34.5923
Epoch 217/1000
460/460 [==============================] - 1s 1ms/step - loss: 1029.1434 - mse
: 977.4537 - val_loss: 103.0976 - val_mse: 51.5644
Epoch 218/1000
460/460 [==============================] - 1s 1ms/step - loss: 682.5803 - mse:
631.5117 - val_loss: 84.3800 - val_mse: 33.9169
Epoch 219/1000
460/460 [==============================] - 1s 1ms/step - loss: 560.9132 - mse:
509.1540 - val_loss: 277.1803 - val_mse: 225.8474
Epoch 220/1000
460/460 [==============================] - 1s 1ms/step - loss: 2671.9387 - mse
: 2621.3291 - val_loss: 1408.6907 - val_mse: 1358.8691
Epoch 221/1000
460/460 [==============================] - 1s 1ms/step - loss: 390.4040 - mse:
340.5406 - val_loss: 133.1494 - val_mse: 83.4442
Epoch 222/1000
460/460 [==============================] - 1s 1ms/step - loss: 1248.9620 - mse
: 1199.0944 - val_loss: 212.3658 - val_mse: 161.4259
Epoch 223/1000
460/460 [==============================] - 1s 1ms/step - loss: 433.4176 - mse:
382.3018 - val_loss: 320.4186 - val_mse: 269.6006
Epoch 224/1000
460/460 [==============================] - 0s 1ms/step - loss: 4445.8545 - mse
: 4394.0854 - val_loss: 208.3929 - val_mse: 155.9782
Epoch 225/1000
460/460 [==============================] - 1s 1ms/step - loss: 151.6464 - mse:
99.7625 - val_loss: 112.1265 - val_mse: 60.6711
Epoch 226/1000
460/460 [==============================] - 1s 1ms/step - loss: 130.8988 - mse:
79.7725 - val_loss: 119.6935 - val_mse: 68.9304
Epoch 227/1000
460/460 [==============================] - 1s 1ms/step - loss: 2465.0645 - mse
: 2414.1128 - val_loss: 254.5222 - val_mse: 203.3172
Epoch 228/1000
460/460 [==============================] - 1s 1ms/step - loss: 330.4965 - mse:
280.0712 - val_loss: 7556.6372 - val_mse: 7506.3481
Epoch 229/1000
460/460 [==============================] - 1s 1ms/step - loss: 1389.4807 - mse
: 1339.0959 - val_loss: 107.7722 - val_mse: 57.9989
Epoch 230/1000
460/460 [==============================] - 1s 1ms/step - loss: 134.3468 - mse:
84.7090 - val_loss: 215.1629 - val_mse: 165.5863
Epoch 231/1000
460/460 [==============================] - 1s 1ms/step - loss: 840.2066 - mse:
```

```
790.3157 - val_loss: 181.1005 - val_mse: 131.3909
Epoch 232/1000
460/460 [==============================] - 1s 1ms/step - loss: 1107.9554 - mse
: 1058.2189 - val_loss: 3840.6028 - val_mse: 3790.7114
Epoch 233/1000
460/460 [==============================] - 1s 1ms/step - loss: 1633.0679 - mse
: 1581.2784 - val_loss: 100.7297 - val_mse: 49.5502
Epoch 234/1000
460/460 [==============================] - 1s 1ms/step - loss: 3155.9004 - mse
: 3105.0122 - val_loss: 486.9540 - val_mse: 436.7742
Epoch 235/1000
460/460 [==============================] - 1s 1ms/step - loss: 171.5735 - mse:
121.4994 - val_loss: 128.1583 - val_mse: 78.2132
Epoch 236/1000
460/460 [==============================] - 1s 1ms/step - loss: 174.7087 - mse:
124.7946 - val_loss: 90.6507 - val_mse: 40.6330
Epoch 237/1000
460/460 [==============================] - 1s 1ms/step - loss: 424.5966 - mse:
374.8716 - val_loss: 55103.3711 - val_mse: 55052.9375
Epoch 238/1000
460/460 [==============================] - 1s 1ms/step - loss: 1923.1582 - mse
: 1872.4512 - val_loss: 96.8857 - val_mse: 47.1125
Epoch 239/1000
460/460 [==============================] - 1s 1ms/step - loss: 250.7670 - mse:
200.9066 - val_loss: 616.5516 - val_mse: 566.9201
Epoch 240/1000
460/460 [==============================] - 1s 1ms/step - loss: 3226.9233 - mse
: 3176.6550 - val_loss: 808.8340 - val_mse: 756.1902
Epoch 241/1000
460/460 [==============================] - 1s 1ms/step - loss: 451.3097 - mse:
399.2613 - val_loss: 309.1816 - val_mse: 257.5183
Epoch 242/1000
460/460 [==============================] - 1s 1ms/step - loss: 1683.8606 - mse
: 1632.2002 - val_loss: 288.0334 - val_mse: 236.0912
Epoch 243/1000
460/460 [==============================] - 1s 1ms/step - loss: 620.6892 - mse:
569.0763 - val_loss: 770.4210 - val_mse: 718.7485
Epoch 244/1000
460/460 [==============================] - 1s 1ms/step - loss: 175.6707 - mse:
124.2406 - val_loss: 276.1696 - val_mse: 224.7984
Epoch 245/1000
460/460 [==============================] - 1s 1ms/step - loss: 1349.4678 - mse
: 1297.7629 - val_loss: 5731.2559 - val_mse: 5679.5557
Epoch 246/1000
460/460 [==============================] - 1s 1ms/step - loss: 1092.7039 - mse
: 1041.9091 - val_loss: 103.3489 - val_mse: 52.6184
Epoch 247/1000
460/460 [==============================] - 1s 1ms/step - loss: 591.7978 - mse:
541.2543 - val_loss: 94.6572 - val_mse: 44.3511
Epoch 248/1000
460/460 [==============================] - 1s 1ms/step - loss: 2484.3552 - mse
: 2433.4368 - val_loss: 112.6074 - val_mse: 61.3345
Epoch 249/1000
460/460 [==============================] - 1s 1ms/step - loss: 113.3573 - mse:
62.4167 - val_loss: 85.8536 - val_mse: 35.0344
Epoch 250/1000
460/460 [==============================] - 1s 1ms/step - loss: 163.1296 - mse:
112.4456 - val_loss: 275.5723 - val_mse: 225.0845
Epoch 251/1000
460/460 [==============================] - 1s 1ms/step - loss: 1972.9969 - mse
: 1922.0547 - val_loss: 148.4650 - val_mse: 97.1241
```

```
Epoch 252/1000
460/460 [==============================] - 1s 1ms/step - loss: 274.4511 - mse:
223.7070 - val_loss: 332.7793 - val_mse: 282.1779
Epoch 253/1000
460/460 [==============================] - 1s 1ms/step - loss: 476.9696 - mse:
426.7683 - val_loss: 2549.4097 - val_mse: 2498.9558
Epoch 254/1000
460/460 [==============================] - 1s 1ms/step - loss: 1782.5360 - mse
: 1732.2296 - val_loss: 29861.1289 - val_mse: 29809.0117
Epoch 255/1000
460/460 [==============================] - 1s 1ms/step - loss: 2034.1024 - mse
: 1982.0026 - val_loss: 108.4413 - val_mse: 57.2530
Epoch 256/1000
460/460 [==============================] - 1s 1ms/step - loss: 1092.0594 - mse
: 1041.1567 - val_loss: 1114.1469 - val_mse: 1063.6124
Epoch 257/1000
460/460 [==============================] - 1s 1ms/step - loss: 361.7957 - mse:
311.3341 - val_loss: 215.5937 - val_mse: 165.2531
Epoch 258/1000
460/460 [==============================] - 1s 1ms/step - loss: 431.5070 - mse:
381.1918 - val_loss: 1162.8954 - val_mse: 1112.4347
Epoch 259/1000
460/460 [==============================] - 1s 1ms/step - loss: 386.6497 - mse:
334.8210 - val_loss: 2984.7908 - val_mse: 2932.7988
Epoch 260/1000
460/460 [==============================] - 1s 1ms/step - loss: 2443.4897 - mse
: 2391.7371 - val_loss: 160.4087 - val_mse: 109.5085
Epoch 261/1000
460/460 [==============================] - 1s 1ms/step - loss: 196.1449 - mse:
145.6784 - val_loss: 190.1190 - val_mse: 139.8280
Epoch 262/1000
460/460 [==============================] - 1s 1ms/step - loss: 219.4107 - mse:
169.6357 - val_loss: 102.2783 - val_mse: 52.6451
Epoch 263/1000
460/460 [==============================] - 1s 1ms/step - loss: 1409.5964 - mse
: 1359.5607 - val_loss: 166.2194 - val_mse: 116.2495
Epoch 264/1000
460/460 [==============================] - 1s 1ms/step - loss: 619.8118 - mse:
569.9672 - val_loss: 7159.4360 - val_mse: 7108.9980
Epoch 265/1000
460/460 [==============================] - 1s 1ms/step - loss: 679.0892 - mse:
629.7050 - val_loss: 1598.4327 - val_mse: 1549.0166
Epoch 266/1000
460/460 [==============================] - 1s 1ms/step - loss: 1284.2096 - mse
: 1234.1331 - val_loss: 1355.6405 - val_mse: 1304.9617
Epoch 267/1000
460/460 [==============================] - 1s 1ms/step - loss: 736.5588 - mse:
686.4941 - val_loss: 86.5990 - val_mse: 36.4718
Epoch 268/1000
460/460 [==============================] - 1s 1ms/step - loss: 2562.8994 - mse
: 2512.4170 - val_loss: 159.1938 - val_mse: 109.1006
Epoch 269/1000
460/460 [==============================] - 1s 1ms/step - loss: 1550.6548 - mse
: 1500.3540 - val_loss: 840.1555 - val_mse: 788.4342
Epoch 270/1000
460/460 [==============================] - 1s 1ms/step - loss: 266.7203 - mse:
216.0901 - val_loss: 84.1153 - val_mse: 33.8338
Epoch 271/1000
460/460 [==============================] - 1s 1ms/step - loss: 197.2602 - mse:
147.1108 - val_loss: 87.2845 - val_mse: 37.3084
Epoch 272/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 2768.1975 - mse
: 2717.7170 - val_loss: 145.3070 - val_mse: 93.9779
Epoch 273/1000
460/460 [==============================] - 1s 1ms/step - loss: 147.4879 - mse:
97.1452 - val_loss: 242.1342 - val_mse: 192.3539
Epoch 274/1000
460/460 [==============================] - 1s 2ms/step - loss: 134.5714 - mse:
84.8792 - val_loss: 175.8362 - val_mse: 126.2974
Epoch 275/1000
460/460 [==============================] - 1s 1ms/step - loss: 6640.3682 - mse
: 6586.9458 - val_loss: 110.6605 - val_mse: 57.2302
Epoch 276/1000
460/460 [==============================] - 1s 2ms/step - loss: 140.9572 - mse:
88.4577 - val_loss: 90.9161 - val_mse: 39.3074
Epoch 277/1000
460/460 [==============================] - 1s 2ms/step - loss: 181.0421 - mse:
129.8997 - val_loss: 173.2307 - val_mse: 122.4675
Epoch 278/1000
460/460 [==============================] - 1s 1ms/step - loss: 334.2015 - mse:
283.6669 - val_loss: 83.5221 - val_mse: 33.1586
Epoch 279/1000
460/460 [==============================] - 1s 2ms/step - loss: 254.2737 - mse:
204.0584 - val_loss: 234.7229 - val_mse: 184.5672
Epoch 280/1000
460/460 [==============================] - 1s 1ms/step - loss: 1158.9950 - mse
: 1108.5431 - val_loss: 87.2924 - val_mse: 37.1544
Epoch 281/1000
460/460 [==============================] - 1s 1ms/step - loss: 2660.7092 - mse
: 2609.7593 - val_loss: 91.2510 - val_mse: 40.5383
Epoch 282/1000
460/460 [==============================] - 1s 1ms/step - loss: 266.8306 - mse:
216.5524 - val_loss: 81.9629 - val_mse: 32.1188
Epoch 283/1000
460/460 [==============================] - 1s 2ms/step - loss: 7525.8872 - mse
: 7475.4131 - val_loss: 1236.4683 - val_mse: 1183.7966
Epoch 284/1000
460/460 [==============================] - 1s 1ms/step - loss: 201.4013 - mse:
149.4268 - val_loss: 109.0127 - val_mse: 57.5335
Epoch 285/1000
460/460 [==============================] - 1s 1ms/step - loss: 290.5015 - mse:
239.0222 - val_loss: 165.2098 - val_mse: 113.7745
Epoch 286/1000
460/460 [==============================] - 1s 1ms/step - loss: 150.9725 - mse:
99.8225 - val_loss: 87.2556 - val_mse: 36.2985
Epoch 287/1000
460/460 [==============================] - 1s 2ms/step - loss: 216.8912 - mse:
166.0116 - val_loss: 94.1057 - val_mse: 43.3734
Epoch 288/1000
460/460 [==============================] - 1s 1ms/step - loss: 349.2448 - mse:
298.6185 - val_loss: 113.2553 - val_mse: 62.5766
Epoch 289/1000
460/460 [==============================] - 1s 1ms/step - loss: 640.8276 - mse:
590.3793 - val_loss: 1131.1829 - val_mse: 1081.1337
Epoch 290/1000
460/460 [==============================] - 1s 1ms/step - loss: 3559.8406 - mse
: 3508.1418 - val_loss: 82.4614 - val_mse: 30.7059
Epoch 291/1000
460/460 [==============================] - 1s 1ms/step - loss: 117.3795 - mse:
65.4387 - val_loss: 85.4789 - val_mse: 33.4208
Epoch 292/1000
460/460 [==============================] - 1s 1ms/step - loss: 292.6759 - mse:
```

```
240.5934 - val_loss: 422.9982 - val_mse: 370.9495
Epoch 293/1000
460/460 [==============================] - 1s 1ms/step - loss: 2930.1785 - mse
: 2877.7649 - val_loss: 685.5585 - val_mse: 633.4683
Epoch 294/1000
460/460 [==============================] - 1s 1ms/step - loss: 164.6627 - mse:
113.2559 - val_loss: 228.5683 - val_mse: 177.3971
Epoch 295/1000
460/460 [==============================] - 1s 1ms/step - loss: 1138.9774 - mse
: 1087.9061 - val_loss: 38554.0938 - val_mse: 38502.4180
Epoch 296/1000
460/460 [==============================] - 1s 1ms/step - loss: 1516.6309 - mse
: 1466.1244 - val_loss: 91.4844 - val_mse: 41.2290
Epoch 297/1000
460/460 [==============================] - 1s 1ms/step - loss: 137.9396 - mse:
87.7026 - val_loss: 95.5219 - val_mse: 45.1603
Epoch 298/1000
460/460 [==============================] - 1s 1ms/step - loss: 246.2493 - mse:
196.1030 - val_loss: 100.5500 - val_mse: 50.3678
Epoch 299/1000
460/460 [==============================] - 1s 1ms/step - loss: 1461.7108 - mse
: 1411.0146 - val_loss: 4706.4165 - val_mse: 4655.0698
Epoch 300/1000
460/460 [==============================] - 1s 2ms/step - loss: 1618.8330 - mse
: 1568.4388 - val_loss: 38419.5586 - val_mse: 38366.9141
Epoch 301/1000
460/460 [==============================] - 1s 2ms/step - loss: 1281.0187 - mse
: 1229.7756 - val_loss: 903.9978 - val_mse: 852.9892
Epoch 302/1000
460/460 [==============================] - 1s 2ms/step - loss: 351.1554 - mse:
300.3181 - val_loss: 148.2352 - val_mse: 97.5606
Epoch 303/1000
460/460 [==============================] - 1s 1ms/step - loss: 421.3289 - mse:
370.3183 - val_loss: 155.8310 - val_mse: 104.4170
Epoch 304/1000
460/460 [==============================] - 1s 1ms/step - loss: 523.7001 - mse:
472.3393 - val_loss: 986.7201 - val_mse: 936.0247
Epoch 305/1000
460/460 [==============================] - 1s 1ms/step - loss: 4650.4175 - mse
: 4597.9502 - val_loss: 94.2868 - val_mse: 42.2114
Epoch 306/1000
460/460 [==============================] - 1s 1ms/step - loss: 139.3822 - mse:
87.7772 - val_loss: 112.9041 - val_mse: 61.8665
Epoch 307/1000
460/460 [==============================] - 1s 2ms/step - loss: 184.6579 - mse:
133.6626 - val_loss: 79.7691 - val_mse: 29.0689
Epoch 308/1000
460/460 [==============================] - 1s 2ms/step - loss: 1968.3411 - mse
: 1917.7330 - val_loss: 538.0690 - val_mse: 487.1286
Epoch 309/1000
460/460 [==============================] - 1s 2ms/step - loss: 307.3432 - mse:
256.8152 - val_loss: 148.9315 - val_mse: 98.4882
Epoch 310/1000
460/460 [==============================] - 1s 1ms/step - loss: 5077.5718 - mse
: 5025.4741 - val_loss: 114.5714 - val_mse: 61.2381
Epoch 311/1000
460/460 [==============================] - 1s 1ms/step - loss: 141.7357 - mse:
89.4894 - val_loss: 162.4326 - val_mse: 110.9705
Epoch 312/1000
460/460 [==============================] - 1s 1ms/step - loss: 107.8152 - mse:
57.0071 - val_loss: 80.5006 - val_mse: 29.9873
```

```
Epoch 313/1000
460/460 [==============================] - 1s 1ms/step - loss: 722.2478 - mse:
671.5491 - val_loss: 82.8348 - val_mse: 32.2463
Epoch 314/1000
460/460 [==============================] - 1s 1ms/step - loss: 738.1884 - mse:
687.6453 - val_loss: 85.6083 - val_mse: 35.2159
Epoch 315/1000
460/460 [==============================] - 1s 1ms/step - loss: 1325.1925 - mse
: 1274.5972 - val_loss: 1110.4393 - val_mse: 1060.2961
Epoch 316/1000
460/460 [==============================] - 1s 1ms/step - loss: 702.6887 - mse:
652.5529 - val_loss: 151.9307 - val_mse: 101.9709
Epoch 317/1000
460/460 [==============================] - 1s 1ms/step - loss: 307.5160 - mse:
257.3964 - val_loss: 87.3456 - val_mse: 37.1876
Epoch 318/1000
460/460 [==============================] - 1s 1ms/step - loss: 831.3943 - mse:
780.7769 - val_loss: 79.6886 - val_mse: 29.3845
Epoch 319/1000
460/460 [==============================] - 1s 1ms/step - loss: 535.2234 - mse:
484.7499 - val_loss: 257.1573 - val_mse: 205.9782
Epoch 320/1000
460/460 [==============================] - 1s 1ms/step - loss: 1462.5922 - mse
: 1412.2800 - val_loss: 514.9243 - val_mse: 464.7031
Epoch 321/1000
460/460 [==============================] - 1s 1ms/step - loss: 427.9621 - mse:
377.2703 - val_loss: 142.8057 - val_mse: 92.2770
Epoch 322/1000
460/460 [==============================] - 1s 2ms/step - loss: 1307.2007 - mse
: 1256.4342 - val_loss: 2167.2671 - val_mse: 2115.7415
Epoch 323/1000
460/460 [==============================] - 1s 1ms/step - loss: 766.3799 - mse:
715.7559 - val_loss: 122.3543 - val_mse: 72.1508
Epoch 324/1000
460/460 [==============================] - 1s 1ms/step - loss: 711.7572 - mse:
661.1891 - val_loss: 103.0499 - val_mse: 52.9750
Epoch 325/1000
460/460 [==============================] - 1s 1ms/step - loss: 228.5641 - mse:
178.4046 - val_loss: 432.3512 - val_mse: 381.9024
Epoch 326/1000
460/460 [==============================] - 1s 1ms/step - loss: 2738.4309 - mse
: 2684.4238 - val_loss: 92.3130 - val_mse: 39.1526
Epoch 327/1000
460/460 [==============================] - 1s 1ms/step - loss: 202.6752 - mse:
150.1865 - val_loss: 94.8602 - val_mse: 42.6957
Epoch 328/1000
460/460 [==============================] - 1s 1ms/step - loss: 921.3695 - mse:
869.4348 - val_loss: 9268.2686 - val_mse: 9215.5381
Epoch 329/1000
460/460 [==============================] - 1s 1ms/step - loss: 812.0467 - mse:
760.9555 - val_loss: 222.8280 - val_mse: 172.2286
Epoch 330/1000
460/460 [==============================] - 1s 1ms/step - loss: 290.0368 - mse:
239.3791 - val_loss: 467.4023 - val_mse: 416.7854
Epoch 331/1000
460/460 [==============================] - 1s 1ms/step - loss: 6531.8667 - mse
: 6480.6885 - val_loss: 128.9830 - val_mse: 77.6046
Epoch 332/1000
460/460 [==============================] - 1s 1ms/step - loss: 161.7230 - mse:
110.8046 - val_loss: 165.9625 - val_mse: 115.3451
Epoch 333/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 406.6814 - mse:
356.1477 - val_loss: 106.4100 - val_mse: 55.9544
Epoch 334/1000
460/460 [==============================] - 1s 1ms/step - loss: 153.7670 - mse:
103.3862 - val_loss: 187.2821 - val_mse: 136.8518
Epoch 335/1000
460/460 [==============================] - 1s 1ms/step - loss: 310.4666 - mse:
259.6688 - val_loss: 1782.4354 - val_mse: 1731.8445
Epoch 336/1000
460/460 [==============================] - 1s 1ms/step - loss: 1563.3397 - mse
: 1512.5457 - val_loss: 262.1313 - val_mse: 211.6098
Epoch 337/1000
460/460 [==============================] - 1s 1ms/step - loss: 422.8324 - mse:
372.5035 - val_loss: 570.8513 - val_mse: 520.7833
Epoch 338/1000
460/460 [==============================] - 1s 1ms/step - loss: 4521.9517 - mse
: 4471.5283 - val_loss: 293.0437 - val_mse: 242.3021
Epoch 339/1000
460/460 [==============================] - 1s 2ms/step - loss: 139.5787 - mse:
89.6702 - val_loss: 85.5948 - val_mse: 35.9469
Epoch 340/1000
460/460 [==============================] - 1s 1ms/step - loss: 126.5514 - mse:
76.8792 - val_loss: 84.7037 - val_mse: 35.0066
Epoch 341/1000
460/460 [==============================] - 1s 1ms/step - loss: 149.2843 - mse:
99.4035 - val_loss: 196.9919 - val_mse: 147.1243
Epoch 342/1000
460/460 [==============================] - 1s 1ms/step - loss: 743.0248 - mse:
692.9614 - val_loss: 107.3661 - val_mse: 56.8157
Epoch 343/1000
460/460 [==============================] - 1s 1ms/step - loss: 800.1525 - mse:
749.9400 - val_loss: 21245.8223 - val_mse: 21195.0762
Epoch 344/1000
460/460 [==============================] - 1s 1ms/step - loss: 1361.5719 - mse
: 1310.7046 - val_loss: 171.8308 - val_mse: 121.7421
Epoch 345/1000
460/460 [==============================] - 1s 1ms/step - loss: 305.0211 - mse:
254.8326 - val_loss: 131.0200 - val_mse: 80.3470
Epoch 346/1000
460/460 [==============================] - 1s 1ms/step - loss: 640.3486 - mse:
589.6249 - val_loss: 535.8035 - val_mse: 484.1995
Epoch 347/1000
460/460 [==============================] - 1s 1ms/step - loss: 987.4221 - mse:
936.7850 - val_loss: 92.5268 - val_mse: 42.1383
Epoch 348/1000
460/460 [==============================] - 1s 1ms/step - loss: 1654.0488 - mse
: 1603.6698 - val_loss: 226.3653 - val_mse: 175.6780
Epoch 349/1000
460/460 [==============================] - 1s 1ms/step - loss: 487.2851 - mse:
436.8979 - val_loss: 81.3765 - val_mse: 31.3130
Epoch 350/1000
460/460 [==============================] - 1s 1ms/step - loss: 636.2769 - mse:
585.8247 - val_loss: 79.5173 - val_mse: 29.6343
Epoch 351/1000
460/460 [==============================] - 1s 1ms/step - loss: 2392.3311 - mse
: 2341.1438 - val_loss: 104.5180 - val_mse: 52.4605
Epoch 352/1000
460/460 [==============================] - 1s 1ms/step - loss: 155.5921 - mse:
104.8098 - val_loss: 106.2623 - val_mse: 56.2872
Epoch 353/1000
460/460 [==============================] - 1s 1ms/step - loss: 532.6891 - mse:
```

```
482.5633 - val_loss: 511.7230 - val_mse: 461.5353
Epoch 354/1000
460/460 [==============================] - 1s 1ms/step - loss: 716.7970 - mse:
666.1306 - val_loss: 451.7562 - val_mse: 401.3182
Epoch 355/1000
460/460 [==============================] - 1s 1ms/step - loss: 395.2363 - mse:
344.8998 - val_loss: 2123.5952 - val_mse: 2072.3792
Epoch 356/1000
460/460 [==============================] - 1s 1ms/step - loss: 580.3784 - mse:
529.8051 - val_loss: 87.7647 - val_mse: 37.6456
Epoch 357/1000
460/460 [==============================] - 1s 1ms/step - loss: 483.5552 - mse:
433.0993 - val_loss: 107.8212 - val_mse: 57.3204
Epoch 358/1000
460/460 [==============================] - 1s 1ms/step - loss: 731.3567 - mse:
680.7777 - val_loss: 1042.5171 - val_mse: 992.3988
Epoch 359/1000
460/460 [==============================] - 1s 1ms/step - loss: 1348.8192 - mse
: 1297.5133 - val_loss: 249.6905 - val_mse: 199.3238
Epoch 360/1000
460/460 [==============================] - 1s 1ms/step - loss: 846.5552 - mse:
796.5557 - val_loss: 80.7329 - val_mse: 30.9928
Epoch 361/1000
460/460 [==============================] - 1s 1ms/step - loss: 329.4440 - mse:
279.7309 - val_loss: 133.9051 - val_mse: 84.3464
Epoch 362/1000
460/460 [==============================] - 1s 1ms/step - loss: 1300.9995 - mse
: 1250.2969 - val_loss: 94.4159 - val_mse: 42.7102
Epoch 363/1000
460/460 [==============================] - 1s 1ms/step - loss: 177.2596 - mse:
126.1815 - val_loss: 90.2915 - val_mse: 39.7289
Epoch 364/1000
460/460 [==============================] - 1s 1ms/step - loss: 844.4979 - mse:
794.4510 - val_loss: 1179.0251 - val_mse: 1129.3330
Epoch 365/1000
460/460 [==============================] - 1s 1ms/step - loss: 707.4352 - mse:
657.8044 - val_loss: 221.6655 - val_mse: 172.1163
Epoch 366/1000
460/460 [==============================] - 1s 2ms/step - loss: 497.2292 - mse:
447.3622 - val_loss: 148.9350 - val_mse: 98.6707
Epoch 367/1000
460/460 [==============================] - 1s 2ms/step - loss: 551.3832 - mse:
501.2879 - val_loss: 222.3750 - val_mse: 171.1439
Epoch 368/1000
460/460 [==============================] - 1s 2ms/step - loss: 1805.1252 - mse
: 1754.5712 - val_loss: 1395.4132 - val_mse: 1345.7487
Epoch 369/1000
460/460 [==============================] - 1s 1ms/step - loss: 288.1138 - mse:
238.3747 - val_loss: 214.7276 - val_mse: 165.1573
Epoch 370/1000
460/460 [==============================] - 1s 2ms/step - loss: 514.5521 - mse:
464.8027 - val_loss: 973.0176 - val_mse: 922.6269
Epoch 371/1000
460/460 [==============================] - 1s 2ms/step - loss: 5279.0112 - mse
: 5226.9463 - val_loss: 204.0875 - val_mse: 150.7240
Epoch 372/1000
460/460 [==============================] - 1s 2ms/step - loss: 158.0104 - mse:
105.1205 - val_loss: 766.5322 - val_mse: 713.8104
Epoch 373/1000
460/460 [==============================] - 1s 2ms/step - loss: 165.7997 - mse:
113.4528 - val_loss: 101.9699 - val_mse: 49.9928
```

```
Epoch 374/1000
460/460 [==============================] - 1s 2ms/step - loss: 211.9191 - mse:
160.2253 - val_loss: 272.9564 - val_mse: 221.4270
Epoch 375/1000
460/460 [==============================] - 1s 2ms/step - loss: 719.3179 - mse:
667.8509 - val_loss: 159.2755 - val_mse: 108.2185
Epoch 376/1000
460/460 [==============================] - 1s 1ms/step - loss: 210.2741 - mse:
159.6584 - val_loss: 641.2985 - val_mse: 591.0008
Epoch 377/1000
460/460 [==============================] - 1s 1ms/step - loss: 1648.6680 - mse
: 1598.0977 - val_loss: 531.5876 - val_mse: 481.0588
Epoch 378/1000
460/460 [==============================] - 1s 1ms/step - loss: 359.6915 - mse:
309.3278 - val_loss: 110.0939 - val_mse: 59.6297
Epoch 379/1000
460/460 [==============================] - 1s 1ms/step - loss: 476.5635 - mse:
426.2575 - val_loss: 116.3250 - val_mse: 65.8332
Epoch 380/1000
460/460 [==============================] - 1s 1ms/step - loss: 2973.3127 - mse
: 2921.7173 - val_loss: 100.3992 - val_mse: 48.6643
Epoch 381/1000
460/460 [==============================] - 1s 1ms/step - loss: 125.2831 - mse:
74.0352 - val_loss: 80.1639 - val_mse: 29.1356
Epoch 382/1000
460/460 [==============================] - 1s 2ms/step - loss: 211.7641 - mse:
161.1427 - val_loss: 88.0696 - val_mse: 37.9149
Epoch 383/1000
460/460 [==============================] - 1s 1ms/step - loss: 303.1205 - mse:
253.0193 - val_loss: 228.9567 - val_mse: 178.8103
Epoch 384/1000
460/460 [==============================] - 1s 1ms/step - loss: 456.6577 - mse:
406.5942 - val_loss: 197.3353 - val_mse: 147.4264
Epoch 385/1000
460/460 [==============================] - 1s 1ms/step - loss: 18444.7852 - ms
e: 18391.4355 - val_loss: 110.5005 - val_mse: 56.8594
Epoch 386/1000
460/460 [==============================] - 1s 1ms/step - loss: 93.9933 - mse:
40.5028 - val_loss: 87.8770 - val_mse: 34.5723
Epoch 387/1000
460/460 [==============================] - 1s 1ms/step - loss: 97.0109 - mse:
44.0077 - val_loss: 83.0991 - val_mse: 30.4265
Epoch 388/1000
460/460 [==============================] - 1s 2ms/step - loss: 92.9499 - mse:
40.1995 - val_loss: 79.3547 - val_mse: 26.7197
Epoch 389/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.0160 - mse:
80.6219 - val_loss: 80.2751 - val_mse: 28.1559
Epoch 390/1000
460/460 [==============================] - 1s 1ms/step - loss: 163.2166 - mse:
111.2372 - val_loss: 109.4815 - val_mse: 57.3455
Epoch 391/1000
460/460 [==============================] - 1s 1ms/step - loss: 306.1833 - mse:
254.0942 - val_loss: 5205.6968 - val_mse: 5153.7183
Epoch 392/1000
460/460 [==============================] - 1s 2ms/step - loss: 1257.3593 - mse
: 1205.4875 - val_loss: 95.5997 - val_mse: 44.1428
Epoch 393/1000
460/460 [==============================] - 1s 1ms/step - loss: 334.5917 - mse:
283.3452 - val_loss: 2182.7136 - val_mse: 2131.3386
Epoch 394/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 712.2692 - mse:
661.4639 - val_loss: 96.4211 - val_mse: 45.9410
Epoch 395/1000
460/460 [==============================] - 1s 1ms/step - loss: 454.6867 - mse:
404.6669 - val_loss: 82.1124 - val_mse: 32.7099
Epoch 396/1000
460/460 [==============================] - 1s 1ms/step - loss: 1826.5649 - mse
: 1776.6012 - val_loss: 14950.0137 - val_mse: 14899.6973
Epoch 397/1000
460/460 [==============================] - 1s 2ms/step - loss: 1715.5538 - mse
: 1665.7958 - val_loss: 79.8777 - val_mse: 30.4380
Epoch 398/1000
460/460 [==============================] - 1s 1ms/step - loss: 113.1368 - mse:
63.8528 - val_loss: 198.4628 - val_mse: 149.2896
Epoch 399/1000
460/460 [==============================] - 1s 1ms/step - loss: 138.6525 - mse:
89.4279 - val_loss: 115.5984 - val_mse: 66.4354
Epoch 400/1000
460/460 [==============================] - 1s 1ms/step - loss: 1998.6326 - mse
: 1949.3206 - val_loss: 429.2128 - val_mse: 379.7509
Epoch 401/1000
460/460 [==============================] - 1s 1ms/step - loss: 166.7354 - mse:
117.8277 - val_loss: 186.3438 - val_mse: 137.4808
Epoch 402/1000
460/460 [==============================] - 1s 1ms/step - loss: 323.2852 - mse:
274.3459 - val_loss: 90.1455 - val_mse: 41.4304
Epoch 403/1000
460/460 [==============================] - 1s 1ms/step - loss: 887.2947 - mse:
837.8048 - val_loss: 95.2389 - val_mse: 45.6855
Epoch 404/1000
460/460 [==============================] - 1s 1ms/step - loss: 198.1000 - mse:
148.0620 - val_loss: 856.6410 - val_mse: 806.5160
Epoch 405/1000
460/460 [==============================] - 1s 1ms/step - loss: 2308.1069 - mse
: 2256.7202 - val_loss: 334.9552 - val_mse: 283.8845
Epoch 406/1000
460/460 [==============================] - 1s 1ms/step - loss: 167.9346 - mse:
117.2287 - val_loss: 86.1954 - val_mse: 35.8491
Epoch 407/1000
460/460 [==============================] - 1s 1ms/step - loss: 364.2071 - mse:
313.9765 - val_loss: 734.8287 - val_mse: 684.6859
Epoch 408/1000
460/460 [==============================] - 1s 1ms/step - loss: 1904.7177 - mse
: 1854.4363 - val_loss: 49437.4805 - val_mse: 49385.2930
Epoch 409/1000
460/460 [==============================] - 1s 1ms/step - loss: 1208.4298 - mse
: 1157.3561 - val_loss: 88.5357 - val_mse: 38.1073
Epoch 410/1000
460/460 [==============================] - 1s 1ms/step - loss: 114.4190 - mse:
64.1559 - val_loss: 243.9322 - val_mse: 193.6405
Epoch 411/1000
460/460 [==============================] - 1s 1ms/step - loss: 150.9224 - mse:
100.7675 - val_loss: 114.9011 - val_mse: 64.6791
Epoch 412/1000
460/460 [==============================] - 1s 1ms/step - loss: 379.7547 - mse:
329.4162 - val_loss: 86.1600 - val_mse: 35.6660
Epoch 413/1000
460/460 [==============================] - 1s 1ms/step - loss: 779.3582 - mse:
727.7148 - val_loss: 861.1555 - val_mse: 809.4501
Epoch 414/1000
460/460 [==============================] - 1s 1ms/step - loss: 465.0522 - mse:
```

```
414.1164 - val_loss: 77.8754 - val_mse: 27.5666
Epoch 415/1000
460/460 [==============================] - 1s 1ms/step - loss: 4221.0522 - mse
: 4170.1294 - val_loss: 140.0560 - val_mse: 88.7000
Epoch 416/1000
460/460 [==============================] - 1s 1ms/step - loss: 168.1733 - mse:
117.3665 - val_loss: 1122.2385 - val_mse: 1071.7057
Epoch 417/1000
460/460 [==============================] - 1s 1ms/step - loss: 155.9834 - mse:
105.7864 - val_loss: 161.5965 - val_mse: 111.7550
Epoch 418/1000
460/460 [==============================] - 1s 1ms/step - loss: 198.4595 - mse:
148.5916 - val_loss: 489.2244 - val_mse: 439.3548
Epoch 419/1000
460/460 [==============================] - 1s 1ms/step - loss: 858.0514 - mse:
806.9924 - val_loss: 142.7560 - val_mse: 91.5319
Epoch 420/1000
460/460 [==============================] - 1s 1ms/step - loss: 166.0517 - mse:
115.3343 - val_loss: 113.6793 - val_mse: 63.4176
Epoch 421/1000
460/460 [==============================] - 1s 1ms/step - loss: 822.6558 - mse:
772.4645 - val_loss: 78.9101 - val_mse: 28.7921
Epoch 422/1000
460/460 [==============================] - 1s 1ms/step - loss: 213.2863 - mse:
163.4535 - val_loss: 1014.9153 - val_mse: 965.3613
Epoch 423/1000
460/460 [==============================] - 1s 1ms/step - loss: 2164.3020 - mse
: 2113.9827 - val_loss: 79.8353 - val_mse: 28.9097
Epoch 424/1000
460/460 [==============================] - 1s 1ms/step - loss: 122.4256 - mse:
72.3813 - val_loss: 159.4172 - val_mse: 109.6562
Epoch 425/1000
460/460 [==============================] - 1s 1ms/step - loss: 451.4364 - mse:
401.8678 - val_loss: 160.5327 - val_mse: 110.8597
Epoch 426/1000
460/460 [==============================] - 1s 1ms/step - loss: 439.9692 - mse:
390.5605 - val_loss: 123.7098 - val_mse: 74.6497
Epoch 427/1000
460/460 [==============================] - 1s 1ms/step - loss: 2112.1248 - mse
: 2062.0908 - val_loss: 101.7205 - val_mse: 48.8794
Epoch 428/1000
460/460 [==============================] - 1s 1ms/step - loss: 116.0851 - mse:
64.5592 - val_loss: 312.1273 - val_mse: 261.5660
Epoch 429/1000
460/460 [==============================] - 1s 1ms/step - loss: 211.2788 - mse:
161.2469 - val_loss: 81.6659 - val_mse: 32.1262
Epoch 430/1000
460/460 [==============================] - 1s 1ms/step - loss: 924.5272 - mse:
874.7726 - val_loss: 88.0808 - val_mse: 38.6763
Epoch 431/1000
460/460 [==============================] - 1s 1ms/step - loss: 217.3279 - mse:
167.8962 - val_loss: 260.3535 - val_mse: 210.9669
Epoch 432/1000
460/460 [==============================] - 1s 1ms/step - loss: 2918.0886 - mse
: 2867.6699 - val_loss: 105.6180 - val_mse: 55.1378
Epoch 433/1000
460/460 [==============================] - 1s 1ms/step - loss: 154.9725 - mse:
105.1418 - val_loss: 82.2660 - val_mse: 33.0383
Epoch 434/1000
460/460 [==============================] - 1s 1ms/step - loss: 237.6185 - mse:
188.4384 - val_loss: 83.7270 - val_mse: 34.7784
```

```
Epoch 435/1000
460/460 [==============================] - 1s 1ms/step - loss: 2497.9963 - mse
: 2448.5708 - val_loss: 98.1219 - val_mse: 48.8277
Epoch 436/1000
460/460 [==============================] - 1s 1ms/step - loss: 110.4798 - mse:
61.4370 - val_loss: 79.4599 - val_mse: 30.3804
Epoch 437/1000
460/460 [==============================] - 1s 1ms/step - loss: 358.4723 - mse:
309.3130 - val_loss: 94.7945 - val_mse: 45.6016
Epoch 438/1000
460/460 [==============================] - 1s 1ms/step - loss: 918.4260 - mse:
868.5947 - val_loss: 82.6317 - val_mse: 32.9626
Epoch 439/1000
460/460 [==============================] - 1s 1ms/step - loss: 814.9128 - mse:
765.3176 - val_loss: 22377.6523 - val_mse: 22327.4395
Epoch 440/1000
460/460 [==============================] - 1s 1ms/step - loss: 846.1685 - mse:
795.9824 - val_loss: 103.6677 - val_mse: 53.3582
Epoch 441/1000
460/460 [==============================] - 1s 1ms/step - loss: 322.2511 - mse:
272.1956 - val_loss: 87.0038 - val_mse: 37.1689
Epoch 442/1000
460/460 [==============================] - 1s 1ms/step - loss: 1403.8296 - mse
: 1352.8038 - val_loss: 91.2286 - val_mse: 39.4189
Epoch 443/1000
460/460 [==============================] - 1s 1ms/step - loss: 387.7661 - mse:
335.9868 - val_loss: 12956.3750 - val_mse: 12904.5654
Epoch 444/1000
460/460 [==============================] - 1s 1ms/step - loss: 410.1667 - mse:
358.6897 - val_loss: 77.1012 - val_mse: 25.9096
Epoch 445/1000
460/460 [==============================] - 1s 1ms/step - loss: 1006.8393 - mse
: 955.6957 - val_loss: 92.9634 - val_mse: 41.8520
Epoch 446/1000
460/460 [==============================] - 1s 1ms/step - loss: 227.7974 - mse:
176.7721 - val_loss: 162.1897 - val_mse: 111.1794
Epoch 447/1000
460/460 [==============================] - 1s 1ms/step - loss: 3909.2695 - mse
: 3857.4214 - val_loss: 86.9946 - val_mse: 35.1533
Epoch 448/1000
460/460 [==============================] - 1s 1ms/step - loss: 94.8209 - mse:
43.0119 - val_loss: 163.4144 - val_mse: 111.6988
Epoch 449/1000
460/460 [==============================] - 1s 1ms/step - loss: 110.1064 - mse:
58.4364 - val_loss: 82.6772 - val_mse: 31.1317
Epoch 450/1000
460/460 [==============================] - 1s 1ms/step - loss: 244.6554 - mse:
193.1427 - val_loss: 233.3488 - val_mse: 181.9172
Epoch 451/1000
460/460 [==============================] - 1s 1ms/step - loss: 346.1174 - mse:
294.8466 - val_loss: 3309.9888 - val_mse: 3259.1873
Epoch 452/1000
460/460 [==============================] - 1s 1ms/step - loss: 654.5689 - mse:
603.7919 - val_loss: 170.7271 - val_mse: 119.6726
Epoch 453/1000
460/460 [==============================] - 1s 1ms/step - loss: 1323.8801 - mse
: 1272.5568 - val_loss: 88.1946 - val_mse: 37.3014
Epoch 454/1000
460/460 [==============================] - 1s 1ms/step - loss: 223.0369 - mse:
172.4751 - val_loss: 196.5835 - val_mse: 146.3553
Epoch 455/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 342.4546 - mse:
292.2957 - val_loss: 4299.8330 - val_mse: 4249.8945
Epoch 456/1000
460/460 [==============================] - 1s 1ms/step - loss: 5072.1831 - mse
: 5021.2749 - val_loss: 81.6045 - val_mse: 31.1910
Epoch 457/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.4459 - mse:
49.3618 - val_loss: 379.1072 - val_mse: 329.3997
Epoch 458/1000
460/460 [==============================] - 1s 1ms/step - loss: 167.3234 - mse:
117.2175 - val_loss: 874.1065 - val_mse: 823.8516
Epoch 459/1000
460/460 [==============================] - 1s 1ms/step - loss: 351.2325 - mse:
301.0521 - val_loss: 97.1338 - val_mse: 47.0239
Epoch 460/1000
460/460 [==============================] - 1s 1ms/step - loss: 353.3115 - mse:
302.9659 - val_loss: 102.6465 - val_mse: 52.3626
Epoch 461/1000
460/460 [==============================] - 1s 1ms/step - loss: 453.3581 - mse:
402.9042 - val_loss: 1870.9615 - val_mse: 1820.7465
Epoch 462/1000
460/460 [==============================] - 1s 1ms/step - loss: 591.0759 - mse:
540.3569 - val_loss: 146.7921 - val_mse: 96.3146
Epoch 463/1000
460/460 [==============================] - 1s 1ms/step - loss: 462.4640 - mse:
412.0253 - val_loss: 2228.0686 - val_mse: 2177.2139
Epoch 464/1000
460/460 [==============================] - 1s 1ms/step - loss: 1424.0953 - mse
: 1372.8112 - val_loss: 163.2357 - val_mse: 111.7652
Epoch 465/1000
460/460 [==============================] - 1s 1ms/step - loss: 348.2950 - mse:
297.2458 - val_loss: 83.4902 - val_mse: 32.8608
Epoch 466/1000
460/460 [==============================] - 1s 1ms/step - loss: 1538.1896 - mse
: 1487.0486 - val_loss: 194.6895 - val_mse: 143.9838
Epoch 467/1000
460/460 [==============================] - 1s 1ms/step - loss: 144.1956 - mse:
93.9520 - val_loss: 79.3268 - val_mse: 29.5461
Epoch 468/1000
460/460 [==============================] - 1s 1ms/step - loss: 795.6520 - mse:
745.0250 - val_loss: 128.6040 - val_mse: 78.1205
Epoch 469/1000
460/460 [==============================] - 1s 1ms/step - loss: 2433.9834 - mse
: 2383.5034 - val_loss: 4102.7944 - val_mse: 4049.7019
Epoch 470/1000
460/460 [==============================] - 1s 1ms/step - loss: 372.9454 - mse:
321.4420 - val_loss: 118.1942 - val_mse: 67.6544
Epoch 471/1000
460/460 [==============================] - 1s 1ms/step - loss: 158.1727 - mse:
108.0924 - val_loss: 536.0283 - val_mse: 485.3745
Epoch 472/1000
460/460 [==============================] - 1s 1ms/step - loss: 879.4066 - mse:
827.8106 - val_loss: 128.3481 - val_mse: 76.4536
Epoch 473/1000
460/460 [==============================] - 1s 1ms/step - loss: 668.0968 - mse:
617.0509 - val_loss: 92.8373 - val_mse: 42.5440
Epoch 474/1000
460/460 [==============================] - 1s 1ms/step - loss: 844.1592 - mse:
794.0392 - val_loss: 5283.5972 - val_mse: 5233.0952
Epoch 475/1000
460/460 [==============================] - 1s 1ms/step - loss: 251.3029 - mse:
```

```
201.1921 - val_loss: 1789.9532 - val_mse: 1739.7861
Epoch 476/1000
460/460 [==============================] - 1s 1ms/step - loss: 729.3374 - mse:
679.2191 - val_loss: 89.1237 - val_mse: 39.2571
Epoch 477/1000
460/460 [==============================] - 1s 1ms/step - loss: 1020.1588 - mse
: 970.5644 - val_loss: 1120.1816 - val_mse: 1069.9647
Epoch 478/1000
460/460 [==============================] - 1s 1ms/step - loss: 1061.6538 - mse
: 1011.4793 - val_loss: 77.5625 - val_mse: 27.6719
Epoch 479/1000
460/460 [==============================] - 1s 1ms/step - loss: 141.7144 - mse:
92.1043 - val_loss: 83.6628 - val_mse: 34.2105
Epoch 480/1000
460/460 [==============================] - 1s 1ms/step - loss: 2908.6167 - mse
: 2858.6055 - val_loss: 147.2331 - val_mse: 95.4219
Epoch 481/1000
460/460 [==============================] - 1s 1ms/step - loss: 189.9590 - mse:
138.8417 - val_loss: 123.7224 - val_mse: 72.9858
Epoch 482/1000
460/460 [==============================] - 1s 1ms/step - loss: 268.6226 - mse:
218.1408 - val_loss: 3376.2302 - val_mse: 3325.6638
Epoch 483/1000
460/460 [==============================] - 1s 1ms/step - loss: 1081.3799 - mse
: 1031.2721 - val_loss: 83.8607 - val_mse: 34.1993
Epoch 484/1000
460/460 [==============================] - 1s 1ms/step - loss: 226.9938 - mse:
177.3851 - val_loss: 130.0545 - val_mse: 80.5563
Epoch 485/1000
460/460 [==============================] - 1s 1ms/step - loss: 542.3581 - mse:
492.9365 - val_loss: 216.6935 - val_mse: 167.6890
Epoch 486/1000
460/460 [==============================] - 1s 1ms/step - loss: 448.3457 - mse:
398.7196 - val_loss: 115.6108 - val_mse: 65.5008
Epoch 487/1000
460/460 [==============================] - 1s 1ms/step - loss: 177.7912 - mse:
127.7863 - val_loss: 224.3035 - val_mse: 174.4185
Epoch 488/1000
460/460 [==============================] - 1s 1ms/step - loss: 4761.6377 - mse
: 4710.7988 - val_loss: 124.4448 - val_mse: 71.8895
Epoch 489/1000
460/460 [==============================] - 1s 1ms/step - loss: 193.7263 - mse:
141.5774 - val_loss: 139.7971 - val_mse: 87.7841
Epoch 490/1000
460/460 [==============================] - 1s 1ms/step - loss: 102.8250 - mse:
51.2382 - val_loss: 178.8725 - val_mse: 127.6391
Epoch 491/1000
460/460 [==============================] - 1s 1ms/step - loss: 358.2825 - mse:
306.9607 - val_loss: 77.2310 - val_mse: 26.3213
Epoch 492/1000
460/460 [==============================] - 1s 1ms/step - loss: 321.6638 - mse:
271.0273 - val_loss: 29089.5410 - val_mse: 29038.8281
Epoch 493/1000
460/460 [==============================] - 1s 1ms/step - loss: 875.1948 - mse:
825.1433 - val_loss: 555.1165 - val_mse: 504.9252
Epoch 494/1000
460/460 [==============================] - 1s 1ms/step - loss: 1848.6436 - mse
: 1798.6833 - val_loss: 726.2256 - val_mse: 675.8423
Epoch 495/1000
460/460 [==============================] - 1s 1ms/step - loss: 119.7784 - mse:
69.6259 - val_loss: 113.2869 - val_mse: 63.5920
```

```
Epoch 496/1000
460/460 [==============================] - 1s 1ms/step - loss: 155.6180 - mse:
105.6464 - val_loss: 114.1607 - val_mse: 63.8975
Epoch 497/1000
460/460 [==============================] - 1s 1ms/step - loss: 3163.2942 - mse
: 3112.1104 - val_loss: 176.3065 - val_mse: 123.4840
Epoch 498/1000
460/460 [==============================] - 1s 1ms/step - loss: 232.7984 - mse:
180.6227 - val_loss: 102.0504 - val_mse: 50.3996
Epoch 499/1000
460/460 [==============================] - 1s 1ms/step - loss: 145.9004 - mse:
94.4313 - val_loss: 123.3523 - val_mse: 71.9441
Epoch 500/1000
460/460 [==============================] - 1s 1ms/step - loss: 506.6522 - mse:
455.2975 - val_loss: 763.0007 - val_mse: 711.9459
Epoch 501/1000
460/460 [==============================] - 1s 1ms/step - loss: 762.3638 - mse:
711.4916 - val_loss: 266.2919 - val_mse: 215.2930
Epoch 502/1000
460/460 [==============================] - 1s 1ms/step - loss: 156.8504 - mse:
106.1688 - val_loss: 123.0003 - val_mse: 72.5710
Epoch 503/1000
460/460 [==============================] - 1s 1ms/step - loss: 1258.0709 - mse
: 1207.4907 - val_loss: 341.1750 - val_mse: 290.8839
Epoch 504/1000
460/460 [==============================] - 1s 1ms/step - loss: 234.0053 - mse:
183.7674 - val_loss: 1950.6249 - val_mse: 1900.6989
Epoch 505/1000
460/460 [==============================] - 1s 1ms/step - loss: 836.2468 - mse:
786.3657 - val_loss: 221.6925 - val_mse: 172.0627
Epoch 506/1000
460/460 [==============================] - 1s 1ms/step - loss: 526.3564 - mse:
476.7180 - val_loss: 101.9072 - val_mse: 52.4258
Epoch 507/1000
460/460 [==============================] - 1s 1ms/step - loss: 1790.7532 - mse
: 1741.1964 - val_loss: 156.3531 - val_mse: 106.9152
Epoch 508/1000
460/460 [==============================] - 1s 1ms/step - loss: 142.4028 - mse:
93.1240 - val_loss: 84.7014 - val_mse: 35.5689
Epoch 509/1000
460/460 [==============================] - 1s 1ms/step - loss: 379.8729 - mse:
330.6604 - val_loss: 132.8819 - val_mse: 83.9701
Epoch 510/1000
460/460 [==============================] - 1s 1ms/step - loss: 901.4275 - mse:
852.1513 - val_loss: 201.3220 - val_mse: 152.4198
Epoch 511/1000
460/460 [==============================] - 1s 1ms/step - loss: 260.4154 - mse:
211.2162 - val_loss: 101.0151 - val_mse: 51.8248
Epoch 512/1000
460/460 [==============================] - 1s 1ms/step - loss: 4958.6040 - mse
: 4908.6724 - val_loss: 115.2338 - val_mse: 63.9972
Epoch 513/1000
460/460 [==============================] - 1s 1ms/step - loss: 111.5422 - mse:
60.6531 - val_loss: 86.2387 - val_mse: 35.5929
Epoch 514/1000
460/460 [==============================] - 1s 1ms/step - loss: 171.1921 - mse:
120.7244 - val_loss: 114.2834 - val_mse: 63.9346
Epoch 515/1000
460/460 [==============================] - 1s 1ms/step - loss: 560.6331 - mse:
510.6320 - val_loss: 126.7301 - val_mse: 77.0314
Epoch 516/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 391.1924 - mse:
341.4656 - val_loss: 96.2639 - val_mse: 46.1816
Epoch 517/1000
460/460 [==============================] - 1s 1ms/step - loss: 1368.6904 - mse
: 1318.7744 - val_loss: 83.8548 - val_mse: 34.2131
Epoch 518/1000
460/460 [==============================] - 1s 1ms/step - loss: 230.7399 - mse:
181.1953 - val_loss: 83.8894 - val_mse: 34.6102
Epoch 519/1000
460/460 [==============================] - 1s 1ms/step - loss: 466.7802 - mse:
417.4627 - val_loss: 89.4984 - val_mse: 40.4713
Epoch 520/1000
460/460 [==============================] - 1s 1ms/step - loss: 160.3967 - mse:
111.3827 - val_loss: 125.7036 - val_mse: 76.1920
Epoch 521/1000
460/460 [==============================] - 1s 1ms/step - loss: 1723.5239 - mse
: 1673.9441 - val_loss: 190.2945 - val_mse: 141.2596
Epoch 522/1000
460/460 [==============================] - 1s 1ms/step - loss: 134.8051 - mse:
85.3481 - val_loss: 106.7303 - val_mse: 57.1857
Epoch 523/1000
460/460 [==============================] - 1s 1ms/step - loss: 942.4135 - mse:
892.7056 - val_loss: 87.0311 - val_mse: 37.6561
Epoch 524/1000
460/460 [==============================] - 1s 1ms/step - loss: 449.2783 - mse:
399.7517 - val_loss: 225.8900 - val_mse: 176.4800
Epoch 525/1000
460/460 [==============================] - 1s 1ms/step - loss: 434.7027 - mse:
385.5001 - val_loss: 2303.0110 - val_mse: 2253.8176
Epoch 526/1000
460/460 [==============================] - 1s 1ms/step - loss: 1519.0549 - mse
: 1468.1349 - val_loss: 123.4987 - val_mse: 72.7021
Epoch 527/1000
460/460 [==============================] - 1s 1ms/step - loss: 498.2302 - mse:
448.0068 - val_loss: 225.4393 - val_mse: 175.7007
Epoch 528/1000
460/460 [==============================] - 1s 1ms/step - loss: 902.9131 - mse:
853.2728 - val_loss: 939.0333 - val_mse: 889.8045
Epoch 529/1000
460/460 [==============================] - 1s 1ms/step - loss: 850.5234 - mse:
801.2378 - val_loss: 3492.5557 - val_mse: 3443.1265
Epoch 530/1000
460/460 [==============================] - 1s 1ms/step - loss: 331.2456 - mse:
282.0596 - val_loss: 261.6746 - val_mse: 212.1954
Epoch 531/1000
460/460 [==============================] - 1s 1ms/step - loss: 490.7729 - mse:
441.4308 - val_loss: 466.8147 - val_mse: 417.8413
Epoch 532/1000
460/460 [==============================] - 1s 1ms/step - loss: 797.4280 - mse:
748.4157 - val_loss: 94.2128 - val_mse: 44.8364
Epoch 533/1000
460/460 [==============================] - 1s 1ms/step - loss: 707.5208 - mse:
658.3586 - val_loss: 130.9948 - val_mse: 82.1208
Epoch 534/1000
460/460 [==============================] - 1s 1ms/step - loss: 588.4954 - mse:
539.4395 - val_loss: 92.8743 - val_mse: 43.7834
Epoch 535/1000
460/460 [==============================] - 1s 1ms/step - loss: 1645.3234 - mse
: 1596.1548 - val_loss: 87.8231 - val_mse: 38.9187
Epoch 536/1000
460/460 [==============================] - 1s 1ms/step - loss: 198.4725 - mse:
```

```
149.8273 - val_loss: 85.2945 - val_mse: 36.7102
Epoch 537/1000
460/460 [==============================] - 1s 1ms/step - loss: 210.8926 - mse:
162.2145 - val_loss: 298.7397 - val_mse: 249.8489
Epoch 538/1000
460/460 [==============================] - 1s 1ms/step - loss: 1665.9677 - mse
: 1617.0837 - val_loss: 334.5762 - val_mse: 285.0767
Epoch 539/1000
460/460 [==============================] - 1s 1ms/step - loss: 134.7075 - mse:
85.9353 - val_loss: 273.5170 - val_mse: 224.9391
Epoch 540/1000
460/460 [==============================] - 1s 1ms/step - loss: 449.0172 - mse:
400.6515 - val_loss: 305.3639 - val_mse: 257.1451
Epoch 541/1000
460/460 [==============================] - 1s 1ms/step - loss: 570.5848 - mse:
522.0768 - val_loss: 459.4114 - val_mse: 410.2997
Epoch 542/1000
460/460 [==============================] - 1s 1ms/step - loss: 3459.8728 - mse
: 3409.9072 - val_loss: 174.5968 - val_mse: 124.6486
Epoch 543/1000
460/460 [==============================] - 1s 1ms/step - loss: 118.3503 - mse:
68.6190 - val_loss: 116.1904 - val_mse: 66.6698
Epoch 544/1000
460/460 [==============================] - 1s 1ms/step - loss: 183.2419 - mse:
133.7675 - val_loss: 110.7059 - val_mse: 61.4901
Epoch 545/1000
460/460 [==============================] - 1s 1ms/step - loss: 192.7993 - mse:
143.1324 - val_loss: 518.7092 - val_mse: 468.9623
Epoch 546/1000
460/460 [==============================] - 1s 1ms/step - loss: 459.2975 - mse:
409.7583 - val_loss: 92.4845 - val_mse: 43.1120
Epoch 547/1000
460/460 [==============================] - 1s 1ms/step - loss: 309.8886 - mse:
260.6295 - val_loss: 290.1259 - val_mse: 241.1073
Epoch 548/1000
460/460 [==============================] - 1s 1ms/step - loss: 2464.3467 - mse
: 2414.9604 - val_loss: 115.7475 - val_mse: 66.6455
Epoch 549/1000
460/460 [==============================] - 1s 1ms/step - loss: 123.0359 - mse:
74.2555 - val_loss: 143.4411 - val_mse: 94.8969
Epoch 550/1000
460/460 [==============================] - 1s 1ms/step - loss: 269.8453 - mse:
221.6273 - val_loss: 203.9700 - val_mse: 156.0053
Epoch 551/1000
460/460 [==============================] - 1s 1ms/step - loss: 550.9238 - mse:
502.9411 - val_loss: 90.8032 - val_mse: 42.9031
Epoch 552/1000
460/460 [==============================] - 1s 1ms/step - loss: 665.9556 - mse:
617.8649 - val_loss: 80.3571 - val_mse: 32.2067
Epoch 553/1000
460/460 [==============================] - 1s 1ms/step - loss: 820.6854 - mse:
772.5087 - val_loss: 85.5627 - val_mse: 37.6536
Epoch 554/1000
460/460 [==============================] - 1s 1ms/step - loss: 180.3823 - mse:
132.2951 - val_loss: 7170.2598 - val_mse: 7122.4829
Epoch 555/1000
460/460 [==============================] - 1s 1ms/step - loss: 823.5475 - mse:
775.9850 - val_loss: 112.3514 - val_mse: 65.0122
Epoch 556/1000
460/460 [==============================] - 1s 1ms/step - loss: 2221.1338 - mse
: 2173.4673 - val_loss: 1909.7065 - val_mse: 1861.0312
```

```
Epoch 557/1000
460/460 [==============================] - 1s 1ms/step - loss: 135.4215 - mse:
87.3261 - val_loss: 91.8293 - val_mse: 44.1458
Epoch 558/1000
460/460 [==============================] - 1s 1ms/step - loss: 217.3420 - mse:
169.6448 - val_loss: 100.1490 - val_mse: 52.6266
Epoch 559/1000
460/460 [==============================] - 1s 1ms/step - loss: 333.9084 - mse:
286.1378 - val_loss: 77.2912 - val_mse: 29.0413
Epoch 560/1000
460/460 [==============================] - 1s 1ms/step - loss: 1381.2333 - mse
: 1333.3086 - val_loss: 346.0654 - val_mse: 298.3914
Epoch 561/1000
460/460 [==============================] - 1s 1ms/step - loss: 223.7387 - mse:
176.1180 - val_loss: 98.1276 - val_mse: 50.5015
Epoch 562/1000
460/460 [==============================] - 1s 1ms/step - loss: 762.2642 - mse:
714.6002 - val_loss: 92.8461 - val_mse: 45.4558
Epoch 563/1000
460/460 [==============================] - 1s 1ms/step - loss: 344.2179 - mse:
296.8439 - val_loss: 140.3401 - val_mse: 92.9342
Epoch 564/1000
460/460 [==============================] - 1s 1ms/step - loss: 1992.5570 - mse
: 1944.1556 - val_loss: 84.3885 - val_mse: 36.2773
Epoch 565/1000
460/460 [==============================] - 1s 1ms/step - loss: 176.7686 - mse:
129.0611 - val_loss: 205.1459 - val_mse: 157.8487
Epoch 566/1000
460/460 [==============================] - 1s 1ms/step - loss: 413.9267 - mse:
366.4175 - val_loss: 117.0685 - val_mse: 68.9508
Epoch 567/1000
460/460 [==============================] - 1s 1ms/step - loss: 538.1024 - mse:
490.2453 - val_loss: 2810.3845 - val_mse: 2762.5195
Epoch 568/1000
460/460 [==============================] - 1s 1ms/step - loss: 476.4358 - mse:
428.7783 - val_loss: 687.7275 - val_mse: 640.4531
Epoch 569/1000
460/460 [==============================] - 1s 1ms/step - loss: 458.3748 - mse:
410.8826 - val_loss: 90.8219 - val_mse: 43.1520
Epoch 570/1000
460/460 [==============================] - 1s 1ms/step - loss: 300.8376 - mse:
252.8557 - val_loss: 92.4366 - val_mse: 43.9854
Epoch 571/1000
460/460 [==============================] - 1s 1ms/step - loss: 458.5986 - mse:
410.1435 - val_loss: 86.9469 - val_mse: 38.1725
Epoch 572/1000
460/460 [==============================] - 1s 1ms/step - loss: 551.2108 - mse:
502.4800 - val_loss: 137.3766 - val_mse: 88.9137
Epoch 573/1000
460/460 [==============================] - 1s 1ms/step - loss: 485.0385 - mse:
436.4928 - val_loss: 89.2502 - val_mse: 40.8657
Epoch 574/1000
460/460 [==============================] - 1s 1ms/step - loss: 748.2003 - mse:
698.9586 - val_loss: 102.3608 - val_mse: 53.0788
Epoch 575/1000
460/460 [==============================] - 1s 1ms/step - loss: 207.6595 - mse:
158.7698 - val_loss: 86.1440 - val_mse: 37.6084
Epoch 576/1000
460/460 [==============================] - 1s 1ms/step - loss: 2859.6387 - mse
: 2811.1868 - val_loss: 688.6320 - val_mse: 640.4126
Epoch 577/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 175.4276 - mse:
127.5986 - val_loss: 92.3570 - val_mse: 44.9019
Epoch 578/1000
460/460 [==============================] - 1s 1ms/step - loss: 169.3732 - mse:
121.8844 - val_loss: 83.7041 - val_mse: 36.6051
Epoch 579/1000
460/460 [==============================] - 1s 1ms/step - loss: 503.5040 - mse:
455.9927 - val_loss: 317.3773 - val_mse: 269.9629
Epoch 580/1000
460/460 [==============================] - 1s 1ms/step - loss: 308.0877 - mse:
260.8700 - val_loss: 124.3137 - val_mse: 77.3649
Epoch 581/1000
460/460 [==============================] - 1s 1ms/step - loss: 750.8398 - mse:
703.6967 - val_loss: 86.6251 - val_mse: 39.6606
Epoch 582/1000
460/460 [==============================] - 1s 1ms/step - loss: 532.5577 - mse:
485.1113 - val_loss: 93.3378 - val_mse: 45.8835
Epoch 583/1000
460/460 [==============================] - 1s 1ms/step - loss: 395.6732 - mse:
348.3589 - val_loss: 72.6598 - val_mse: 25.4979
Epoch 584/1000
460/460 [==============================] - 1s 1ms/step - loss: 672.2794 - mse:
625.2758 - val_loss: 103.5293 - val_mse: 56.7593
Epoch 585/1000
460/460 [==============================] - 1s 1ms/step - loss: 606.1885 - mse:
559.3563 - val_loss: 418.3818 - val_mse: 371.7117
Epoch 586/1000
460/460 [==============================] - 1s 1ms/step - loss: 302.5345 - mse:
255.2399 - val_loss: 74.4376 - val_mse: 27.2364
Epoch 587/1000
460/460 [==============================] - 1s 1ms/step - loss: 1616.6875 - mse
: 1569.2438 - val_loss: 1652.2507 - val_mse: 1604.3574
Epoch 588/1000
460/460 [==============================] - 1s 1ms/step - loss: 237.6229 - mse:
190.5011 - val_loss: 187.1084 - val_mse: 140.4808
Epoch 589/1000
460/460 [==============================] - 1s 1ms/step - loss: 389.1833 - mse:
341.7115 - val_loss: 107.1927 - val_mse: 59.0289
Epoch 590/1000
460/460 [==============================] - 1s 1ms/step - loss: 1653.9491 - mse
: 1606.0452 - val_loss: 148.7607 - val_mse: 100.9574
Epoch 591/1000
460/460 [==============================] - 1s 1ms/step - loss: 579.3472 - mse:
531.9251 - val_loss: 171.9879 - val_mse: 124.8140
Epoch 592/1000
460/460 [==============================] - 1s 1ms/step - loss: 175.7011 - mse:
128.6207 - val_loss: 123.8986 - val_mse: 76.9987
Epoch 593/1000
460/460 [==============================] - 1s 1ms/step - loss: 357.7463 - mse:
310.8255 - val_loss: 1099.3234 - val_mse: 1052.1831
Epoch 594/1000
460/460 [==============================] - 1s 1ms/step - loss: 569.5587 - mse:
521.9863 - val_loss: 907.6030 - val_mse: 859.9639
Epoch 595/1000
460/460 [==============================] - 1s 1ms/step - loss: 1398.5392 - mse
: 1351.1064 - val_loss: 242.3533 - val_mse: 194.2571
Epoch 596/1000
460/460 [==============================] - 1s 1ms/step - loss: 174.5853 - mse:
126.9356 - val_loss: 100.4456 - val_mse: 53.1346
Epoch 597/1000
460/460 [==============================] - 1s 1ms/step - loss: 3311.8069 - mse
```

```
: 3264.0955 - val_loss: 692.4985 - val_mse: 643.4922
Epoch 598/1000
460/460 [==============================] - 1s 1ms/step - loss: 199.9543 - mse:
151.6417 - val_loss: 77.5336 - val_mse: 29.6652
Epoch 599/1000
460/460 [==============================] - 1s 1ms/step - loss: 263.7663 - mse:
216.2539 - val_loss: 87.5832 - val_mse: 40.3715
Epoch 600/1000
460/460 [==============================] - 1s 1ms/step - loss: 181.5314 - mse:
134.2933 - val_loss: 225.5740 - val_mse: 178.4160
Epoch 601/1000
460/460 [==============================] - 1s 1ms/step - loss: 235.8569 - mse:
188.3352 - val_loss: 80.9184 - val_mse: 33.8808
Epoch 602/1000
460/460 [==============================] - 1s 1ms/step - loss: 1155.2283 - mse
: 1107.5217 - val_loss: 108.9532 - val_mse: 61.4668
Epoch 603/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.8850 - mse:
86.5149 - val_loss: 80.6692 - val_mse: 33.4305
Epoch 604/1000
460/460 [==============================] - 1s 1ms/step - loss: 851.8950 - mse:
804.9789 - val_loss: 85.2944 - val_mse: 38.8394
Epoch 605/1000
460/460 [==============================] - 1s 1ms/step - loss: 2537.9321 - mse
: 2489.9673 - val_loss: 106.5979 - val_mse: 58.9497
Epoch 606/1000
460/460 [==============================] - 1s 1ms/step - loss: 107.0674 - mse:
59.5737 - val_loss: 93.4115 - val_mse: 46.2238
Epoch 607/1000
460/460 [==============================] - 1s 1ms/step - loss: 393.1553 - mse:
346.2866 - val_loss: 4503.2974 - val_mse: 4456.7334
Epoch 608/1000
460/460 [==============================] - 1s 1ms/step - loss: 569.3798 - mse:
522.9461 - val_loss: 1002.3351 - val_mse: 956.0580
Epoch 609/1000
460/460 [==============================] - 1s 1ms/step - loss: 239.7575 - mse:
193.1235 - val_loss: 135.7857 - val_mse: 89.0893
Epoch 610/1000
460/460 [==============================] - 1s 1ms/step - loss: 1221.8142 - mse
: 1174.8724 - val_loss: 93.7725 - val_mse: 46.7615
Epoch 611/1000
460/460 [==============================] - 1s 1ms/step - loss: 178.1871 - mse:
131.4378 - val_loss: 98.0891 - val_mse: 51.2342
Epoch 612/1000
460/460 [==============================] - 1s 1ms/step - loss: 743.0404 - mse:
696.2904 - val_loss: 1782.0963 - val_mse: 1734.7319
Epoch 613/1000
460/460 [==============================] - 1s 1ms/step - loss: 480.0691 - mse:
431.8546 - val_loss: 115.9240 - val_mse: 67.5183
Epoch 614/1000
460/460 [==============================] - 1s 1ms/step - loss: 582.4944 - mse:
535.1237 - val_loss: 129.1976 - val_mse: 82.6922
Epoch 615/1000
460/460 [==============================] - 1s 1ms/step - loss: 508.2781 - mse:
461.8301 - val_loss: 534.9319 - val_mse: 487.8505
Epoch 616/1000
460/460 [==============================] - 1s 1ms/step - loss: 2270.8630 - mse
: 2223.4895 - val_loss: 155.5540 - val_mse: 108.3870
Epoch 617/1000
460/460 [==============================] - 1s 1ms/step - loss: 91.9171 - mse:
44.8998 - val_loss: 101.9741 - val_mse: 55.1101
```

```
Epoch 618/1000
460/460 [==============================] - 1s 1ms/step - loss: 624.2182 - mse:
576.6298 - val_loss: 583.8955 - val_mse: 536.2423
Epoch 619/1000
460/460 [==============================] - 1s 1ms/step - loss: 339.9629 - mse:
292.1880 - val_loss: 584.8121 - val_mse: 536.7693
Epoch 620/1000
460/460 [==============================] - 1s 1ms/step - loss: 1090.7108 - mse
: 1042.6189 - val_loss: 77.6256 - val_mse: 29.5536
Epoch 621/1000
460/460 [==============================] - 1s 1ms/step - loss: 217.0879 - mse:
169.3629 - val_loss: 3944.4355 - val_mse: 3896.7966
Epoch 622/1000
460/460 [==============================] - 1s 1ms/step - loss: 1893.8541 - mse
: 1845.2449 - val_loss: 98.6549 - val_mse: 50.4562
Epoch 623/1000
460/460 [==============================] - 1s 1ms/step - loss: 467.5877 - mse:
419.9269 - val_loss: 144.5929 - val_mse: 97.5690
Epoch 624/1000
460/460 [==============================] - 1s 1ms/step - loss: 320.6438 - mse:
273.6808 - val_loss: 237.2269 - val_mse: 190.3268
Epoch 625/1000
460/460 [==============================] - 1s 1ms/step - loss: 2994.8450 - mse
: 2947.9075 - val_loss: 994.7816 - val_mse: 947.2385
Epoch 626/1000
460/460 [==============================] - 1s 1ms/step - loss: 150.6031 - mse:
103.5315 - val_loss: 91.3084 - val_mse: 44.5103
Epoch 627/1000
460/460 [==============================] - 1s 1ms/step - loss: 208.4145 - mse:
161.8614 - val_loss: 783.2408 - val_mse: 736.8832
Epoch 628/1000
460/460 [==============================] - 1s 1ms/step - loss: 171.4997 - mse:
124.9099 - val_loss: 126.7565 - val_mse: 80.1491
Epoch 629/1000
460/460 [==============================] - 1s 1ms/step - loss: 260.5522 - mse:
214.2939 - val_loss: 206.8121 - val_mse: 160.4407
Epoch 630/1000
460/460 [==============================] - 1s 1ms/step - loss: 991.4051 - mse:
945.0437 - val_loss: 96.6055 - val_mse: 49.2782
Epoch 631/1000
460/460 [==============================] - 1s 1ms/step - loss: 389.4268 - mse:
342.8695 - val_loss: 160.2456 - val_mse: 113.8749
Epoch 632/1000
460/460 [==============================] - 1s 1ms/step - loss: 843.3560 - mse:
797.1068 - val_loss: 80.1032 - val_mse: 34.0858
Epoch 633/1000
460/460 [==============================] - 1s 1ms/step - loss: 2199.5461 - mse
: 2153.1079 - val_loss: 89.1579 - val_mse: 42.4472
Epoch 634/1000
460/460 [==============================] - 1s 1ms/step - loss: 131.7064 - mse:
85.5801 - val_loss: 177.4553 - val_mse: 131.5814
Epoch 635/1000
460/460 [==============================] - 1s 1ms/step - loss: 223.3535 - mse:
177.3367 - val_loss: 630.7582 - val_mse: 584.6993
Epoch 636/1000
460/460 [==============================] - 1s 1ms/step - loss: 356.6617 - mse:
310.6218 - val_loss: 161.1357 - val_mse: 115.3275
Epoch 637/1000
460/460 [==============================] - 1s 1ms/step - loss: 624.7648 - mse:
578.6144 - val_loss: 104.5183 - val_mse: 58.3974
Epoch 638/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 1962.9542 - mse
: 1916.8578 - val_loss: 527.9730 - val_mse: 481.9995
Epoch 639/1000
460/460 [==============================] - 1s 1ms/step - loss: 552.6096 - mse:
506.7839 - val_loss: 1071.2374 - val_mse: 1025.0162
Epoch 640/1000
460/460 [==============================] - 1s 1ms/step - loss: 140.5757 - mse:
94.6975 - val_loss: 77.7414 - val_mse: 31.9402
Epoch 641/1000
460/460 [==============================] - 1s 1ms/step - loss: 342.7724 - mse:
296.6544 - val_loss: 82.4205 - val_mse: 36.1065
Epoch 642/1000
460/460 [==============================] - 1s 1ms/step - loss: 336.1548 - mse:
290.0962 - val_loss: 233.6304 - val_mse: 187.6873
Epoch 643/1000
460/460 [==============================] - 1s 1ms/step - loss: 554.0395 - mse:
507.7299 - val_loss: 79.6124 - val_mse: 33.3427
Epoch 644/1000
460/460 [==============================] - 1s 1ms/step - loss: 1526.6960 - mse
: 1480.6200 - val_loss: 1018.6410 - val_mse: 972.7449
Epoch 645/1000
460/460 [==============================] - 1s 1ms/step - loss: 205.0549 - mse:
159.4236 - val_loss: 140.4936 - val_mse: 95.0838
Epoch 646/1000
460/460 [==============================] - 1s 1ms/step - loss: 387.7312 - mse:
341.8297 - val_loss: 595.1749 - val_mse: 548.5901
Epoch 647/1000
460/460 [==============================] - 1s 1ms/step - loss: 495.6681 - mse:
449.3933 - val_loss: 1008.6375 - val_mse: 962.4974
Epoch 648/1000
460/460 [==============================] - 1s 1ms/step - loss: 412.2988 - mse:
366.0854 - val_loss: 275.5164 - val_mse: 228.8745
Epoch 649/1000
460/460 [==============================] - 1s 1ms/step - loss: 780.7670 - mse:
734.6924 - val_loss: 221.3288 - val_mse: 175.1374
Epoch 650/1000
460/460 [==============================] - 1s 1ms/step - loss: 1275.6473 - mse
: 1229.2083 - val_loss: 91.3210 - val_mse: 45.3671
Epoch 651/1000
460/460 [==============================] - 1s 1ms/step - loss: 218.3100 - mse:
172.4838 - val_loss: 255.7255 - val_mse: 210.0144
Epoch 652/1000
460/460 [==============================] - 1s 1ms/step - loss: 224.0513 - mse:
178.2834 - val_loss: 149.1596 - val_mse: 103.4281
Epoch 653/1000
460/460 [==============================] - 1s 1ms/step - loss: 580.6467 - mse:
534.7352 - val_loss: 76.8800 - val_mse: 30.8044
Epoch 654/1000
460/460 [==============================] - 1s 1ms/step - loss: 2294.4973 - mse
: 2248.5090 - val_loss: 87.9246 - val_mse: 42.3664
Epoch 655/1000
460/460 [==============================] - 1s 1ms/step - loss: 127.0686 - mse:
81.4864 - val_loss: 73.7245 - val_mse: 27.6694
Epoch 656/1000
460/460 [==============================] - 1s 1ms/step - loss: 599.4217 - mse:
553.7827 - val_loss: 485.4267 - val_mse: 439.3843
Epoch 657/1000
460/460 [==============================] - 1s 1ms/step - loss: 1879.1912 - mse
: 1832.1165 - val_loss: 232.1462 - val_mse: 185.3854
Epoch 658/1000
460/460 [==============================] - 1s 1ms/step - loss: 95.7730 - mse:
```

```
49.2523 - val_loss: 77.2322 - val_mse: 30.9871
Epoch 659/1000
460/460 [==============================] - 1s 1ms/step - loss: 781.2130 - mse:
735.2625 - val_loss: 194.4515 - val_mse: 148.8362
Epoch 660/1000
460/460 [==============================] - 1s 1ms/step - loss: 842.9559 - mse:
797.5824 - val_loss: 108.2300 - val_mse: 63.3401
Epoch 661/1000
460/460 [==============================] - 1s 1ms/step - loss: 117.0585 - mse:
72.2345 - val_loss: 851.3175 - val_mse: 806.7351
Epoch 662/1000
460/460 [==============================] - 1s 1ms/step - loss: 952.3446 - mse:
907.5358 - val_loss: 134.7565 - val_mse: 89.9338
Epoch 663/1000
460/460 [==============================] - 1s 1ms/step - loss: 154.7584 - mse:
110.2137 - val_loss: 73.8595 - val_mse: 28.9321
Epoch 664/1000
460/460 [==============================] - 1s 1ms/step - loss: 648.4265 - mse:
603.8551 - val_loss: 71.0704 - val_mse: 26.8194
Epoch 665/1000
460/460 [==============================] - 1s 1ms/step - loss: 127.8981 - mse:
83.6699 - val_loss: 169.5223 - val_mse: 125.4229
Epoch 666/1000
460/460 [==============================] - 1s 1ms/step - loss: 1062.9341 - mse
: 1018.6387 - val_loss: 133.6917 - val_mse: 89.1244
Epoch 667/1000
460/460 [==============================] - 1s 1ms/step - loss: 413.1318 - mse:
368.9663 - val_loss: 126.8507 - val_mse: 82.9581
Epoch 668/1000
460/460 [==============================] - 1s 1ms/step - loss: 2143.5012 - mse
: 2099.4956 - val_loss: 154.8264 - val_mse: 111.0102
Epoch 669/1000
460/460 [==============================] - 1s 1ms/step - loss: 112.8698 - mse:
68.5415 - val_loss: 115.8867 - val_mse: 71.9496
Epoch 670/1000
460/460 [==============================] - 1s 1ms/step - loss: 329.9292 - mse:
286.1770 - val_loss: 91.0653 - val_mse: 47.5665
Epoch 671/1000
460/460 [==============================] - 1s 1ms/step - loss: 514.4247 - mse:
470.1388 - val_loss: 73.8622 - val_mse: 29.7367
Epoch 672/1000
460/460 [==============================] - 1s 1ms/step - loss: 673.6138 - mse:
628.9088 - val_loss: 105.2639 - val_mse: 60.5538
Epoch 673/1000
460/460 [==============================] - 1s 1ms/step - loss: 291.3541 - mse:
246.8880 - val_loss: 81.1067 - val_mse: 37.0983
Epoch 674/1000
460/460 [==============================] - 1s 1ms/step - loss: 355.4771 - mse:
311.5356 - val_loss: 75.9029 - val_mse: 32.1293
Epoch 675/1000
460/460 [==============================] - 1s 1ms/step - loss: 1734.2305 - mse
: 1690.1611 - val_loss: 77.1934 - val_mse: 33.4650
Epoch 676/1000
460/460 [==============================] - 1s 1ms/step - loss: 163.7066 - mse:
119.5775 - val_loss: 1946.9711 - val_mse: 1902.9193
Epoch 677/1000
460/460 [==============================] - 1s 1ms/step - loss: 484.9852 - mse:
441.0981 - val_loss: 253.8753 - val_mse: 210.2754
Epoch 678/1000
460/460 [==============================] - 1s 1ms/step - loss: 562.8260 - mse:
519.1752 - val_loss: 1267.6658 - val_mse: 1223.9303
```

```
Epoch 679/1000
460/460 [==============================] - 1s 1ms/step - loss: 557.4459 - mse:
513.5441 - val_loss: 84.4256 - val_mse: 40.5979
Epoch 680/1000
460/460 [==============================] - 1s 1ms/step - loss: 1012.3431 - mse
: 968.1702 - val_loss: 84.5532 - val_mse: 40.0624
Epoch 681/1000
460/460 [==============================] - 1s 1ms/step - loss: 169.4689 - mse:
125.4242 - val_loss: 387.2974 - val_mse: 343.5422
Epoch 682/1000
460/460 [==============================] - 1s 1ms/step - loss: 804.6113 - mse:
760.8529 - val_loss: 81.6099 - val_mse: 38.1771
Epoch 683/1000
460/460 [==============================] - 1s 1ms/step - loss: 742.9479 - mse:
699.2660 - val_loss: 131.9561 - val_mse: 88.2919
Epoch 684/1000
460/460 [==============================] - 1s 1ms/step - loss: 1957.0992 - mse
: 1912.9893 - val_loss: 216.4588 - val_mse: 171.3060
Epoch 685/1000
460/460 [==============================] - 1s 1ms/step - loss: 103.5858 - mse:
59.1961 - val_loss: 75.4835 - val_mse: 31.4745
Epoch 686/1000
460/460 [==============================] - 1s 1ms/step - loss: 128.1042 - mse:
84.3117 - val_loss: 253.1945 - val_mse: 209.4257
Epoch 687/1000
460/460 [==============================] - 1s 1ms/step - loss: 340.8279 - mse:
297.2093 - val_loss: 224.2979 - val_mse: 180.4588
Epoch 688/1000
460/460 [==============================] - 1s 1ms/step - loss: 490.8115 - mse:
446.9262 - val_loss: 93.3098 - val_mse: 49.1645
Epoch 689/1000
460/460 [==============================] - 1s 1ms/step - loss: 466.0359 - mse:
421.9755 - val_loss: 62823.1875 - val_mse: 62779.5547
Epoch 690/1000
460/460 [==============================] - 1s 1ms/step - loss: 2709.4758 - mse
: 2664.6069 - val_loss: 80.9412 - val_mse: 36.4642
Epoch 691/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.8544 - mse:
55.7427 - val_loss: 148.7801 - val_mse: 104.8036
Epoch 692/1000
460/460 [==============================] - 1s 1ms/step - loss: 483.1190 - mse:
439.0724 - val_loss: 127.9933 - val_mse: 84.1412
Epoch 693/1000
460/460 [==============================] - 1s 1ms/step - loss: 8617.3770 - mse
: 8572.4775 - val_loss: 239.3160 - val_mse: 192.8659
Epoch 694/1000
460/460 [==============================] - 1s 1ms/step - loss: 147.2298 - mse:
101.4070 - val_loss: 114.9355 - val_mse: 69.5811
Epoch 695/1000
460/460 [==============================] - 1s 1ms/step - loss: 94.3357 - mse:
49.1813 - val_loss: 74.5696 - val_mse: 29.8615
Epoch 696/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.5190 - mse:
54.9512 - val_loss: 79.9120 - val_mse: 35.4908
Epoch 697/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.4106 - mse:
55.1243 - val_loss: 71.2250 - val_mse: 27.1507
Epoch 698/1000
460/460 [==============================] - 1s 1ms/step - loss: 149.2034 - mse:
105.1829 - val_loss: 105.1982 - val_mse: 61.3851
Epoch 699/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 1120.0312 - mse
: 1075.9618 - val_loss: 224.3423 - val_mse: 180.6476
Epoch 700/1000
460/460 [==============================] - 1s 1ms/step - loss: 182.8186 - mse:
139.3629 - val_loss: 236.8121 - val_mse: 193.1976
Epoch 701/1000
460/460 [==============================] - 1s 1ms/step - loss: 405.8102 - mse:
362.4229 - val_loss: 3818.7622 - val_mse: 3774.6106
Epoch 702/1000
460/460 [==============================] - 1s 1ms/step - loss: 2374.4658 - mse
: 2330.6519 - val_loss: 85.5137 - val_mse: 42.0449
Epoch 703/1000
460/460 [==============================] - 1s 1ms/step - loss: 133.7982 - mse:
90.6769 - val_loss: 224.2349 - val_mse: 181.4302
Epoch 704/1000
460/460 [==============================] - 1s 1ms/step - loss: 111.7447 - mse:
68.8157 - val_loss: 75.7946 - val_mse: 32.9516
Epoch 705/1000
460/460 [==============================] - 1s 1ms/step - loss: 172.9556 - mse:
129.9176 - val_loss: 4741.9346 - val_mse: 4698.8667
Epoch 706/1000
460/460 [==============================] - 1s 1ms/step - loss: 1584.9679 - mse
: 1541.7754 - val_loss: 192.5850 - val_mse: 149.3387
Epoch 707/1000
460/460 [==============================] - 1s 1ms/step - loss: 102.0691 - mse:
59.0273 - val_loss: 79.3281 - val_mse: 36.5694
Epoch 708/1000
460/460 [==============================] - 1s 1ms/step - loss: 4346.7358 - mse
: 4304.0044 - val_loss: 223.8334 - val_mse: 180.7591
Epoch 709/1000
460/460 [==============================] - 1s 1ms/step - loss: 105.4517 - mse:
62.6499 - val_loss: 100.7728 - val_mse: 58.0350
Epoch 710/1000
460/460 [==============================] - 1s 1ms/step - loss: 87.0558 - mse:
44.4025 - val_loss: 75.2059 - val_mse: 32.1008
Epoch 711/1000
460/460 [==============================] - 1s 1ms/step - loss: 110.0854 - mse:
67.5076 - val_loss: 217.9029 - val_mse: 175.6147
Epoch 712/1000
460/460 [==============================] - 1s 1ms/step - loss: 240.6980 - mse:
198.1659 - val_loss: 236.8469 - val_mse: 194.3953
Epoch 713/1000
460/460 [==============================] - 1s 1ms/step - loss: 400.8892 - mse:
358.2998 - val_loss: 156.3265 - val_mse: 113.3381
Epoch 714/1000
460/460 [==============================] - 1s 1ms/step - loss: 1563.8989 - mse
: 1520.6234 - val_loss: 84.9046 - val_mse: 41.4060
Epoch 715/1000
460/460 [==============================] - 1s 1ms/step - loss: 109.8481 - mse:
66.4167 - val_loss: 94.9015 - val_mse: 51.7514
Epoch 716/1000
460/460 [==============================] - 1s 1ms/step - loss: 821.7927 - mse:
778.7943 - val_loss: 102.1300 - val_mse: 59.6017
Epoch 717/1000
460/460 [==============================] - 1s 1ms/step - loss: 201.5484 - mse:
159.2922 - val_loss: 110.8153 - val_mse: 68.7859
Epoch 718/1000
460/460 [==============================] - 1s 1ms/step - loss: 2624.6145 - mse
: 2582.0789 - val_loss: 997.7914 - val_mse: 954.9282
Epoch 719/1000
460/460 [==============================] - 1s 1ms/step - loss: 150.7883 - mse:
```

```
108.7301 - val_loss: 94.0018 - val_mse: 51.7294
Epoch 720/1000
460/460 [==============================] - 1s 1ms/step - loss: 107.5292 - mse:
65.6590 - val_loss: 172.6853 - val_mse: 130.9894
Epoch 721/1000
460/460 [==============================] - 1s 1ms/step - loss: 855.0030 - mse:
813.0757 - val_loss: 117.1112 - val_mse: 75.0278
Epoch 722/1000
460/460 [==============================] - 1s 1ms/step - loss: 966.4653 - mse:
924.3611 - val_loss: 70.8108 - val_mse: 28.8449
Epoch 723/1000
460/460 [==============================] - 1s 1ms/step - loss: 211.0880 - mse:
169.1581 - val_loss: 93.5336 - val_mse: 51.7359
Epoch 724/1000
460/460 [==============================] - 1s 1ms/step - loss: 665.1808 - mse:
623.5024 - val_loss: 201.9622 - val_mse: 160.4139
Epoch 725/1000
460/460 [==============================] - 1s 1ms/step - loss: 168.2222 - mse:
126.6086 - val_loss: 73.3961 - val_mse: 31.3231
Epoch 726/1000
460/460 [==============================] - 1s 1ms/step - loss: 1024.9639 - mse
: 982.9858 - val_loss: 80.0687 - val_mse: 38.3938
Epoch 727/1000
460/460 [==============================] - 1s 1ms/step - loss: 389.7216 - mse:
347.3286 - val_loss: 129.2315 - val_mse: 86.4648
Epoch 728/1000
460/460 [==============================] - 1s 1ms/step - loss: 2547.1851 - mse
: 2504.4717 - val_loss: 76.1554 - val_mse: 33.5539
Epoch 729/1000
460/460 [==============================] - 1s 1ms/step - loss: 120.5159 - mse:
77.9930 - val_loss: 258.9755 - val_mse: 216.6449
Epoch 730/1000
460/460 [==============================] - 1s 1ms/step - loss: 125.0319 - mse:
82.6747 - val_loss: 75.6838 - val_mse: 33.3491
Epoch 731/1000
460/460 [==============================] - 1s 1ms/step - loss: 495.3571 - mse:
452.9593 - val_loss: 74.9102 - val_mse: 32.4100
Epoch 732/1000
460/460 [==============================] - 1s 1ms/step - loss: 584.4227 - mse:
541.9434 - val_loss: 86.2583 - val_mse: 43.4210
Epoch 733/1000
460/460 [==============================] - 1s 1ms/step - loss: 1016.5358 - mse
: 973.5407 - val_loss: 86.1437 - val_mse: 43.5959
Epoch 734/1000
460/460 [==============================] - 1s 1ms/step - loss: 187.2241 - mse:
144.7586 - val_loss: 109.6629 - val_mse: 67.2006
Epoch 735/1000
460/460 [==============================] - 1s 1ms/step - loss: 1140.9911 - mse
: 1098.4091 - val_loss: 460.8648 - val_mse: 418.0941
Epoch 736/1000
460/460 [==============================] - 1s 1ms/step - loss: 195.0173 - mse:
152.9344 - val_loss: 82.3519 - val_mse: 40.2703
Epoch 737/1000
460/460 [==============================] - 1s 1ms/step - loss: 467.6483 - mse:
425.6432 - val_loss: 73.1487 - val_mse: 31.4558
Epoch 738/1000
460/460 [==============================] - 1s 1ms/step - loss: 219.0469 - mse:
177.1386 - val_loss: 686.7335 - val_mse: 644.8991
Epoch 739/1000
460/460 [==============================] - 1s 1ms/step - loss: 402.7697 - mse:
360.7863 - val_loss: 128.1162 - val_mse: 86.2197
```

```
Epoch 740/1000
460/460 [==============================] - 1s 1ms/step - loss: 1055.3915 - mse
: 1013.2613 - val_loss: 133.3688 - val_mse: 91.3316
Epoch 741/1000
460/460 [==============================] - 1s 1ms/step - loss: 154.4661 - mse:
112.5699 - val_loss: 811.0610 - val_mse: 769.1341
Epoch 742/1000
460/460 [==============================] - 1s 1ms/step - loss: 902.1215 - mse:
860.2830 - val_loss: 427.0591 - val_mse: 384.7263
Epoch 743/1000
460/460 [==============================] - 1s 1ms/step - loss: 754.4502 - mse:
712.1387 - val_loss: 139.9329 - val_mse: 97.7701
Epoch 744/1000
460/460 [==============================] - 1s 1ms/step - loss: 193.2222 - mse:
151.2581 - val_loss: 68.1091 - val_mse: 26.1911
Epoch 745/1000
460/460 [==============================] - 1s 1ms/step - loss: 1384.1886 - mse
: 1342.3325 - val_loss: 100.5734 - val_mse: 58.9718
Epoch 746/1000
460/460 [==============================] - 1s 1ms/step - loss: 127.0759 - mse:
85.4364 - val_loss: 381.7630 - val_mse: 340.2044
Epoch 747/1000
460/460 [==============================] - 1s 1ms/step - loss: 349.4095 - mse:
307.8657 - val_loss: 137.1026 - val_mse: 95.5208
Epoch 748/1000
460/460 [==============================] - 1s 1ms/step - loss: 1431.1255 - mse
: 1389.4894 - val_loss: 32949.3984 - val_mse: 32907.6172
Epoch 749/1000
460/460 [==============================] - 1s 1ms/step - loss: 827.6298 - mse:
785.9838 - val_loss: 944.6813 - val_mse: 903.1843
Epoch 750/1000
460/460 [==============================] - 1s 1ms/step - loss: 265.9993 - mse:
224.4573 - val_loss: 1195.2605 - val_mse: 1153.5693
Epoch 751/1000
460/460 [==============================] - 1s 2ms/step - loss: 269.9887 - mse:
228.0002 - val_loss: 125.4927 - val_mse: 83.3304
Epoch 752/1000
460/460 [==============================] - 1s 1ms/step - loss: 1337.9186 - mse
: 1296.0555 - val_loss: 103.1915 - val_mse: 61.2871
Epoch 753/1000
460/460 [==============================] - 1s 1ms/step - loss: 515.3245 - mse:
473.2125 - val_loss: 118.5703 - val_mse: 76.8158
Epoch 754/1000
460/460 [==============================] - 1s 1ms/step - loss: 700.0547 - mse:
658.0156 - val_loss: 87.3555 - val_mse: 45.2745
Epoch 755/1000
460/460 [==============================] - 1s 1ms/step - loss: 115.1325 - mse:
73.1096 - val_loss: 495.1215 - val_mse: 453.0403
Epoch 756/1000
460/460 [==============================] - 1s 1ms/step - loss: 959.9792 - mse:
917.8038 - val_loss: 21118.3477 - val_mse: 21075.5605
Epoch 757/1000
460/460 [==============================] - 1s 1ms/step - loss: 839.4385 - mse:
796.7283 - val_loss: 108.8205 - val_mse: 66.0905
Epoch 758/1000
460/460 [==============================] - 1s 1ms/step - loss: 1113.9590 - mse
: 1071.2554 - val_loss: 179.6134 - val_mse: 137.0715
Epoch 759/1000
460/460 [==============================] - 1s 1ms/step - loss: 204.1427 - mse:
161.3975 - val_loss: 205.3587 - val_mse: 162.9356
Epoch 760/1000
```

```
460/460 [==============================] - 1s 1ms/step - loss: 358.4240 - mse:
315.3808 - val_loss: 82.5662 - val_mse: 39.8722
Epoch 761/1000
460/460 [==============================] - 1s 2ms/step - loss: 288.3062 - mse:
245.8363 - val_loss: 318.0726 - val_mse: 275.8862
Epoch 762/1000
460/460 [==============================] - 1s 2ms/step - loss: 1177.5570 - mse
: 1135.6548 - val_loss: 150.3723 - val_mse: 108.9285
Epoch 763/1000
460/460 [==============================] - 1s 1ms/step - loss: 156.0070 - mse:
114.3015 - val_loss: 722.7451 - val_mse: 681.0468
Epoch 764/1000
460/460 [==============================] - 1s 2ms/step - loss: 3813.5613 - mse
: 3771.0955 - val_loss: 204.2096 - val_mse: 161.5330
Epoch 765/1000
460/460 [==============================] - 1s 2ms/step - loss: 114.2081 - mse:
72.1047 - val_loss: 71.3556 - val_mse: 29.5022
Epoch 766/1000
460/460 [==============================] - 1s 2ms/step - loss: 90.1987 - mse:
48.5590 - val_loss: 123.1568 - val_mse: 81.5929
Epoch 767/1000
460/460 [==============================] - 1s 2ms/step - loss: 182.4944 - mse:
140.9865 - val_loss: 277.0580 - val_mse: 235.5905
Epoch 768/1000
460/460 [==============================] - 1s 1ms/step - loss: 350.5014 - mse:
308.8775 - val_loss: 157.1134 - val_mse: 115.6432
Epoch 769/1000
460/460 [==============================] - 1s 1ms/step - loss: 779.6812 - mse:
738.0328 - val_loss: 215.7779 - val_mse: 174.2199
Epoch 770/1000
460/460 [==============================] - 1s 1ms/step - loss: 829.1527 - mse:
787.2018 - val_loss: 88.1123 - val_mse: 45.9870
Epoch 771/1000
460/460 [==============================] - 1s 1ms/step - loss: 318.3404 - mse:
276.4483 - val_loss: 72.8639 - val_mse: 31.5293
Epoch 772/1000
460/460 [==============================] - 1s 1ms/step - loss: 223.8637 - mse:
182.4779 - val_loss: 631.4195 - val_mse: 590.1005
Epoch 773/1000
460/460 [==============================] - 1s 1ms/step - loss: 819.4076 - mse:
777.7408 - val_loss: 276.1659 - val_mse: 234.6609
Epoch 774/1000
460/460 [==============================] - 1s 1ms/step - loss: 276.1302 - mse:
234.5777 - val_loss: 76.5860 - val_mse: 35.1697
Epoch 775/1000
460/460 [==============================] - 1s 1ms/step - loss: 435.7043 - mse:
394.1791 - val_loss: 174.3698 - val_mse: 133.0036
Epoch 776/1000
460/460 [==============================] - 1s 1ms/step - loss: 279.1028 - mse:
237.9638 - val_loss: 966.3652 - val_mse: 925.3516
Epoch 777/1000
460/460 [==============================] - 1s 1ms/step - loss: 1598.2019 - mse
: 1556.9120 - val_loss: 70.2455 - val_mse: 29.1478
Epoch 778/1000
460/460 [==============================] - 1s 1ms/step - loss: 194.4611 - mse:
153.3448 - val_loss: 101.4322 - val_mse: 60.3518
Epoch 779/1000
460/460 [==============================] - 1s 2ms/step - loss: 585.3388 - mse:
543.2067 - val_loss: 1832.6144 - val_mse: 1790.3484
Epoch 780/1000
460/460 [==============================] - 1s 2ms/step - loss: 267.8169 - mse:
```

```
225.8688 - val_loss: 4707.3091 - val_mse: 4664.9053
Epoch 781/1000
460/460 [==============================] - 1s 2ms/step - loss: 286.0475 - mse:
244.2160 - val_loss: 77.5325 - val_mse: 35.8733
Epoch 782/1000
460/460 [==============================] - 1s 1ms/step - loss: 1809.6372 - mse
: 1767.2566 - val_loss: 206.4824 - val_mse: 163.6037
Epoch 783/1000
460/460 [==============================] - 1s 1ms/step - loss: 127.6805 - mse:
85.4263 - val_loss: 252.7989 - val_mse: 210.4677
Epoch 784/1000
460/460 [==============================] - 1s 1ms/step - loss: 338.6280 - mse:
296.5928 - val_loss: 333.9813 - val_mse: 292.0493
Epoch 785/1000
460/460 [==============================] - 1s 1ms/step - loss: 5339.6030 - mse
: 5296.6602 - val_loss: 89.1154 - val_mse: 45.9069
Epoch 786/1000
460/460 [==============================] - 1s 1ms/step - loss: 120.7732 - mse:
77.9079 - val_loss: 77.9800 - val_mse: 35.5223
Epoch 787/1000
460/460 [==============================] - 1s 1ms/step - loss: 99.1297 - mse:
56.8001 - val_loss: 748.8997 - val_mse: 706.8444
Epoch 788/1000
460/460 [==============================] - 1s 1ms/step - loss: 148.2468 - mse:
106.5401 - val_loss: 200.9846 - val_mse: 159.1975
Epoch 789/1000
460/460 [==============================] - 1s 1ms/step - loss: 909.7169 - mse:
867.8849 - val_loss: 90.9220 - val_mse: 49.2538
Epoch 790/1000
460/460 [==============================] - 1s 1ms/step - loss: 219.6064 - mse:
177.9724 - val_loss: 77.5178 - val_mse: 36.0149
Epoch 791/1000
460/460 [==============================] - 1s 1ms/step - loss: 345.5629 - mse:
304.1343 - val_loss: 324.6105 - val_mse: 283.5561
Epoch 792/1000
460/460 [==============================] - 1s 1ms/step - loss: 326.9129 - mse:
285.5955 - val_loss: 170.1079 - val_mse: 128.4105
Epoch 793/1000
460/460 [==============================] - 1s 1ms/step - loss: 679.6778 - mse:
638.2471 - val_loss: 70.8905 - val_mse: 29.5250
Epoch 794/1000
460/460 [==============================] - 1s 1ms/step - loss: 367.3939 - mse:
326.1111 - val_loss: 67.7387 - val_mse: 26.6201
Epoch 795/1000
460/460 [==============================] - 1s 1ms/step - loss: 542.0229 - mse:
500.9503 - val_loss: 5447.1392 - val_mse: 5406.0938
Epoch 796/1000
460/460 [==============================] - 1s 1ms/step - loss: 652.2768 - mse:
611.1970 - val_loss: 67.7747 - val_mse: 26.9641
Epoch 797/1000
460/460 [==============================] - 1s 1ms/step - loss: 249.6714 - mse:
208.5775 - val_loss: 189.0772 - val_mse: 147.7556
Epoch 798/1000
460/460 [==============================] - 1s 1ms/step - loss: 1170.8199 - mse
: 1129.2504 - val_loss: 113.7969 - val_mse: 72.0981
Epoch 799/1000
460/460 [==============================] - 1s 1ms/step - loss: 192.9551 - mse:
151.5036 - val_loss: 574.4130 - val_mse: 533.1719
Epoch 800/1000
460/460 [==============================] - 1s 1ms/step - loss: 1287.5087 - mse
: 1246.0144 - val_loss: 146.6914 - val_mse: 105.4832
```

```
Epoch 801/1000
460/460 [==============================] - 1s 1ms/step - loss: 192.9149 - mse:
151.7359 - val_loss: 71.2010 - val_mse: 30.2318
Epoch 802/1000
460/460 [==============================] - 1s 1ms/step - loss: 1179.8154 - mse
: 1138.7305 - val_loss: 112.8609 - val_mse: 71.2734
Epoch 803/1000
460/460 [==============================] - 1s 1ms/step - loss: 221.5412 - mse:
180.4093 - val_loss: 291.6163 - val_mse: 250.7571
Epoch 804/1000
460/460 [==============================] - 1s 1ms/step - loss: 826.0622 - mse:
784.8695 - val_loss: 1138.2224 - val_mse: 1096.2175
Epoch 805/1000
460/460 [==============================] - 1s 1ms/step - loss: 152.8280 - mse:
111.5884 - val_loss: 90.9037 - val_mse: 49.9973
Epoch 806/1000
460/460 [==============================] - 1s 1ms/step - loss: 270.2712 - mse:
229.0117 - val_loss: 153.3444 - val_mse: 112.1697
Epoch 807/1000
460/460 [==============================] - 1s 1ms/step - loss: 2194.2441 - mse
: 2150.7830 - val_loss: 82.0680 - val_mse: 38.8290
Epoch 808/1000
460/460 [==============================] - 1s 1ms/step - loss: 404.4680 - mse:
361.1917 - val_loss: 77.0351 - val_mse: 33.7977
Epoch 809/1000
460/460 [==============================] - 1s 1ms/step - loss: 278.6625 - mse:
235.6003 - val_loss: 72.2672 - val_mse: 29.4619
Epoch 810/1000
460/460 [==============================] - 1s 1ms/step - loss: 272.9541 - mse:
230.3568 - val_loss: 311.8893 - val_mse: 269.3257
Epoch 811/1000
460/460 [==============================] - 1s 1ms/step - loss: 559.0856 - mse:
516.7456 - val_loss: 4729.5659 - val_mse: 4687.3262
Epoch 812/1000
460/460 [==============================] - 1s 1ms/step - loss: 1098.8794 - mse
: 1056.7955 - val_loss: 88.1315 - val_mse: 46.2491
Epoch 813/1000
460/460 [==============================] - 1s 1ms/step - loss: 2701.7678 - mse
: 2659.3918 - val_loss: 84.5693 - val_mse: 41.8878
Epoch 814/1000
460/460 [==============================] - 1s 1ms/step - loss: 114.5105 - mse:
72.1673 - val_loss: 110.6140 - val_mse: 68.6852
Epoch 815/1000
460/460 [==============================] - 1s 1ms/step - loss: 105.2680 - mse:
63.6264 - val_loss: 111.5148 - val_mse: 70.0922
Epoch 816/1000
460/460 [==============================] - 1s 1ms/step - loss: 686.0236 - mse:
644.3851 - val_loss: 939.9489 - val_mse: 898.3436
Epoch 817/1000
460/460 [==============================] - 1s 1ms/step - loss: 537.5079 - mse:
496.0436 - val_loss: 99.4758 - val_mse: 58.3372
Epoch 818/1000
460/460 [==============================] - 1s 1ms/step - loss: 177.3650 - mse:
136.2511 - val_loss: 104.1102 - val_mse: 62.9965
Epoch 819/1000
460/460 [==============================] - 1s 1ms/step - loss: 304.8905 - mse:
263.6237 - val_loss: 661.9817 - val_mse: 620.9958
Epoch 820/1000
460/460 [==============================] - 0s 1ms/step - loss: 289.6576 - mse:
248.9394 - val_loss: 1620.9379 - val_mse: 1580.3014
Epoch 821/1000
```

```
460/460 [==============================] - 0s 1ms/step - loss: 1768.8624 - mse
: 1727.6766 - val_loss: 208.4731 - val_mse: 167.2250
Epoch 822/1000
460/460 [==============================] - 0s 1ms/step - loss: 201.3227 - mse:
160.3851 - val_loss: 140.3753 - val_mse: 99.4667
Epoch 823/1000
460/460 [==============================] - 0s 1ms/step - loss: 144.1413 - mse:
103.1425 - val_loss: 101.5203 - val_mse: 60.8578
Epoch 824/1000
460/460 [==============================] - 0s 1ms/step - loss: 325.6562 - mse:
284.9241 - val_loss: 85.4793 - val_mse: 44.5083
Epoch 825/1000
460/460 [==============================] - 0s 1ms/step - loss: 1477.4453 - mse
: 1436.2545 - val_loss: 179.3003 - val_mse: 138.6382
Epoch 826/1000
460/460 [==============================] - 0s 1ms/step - loss: 473.6609 - mse:
433.0357 - val_loss: 247.0400 - val_mse: 206.3849
Epoch 827/1000
460/460 [==============================] - 0s 1ms/step - loss: 181.9975 - mse:
141.5079 - val_loss: 808.2906 - val_mse: 767.8255
Epoch 828/1000
460/460 [==============================] - 0s 1ms/step - loss: 409.8824 - mse:
369.3141 - val_loss: 109.9547 - val_mse: 69.3997
Epoch 829/1000
460/460 [==============================] - 0s 1ms/step - loss: 1255.0930 - mse
: 1214.1971 - val_loss: 89.6051 - val_mse: 48.7447
Epoch 830/1000
460/460 [==============================] - 0s 1ms/step - loss: 106.5882 - mse:
66.0023 - val_loss: 219.3770 - val_mse: 178.9212
Epoch 831/1000
460/460 [==============================] - 0s 1ms/step - loss: 441.0627 - mse:
400.6638 - val_loss: 501.7253 - val_mse: 461.0932
Epoch 832/1000
460/460 [==============================] - 0s 1ms/step - loss: 347.8535 - mse:
307.5325 - val_loss: 81.7480 - val_mse: 41.2491
Epoch 833/1000
460/460 [==============================] - 0s 1ms/step - loss: 1309.8060 - mse
: 1269.2686 - val_loss: 434.1508 - val_mse: 393.4950
Epoch 834/1000
460/460 [==============================] - 0s 1ms/step - loss: 128.2443 - mse:
87.9479 - val_loss: 68.9130 - val_mse: 28.7790
Epoch 835/1000
460/460 [==============================] - 0s 1ms/step - loss: 166.5643 - mse:
126.4918 - val_loss: 349.2800 - val_mse: 309.3262
Epoch 836/1000
460/460 [==============================] - 0s 1ms/step - loss: 861.8237 - mse:
821.1047 - val_loss: 89.3955 - val_mse: 48.8970
Epoch 837/1000
460/460 [==============================] - 0s 1ms/step - loss: 716.8156 - mse:
676.5222 - val_loss: 1410.0876 - val_mse: 1369.3636
Epoch 838/1000
460/460 [==============================] - 0s 1ms/step - loss: 537.2059 - mse:
496.9832 - val_loss: 165.6775 - val_mse: 125.4495
Epoch 839/1000
460/460 [==============================] - 0s 1ms/step - loss: 327.6929 - mse:
287.2820 - val_loss: 94.5071 - val_mse: 54.0763
Epoch 840/1000
460/460 [==============================] - 0s 1ms/step - loss: 274.8819 - mse:
234.6470 - val_loss: 5668.2637 - val_mse: 5628.0454
Epoch 841/1000
460/460 [==============================] - 0s 1ms/step - loss: 1059.1704 - mse
```

```
: 1019.0087 - val_loss: 116.1415 - val_mse: 76.4342
Epoch 842/1000
460/460 [==============================] - 0s 1ms/step - loss: 129.6527 - mse:
89.8819 - val_loss: 75.9569 - val_mse: 36.2635
Epoch 843/1000
460/460 [==============================] - 0s 1ms/step - loss: 1980.7612 - mse
: 1940.5078 - val_loss: 68.4236 - val_mse: 28.3643
Epoch 844/1000
460/460 [==============================] - 0s 1ms/step - loss: 429.7003 - mse:
389.9360 - val_loss: 141.2470 - val_mse: 101.7888
Epoch 845/1000
460/460 [==============================] - 0s 1ms/step - loss: 130.7783 - mse:
91.3720 - val_loss: 72.3917 - val_mse: 33.0651
Epoch 846/1000
460/460 [==============================] - 0s 1ms/step - loss: 215.8669 - mse:
176.5812 - val_loss: 86.1064 - val_mse: 46.6892
Epoch 847/1000
460/460 [==============================] - 0s 1ms/step - loss: 602.9253 - mse:
563.3671 - val_loss: 68.5456 - val_mse: 29.0182
Epoch 848/1000
460/460 [==============================] - 0s 1ms/step - loss: 252.6420 - mse:
213.2480 - val_loss: 71.0013 - val_mse: 31.8095
Epoch 849/1000
460/460 [==============================] - 0s 1ms/step - loss: 432.5289 - mse:
393.0154 - val_loss: 742.6755 - val_mse: 702.9860
Epoch 850/1000
460/460 [==============================] - 0s 1ms/step - loss: 391.3642 - mse:
352.1561 - val_loss: 66.9282 - val_mse: 28.2071
Epoch 851/1000
460/460 [==============================] - 0s 1ms/step - loss: 4999.0454 - mse
: 4959.3315 - val_loss: 77.4946 - val_mse: 37.1609
Epoch 852/1000
460/460 [==============================] - 0s 1ms/step - loss: 93.3413 - mse:
53.0047 - val_loss: 67.4864 - val_mse: 27.1764
Epoch 853/1000
460/460 [==============================] - 0s 1ms/step - loss: 81.7053 - mse:
41.5739 - val_loss: 68.5233 - val_mse: 28.5183
Epoch 854/1000
460/460 [==============================] - 0s 1ms/step - loss: 104.9723 - mse:
65.1464 - val_loss: 163.5887 - val_mse: 124.1297
Epoch 855/1000
460/460 [==============================] - 0s 1ms/step - loss: 133.2397 - mse:
94.0068 - val_loss: 181.5902 - val_mse: 142.7904
Epoch 856/1000
460/460 [==============================] - 0s 1ms/step - loss: 206.7636 - mse:
168.0151 - val_loss: 830.6842 - val_mse: 792.0539
Epoch 857/1000
460/460 [==============================] - 0s 1ms/step - loss: 978.3616 - mse:
939.5037 - val_loss: 136.5518 - val_mse: 97.7406
Epoch 858/1000
460/460 [==============================] - 0s 1ms/step - loss: 170.3685 - mse:
131.6138 - val_loss: 88.7499 - val_mse: 50.0207
Epoch 859/1000
460/460 [==============================] - 0s 1ms/step - loss: 502.5673 - mse:
463.7589 - val_loss: 233.9419 - val_mse: 195.0611
Epoch 860/1000
460/460 [==============================] - 0s 1ms/step - loss: 416.4222 - mse:
377.7726 - val_loss: 872.4516 - val_mse: 833.6351
Epoch 861/1000
460/460 [==============================] - 0s 1ms/step - loss: 1005.4788 - mse
: 966.8326 - val_loss: 599.6281 - val_mse: 560.7460
```

```
Epoch 862/1000
460/460 [==============================] - 0s 1ms/step - loss: 175.1102 - mse: 
136.2606 - val_loss: 69.5728 - val_mse: 30.9594
Epoch 863/1000
460/460 [==============================] - 0s 1ms/step - loss: 195.6294 - mse: 
156.8041 - val_loss: 225.5752 - val_mse: 186.3862
Epoch 864/1000
460/460 [==============================] - 0s 1ms/step - loss: 646.1456 - mse: 
607.1332 - val_loss: 129.9398 - val_mse: 91.2961
Epoch 865/1000
460/460 [==============================] - 0s 1ms/step - loss: 443.3812 - mse: 
404.4400 - val_loss: 524.2974 - val_mse: 485.4934
Epoch 866/1000
460/460 [==============================] - 0s 1ms/step - loss: 1488.4259 - mse
: 1449.4550 - val_loss: 469.5039 - val_mse: 430.6004
Epoch 867/1000
460/460 [==============================] - 0s 1ms/step - loss: 216.0106 - mse: 
176.8246 - val_loss: 77.8046 - val_mse: 38.1453
Epoch 868/1000
460/460 [==============================] - 0s 1ms/step - loss: 714.7279 - mse: 
674.9432 - val_loss: 180.2666 - val_mse: 139.8219
Epoch 869/1000
460/460 [==============================] - 0s 1ms/step - loss: 159.3096 - mse: 
119.4627 - val_loss: 72.9383 - val_mse: 33.3794
Epoch 870/1000
460/460 [==============================] - 0s 1ms/step - loss: 329.7756 - mse: 
290.4397 - val_loss: 18182.6855 - val_mse: 18143.4004
Epoch 871/1000
460/460 [==============================] - 0s 1ms/step - loss: 1813.9458 - mse
: 1774.5345 - val_loss: 68.0504 - val_mse: 29.0177
Epoch 872/1000
460/460 [==============================] - 0s 1ms/step - loss: 150.5134 - mse: 
111.4202 - val_loss: 246.1924 - val_mse: 206.1013
Epoch 873/1000
460/460 [==============================] - 0s 1ms/step - loss: 443.9150 - mse: 
404.1124 - val_loss: 69.8156 - val_mse: 30.2282
Epoch 874/1000
460/460 [==============================] - 0s 1ms/step - loss: 164.2728 - mse: 
124.7726 - val_loss: 210.2542 - val_mse: 171.0325
Epoch 875/1000
460/460 [==============================] - 0s 1ms/step - loss: 288.0655 - mse: 
248.8755 - val_loss: 2910.9243 - val_mse: 2871.8384
Epoch 876/1000
460/460 [==============================] - 0s 1ms/step - loss: 1693.6425 - mse
: 1654.4879 - val_loss: 82.4427 - val_mse: 43.5135
Epoch 877/1000
460/460 [==============================] - 0s 1ms/step - loss: 173.9759 - mse: 
135.0447 - val_loss: 142.5157 - val_mse: 103.6726
Epoch 878/1000
460/460 [==============================] - 1s 1ms/step - loss: 190.1241 - mse: 
151.0979 - val_loss: 326.6219 - val_mse: 287.6538
Epoch 879/1000
460/460 [==============================] - 1s 1ms/step - loss: 267.9171 - mse: 
228.8325 - val_loss: 70.9899 - val_mse: 31.4156
Epoch 880/1000
460/460 [==============================] - 0s 1ms/step - loss: 1504.7620 - mse
: 1465.3862 - val_loss: 125.0058 - val_mse: 85.8614
Epoch 881/1000
460/460 [==============================] - 0s 1ms/step - loss: 109.3197 - mse: 
70.4337 - val_loss: 96.6076 - val_mse: 57.8264
Epoch 882/1000
```

```
460/460 [==============================] - 0s 1ms/step - loss: 241.5009 - mse:
202.7146 - val_loss: 870.0770 - val_mse: 831.1949
Epoch 883/1000
460/460 [==============================] - 0s 1ms/step - loss: 406.8000 - mse:
367.9392 - val_loss: 464.7564 - val_mse: 425.9460
Epoch 884/1000
460/460 [==============================] - 0s 1ms/step - loss: 4947.0454 - mse
: 4907.1870 - val_loss: 112.8816 - val_mse: 72.3050
Epoch 885/1000
460/460 [==============================] - 0s 1ms/step - loss: 92.8985 - mse:
53.1342 - val_loss: 68.5463 - val_mse: 29.3624
Epoch 886/1000
460/460 [==============================] - 0s 1ms/step - loss: 83.6287 - mse:
44.4735 - val_loss: 67.3440 - val_mse: 28.3634
Epoch 887/1000
460/460 [==============================] - 0s 1ms/step - loss: 196.1616 - mse:
157.0969 - val_loss: 335.7484 - val_mse: 296.7747
Epoch 888/1000
460/460 [==============================] - 0s 1ms/step - loss: 382.7660 - mse:
343.6247 - val_loss: 82.2539 - val_mse: 43.3715
Epoch 889/1000
460/460 [==============================] - 0s 1ms/step - loss: 123.1141 - mse:
84.0124 - val_loss: 99.1669 - val_mse: 60.2230
Epoch 890/1000
460/460 [==============================] - 0s 1ms/step - loss: 155.1122 - mse:
115.9965 - val_loss: 1548.7043 - val_mse: 1509.5236
Epoch 891/1000
460/460 [==============================] - 0s 1ms/step - loss: 2112.2175 - mse
: 2072.8577 - val_loss: 368.9382 - val_mse: 329.7481
Epoch 892/1000
460/460 [==============================] - 0s 1ms/step - loss: 247.3659 - mse:
208.2679 - val_loss: 279.1917 - val_mse: 239.9962
Epoch 893/1000
460/460 [==============================] - 0s 1ms/step - loss: 547.8223 - mse:
508.6929 - val_loss: 299.6041 - val_mse: 260.2881
Epoch 894/1000
460/460 [==============================] - 0s 1ms/step - loss: 112.3572 - mse:
73.1589 - val_loss: 64.9173 - val_mse: 25.9562
Epoch 895/1000
460/460 [==============================] - 0s 1ms/step - loss: 210.0039 - mse:
170.8182 - val_loss: 211.5668 - val_mse: 172.4215
Epoch 896/1000
460/460 [==============================] - 0s 1ms/step - loss: 535.4907 - mse:
496.6414 - val_loss: 1531.8824 - val_mse: 1493.2833
Epoch 897/1000
460/460 [==============================] - 0s 1ms/step - loss: 396.8438 - mse:
358.4045 - val_loss: 1545.1633 - val_mse: 1506.2876
Epoch 898/1000
460/460 [==============================] - 0s 1ms/step - loss: 1338.7389 - mse
: 1299.8140 - val_loss: 3071.8743 - val_mse: 3033.4307
Epoch 899/1000
460/460 [==============================] - 0s 1ms/step - loss: 588.3403 - mse:
549.6414 - val_loss: 69.5334 - val_mse: 30.1775
Epoch 900/1000
460/460 [==============================] - 0s 1ms/step - loss: 175.4176 - mse:
136.4212 - val_loss: 963.4727 - val_mse: 923.9686
Epoch 901/1000
460/460 [==============================] - 0s 1ms/step - loss: 359.5916 - mse:
320.1304 - val_loss: 66.4291 - val_mse: 27.3148
Epoch 902/1000
460/460 [==============================] - 0s 1ms/step - loss: 397.2143 - mse:
```

```
358.2751 - val_loss: 142.2691 - val_mse: 102.6561
Epoch 903/1000
460/460 [==============================] - 0s 1ms/step - loss: 176.9772 - mse:
137.9192 - val_loss: 284.0092 - val_mse: 245.0283
Epoch 904/1000
460/460 [==============================] - 0s 1ms/step - loss: 864.6298 - mse:
825.3125 - val_loss: 66.8399 - val_mse: 27.5010
Epoch 905/1000
460/460 [==============================] - 0s 1ms/step - loss: 745.6842 - mse:
706.2772 - val_loss: 305.7231 - val_mse: 266.3110
Epoch 906/1000
460/460 [==============================] - 0s 1ms/step - loss: 137.1833 - mse:
97.9784 - val_loss: 71.3547 - val_mse: 32.2397
Epoch 907/1000
460/460 [==============================] - 0s 1ms/step - loss: 608.6214 - mse:
569.6235 - val_loss: 80.1380 - val_mse: 41.1986
Epoch 908/1000
460/460 [==============================] - 0s 1ms/step - loss: 641.8598 - mse:
602.9998 - val_loss: 165.9542 - val_mse: 127.1162
Epoch 909/1000
460/460 [==============================] - 0s 1ms/step - loss: 205.6882 - mse:
166.9962 - val_loss: 133.1502 - val_mse: 94.4267
Epoch 910/1000
460/460 [==============================] - 0s 1ms/step - loss: 353.7524 - mse:
315.1913 - val_loss: 494.3716 - val_mse: 455.8286
Epoch 911/1000
460/460 [==============================] - 0s 1ms/step - loss: 186.9790 - mse:
148.5162 - val_loss: 367.4444 - val_mse: 328.9745
Epoch 912/1000
460/460 [==============================] - 0s 1ms/step - loss: 1002.5255 - mse
: 963.8745 - val_loss: 508.5178 - val_mse: 469.9861
Epoch 913/1000
460/460 [==============================] - 0s 1ms/step - loss: 555.1239 - mse:
516.4604 - val_loss: 88.9922 - val_mse: 50.6215
Epoch 914/1000
460/460 [==============================] - 0s 1ms/step - loss: 205.2525 - mse:
166.7303 - val_loss: 1541.1708 - val_mse: 1502.2908
Epoch 915/1000
460/460 [==============================] - 0s 1ms/step - loss: 1231.9366 - mse
: 1193.2206 - val_loss: 160.8688 - val_mse: 122.0919
Epoch 916/1000
460/460 [==============================] - 0s 1ms/step - loss: 131.3184 - mse:
92.5452 - val_loss: 68.2937 - val_mse: 29.3752
Epoch 917/1000
460/460 [==============================] - 0s 1ms/step - loss: 280.7511 - mse:
241.8935 - val_loss: 3223.9910 - val_mse: 3185.2273
Epoch 918/1000
460/460 [==============================] - 0s 1ms/step - loss: 418.7351 - mse:
379.9459 - val_loss: 268.1154 - val_mse: 229.2244
Epoch 919/1000
460/460 [==============================] - 0s 1ms/step - loss: 1943.4895 - mse
: 1903.8339 - val_loss: 169.5253 - val_mse: 129.9777
Epoch 920/1000
460/460 [==============================] - 0s 1ms/step - loss: 97.2791 - mse:
58.0246 - val_loss: 66.6870 - val_mse: 27.7320
Epoch 921/1000
460/460 [==============================] - 0s 1ms/step - loss: 208.4689 - mse:
169.4375 - val_loss: 551.6633 - val_mse: 512.7723
Epoch 922/1000
460/460 [==============================] - 0s 1ms/step - loss: 239.0408 - mse:
200.1644 - val_loss: 127.6757 - val_mse: 88.9192
```

```
Epoch 923/1000
460/460 [==============================] - 0s 1ms/step - loss: 512.0072 - mse:
473.0558 - val_loss: 123.5139 - val_mse: 84.4569
Epoch 924/1000
460/460 [==============================] - 0s 1ms/step - loss: 196.4255 - mse:
157.7159 - val_loss: 77.6402 - val_mse: 38.9417
Epoch 925/1000
460/460 [==============================] - 0s 1ms/step - loss: 7239.6484 - mse
: 7199.9395 - val_loss: 124.0286 - val_mse: 83.7457
Epoch 926/1000
460/460 [==============================] - 0s 1ms/step - loss: 87.0233 - mse:
47.0362 - val_loss: 100.7227 - val_mse: 60.9805
Epoch 927/1000
460/460 [==============================] - 0s 1ms/step - loss: 80.4428 - mse:
40.8668 - val_loss: 71.0157 - val_mse: 31.6253
Epoch 928/1000
460/460 [==============================] - 0s 1ms/step - loss: 87.6513 - mse:
48.4511 - val_loss: 65.5982 - val_mse: 26.6010
Epoch 929/1000
460/460 [==============================] - 0s 1ms/step - loss: 154.3548 - mse:
115.3761 - val_loss: 65.5611 - val_mse: 26.6073
Epoch 930/1000
460/460 [==============================] - 0s 1ms/step - loss: 1123.4650 - mse
: 1084.5093 - val_loss: 65.2569 - val_mse: 26.4514
Epoch 931/1000
460/460 [==============================] - 0s 1ms/step - loss: 91.9518 - mse:
53.2633 - val_loss: 71.3967 - val_mse: 32.9489
Epoch 932/1000
460/460 [==============================] - 0s 1ms/step - loss: 144.4447 - mse:
105.9197 - val_loss: 219.1971 - val_mse: 180.6514
Epoch 933/1000
460/460 [==============================] - 0s 1ms/step - loss: 349.2902 - mse:
310.7163 - val_loss: 102.6192 - val_mse: 64.1449
Epoch 934/1000
460/460 [==============================] - 0s 1ms/step - loss: 614.0951 - mse:
575.6423 - val_loss: 142.7822 - val_mse: 104.3348
Epoch 935/1000
460/460 [==============================] - 0s 1ms/step - loss: 175.0596 - mse:
136.6591 - val_loss: 162.2560 - val_mse: 123.9464
Epoch 936/1000
460/460 [==============================] - 0s 1ms/step - loss: 1061.4884 - mse
: 1022.7894 - val_loss: 484.8983 - val_mse: 446.2977
Epoch 937/1000
460/460 [==============================] - 0s 1ms/step - loss: 185.8286 - mse:
147.3051 - val_loss: 65.1291 - val_mse: 26.5814
Epoch 938/1000
460/460 [==============================] - 0s 1ms/step - loss: 509.1679 - mse:
470.6306 - val_loss: 153.9638 - val_mse: 115.3143
Epoch 939/1000
460/460 [==============================] - 0s 1ms/step - loss: 1131.1581 - mse
: 1092.8046 - val_loss: 1097.7924 - val_mse: 1059.4922
Epoch 940/1000
460/460 [==============================] - 0s 1ms/step - loss: 617.7358 - mse:
579.5827 - val_loss: 85.6649 - val_mse: 47.5902
Epoch 941/1000
460/460 [==============================] - 0s 1ms/step - loss: 119.7450 - mse:
81.7456 - val_loss: 532.1691 - val_mse: 494.2078
Epoch 942/1000
460/460 [==============================] - 0s 1ms/step - loss: 872.7818 - mse:
834.2179 - val_loss: 109.5599 - val_mse: 71.2729
Epoch 943/1000
```

```
460/460 [==============================] - 0s 1ms/step - loss: 200.4323 - mse:
161.9762 - val_loss: 92.3181 - val_mse: 53.6980
Epoch 944/1000
460/460 [==============================] - 0s 1ms/step - loss: 387.1324 - mse:
348.4689 - val_loss: 1798.5692 - val_mse: 1759.7638
Epoch 945/1000
460/460 [==============================] - 0s 1ms/step - loss: 1514.5262 - mse
: 1475.0850 - val_loss: 70.3279 - val_mse: 31.2978
Epoch 946/1000
460/460 [==============================] - 0s 1ms/step - loss: 171.8837 - mse:
132.9476 - val_loss: 70.8655 - val_mse: 32.0351
Epoch 947/1000
460/460 [==============================] - 0s 1ms/step - loss: 199.5049 - mse:
160.5724 - val_loss: 107.7091 - val_mse: 68.7093
Epoch 948/1000
460/460 [==============================] - 0s 1ms/step - loss: 2326.6648 - mse
: 2287.2549 - val_loss: 72.9595 - val_mse: 32.9281
Epoch 949/1000
460/460 [==============================] - 0s 1ms/step - loss: 127.5169 - mse:
87.8970 - val_loss: 67.9164 - val_mse: 28.8273
Epoch 950/1000
460/460 [==============================] - 0s 1ms/step - loss: 92.7020 - mse:
53.8368 - val_loss: 64.3327 - val_mse: 25.6796
Epoch 951/1000
460/460 [==============================] - 0s 1ms/step - loss: 234.6821 - mse:
196.0800 - val_loss: 103.0358 - val_mse: 64.2507
Epoch 952/1000
460/460 [==============================] - 0s 1ms/step - loss: 196.0096 - mse:
157.2309 - val_loss: 98.1247 - val_mse: 59.4257
Epoch 953/1000
460/460 [==============================] - 0s 1ms/step - loss: 1417.0352 - mse
: 1378.3719 - val_loss: 84.2982 - val_mse: 45.9979
Epoch 954/1000
460/460 [==============================] - 0s 1ms/step - loss: 342.3445 - mse:
303.9666 - val_loss: 168.1701 - val_mse: 129.4773
Epoch 955/1000
460/460 [==============================] - 0s 1ms/step - loss: 340.1295 - mse:
301.6365 - val_loss: 1772.6716 - val_mse: 1734.4491
Epoch 956/1000
460/460 [==============================] - 0s 1ms/step - loss: 2978.9080 - mse
: 2940.3921 - val_loss: 659.7546 - val_mse: 621.1738
Epoch 957/1000
460/460 [==============================] - 0s 1ms/step - loss: 94.0330 - mse:
55.4183 - val_loss: 76.2819 - val_mse: 37.4087
Epoch 958/1000
460/460 [==============================] - 0s 1ms/step - loss: 131.8405 - mse:
93.0898 - val_loss: 85.1503 - val_mse: 46.2524
Epoch 959/1000
460/460 [==============================] - 0s 1ms/step - loss: 839.7734 - mse:
800.9672 - val_loss: 9571.8398 - val_mse: 9532.9424
Epoch 960/1000
460/460 [==============================] - 0s 1ms/step - loss: 849.2642 - mse:
810.0748 - val_loss: 99.3410 - val_mse: 60.4714
Epoch 961/1000
460/460 [==============================] - 0s 1ms/step - loss: 101.8463 - mse:
63.2173 - val_loss: 86.0378 - val_mse: 47.5648
Epoch 962/1000
460/460 [==============================] - 0s 1ms/step - loss: 944.0503 - mse:
905.4486 - val_loss: 70.5107 - val_mse: 31.9831
Epoch 963/1000
460/460 [==============================] - 0s 1ms/step - loss: 847.9873 - mse:
```

```
809.3985 - val_loss: 110526.9453 - val_mse: 110488.1953
Epoch 964/1000
460/460 [==============================] - 0s 1ms/step - loss: 1331.3408 - mse
: 1290.6575 - val_loss: 75.6073 - val_mse: 35.0095
Epoch 965/1000
460/460 [==============================] - 0s 1ms/step - loss: 90.8656 - mse:
50.5782 - val_loss: 78.7491 - val_mse: 38.4606
Epoch 966/1000
460/460 [==============================] - 0s 1ms/step - loss: 100.4389 - mse:
60.3251 - val_loss: 97.2470 - val_mse: 57.2657
Epoch 967/1000
460/460 [==============================] - 1s 1ms/step - loss: 247.1420 - mse:
207.1627 - val_loss: 102.0366 - val_mse: 62.3255
Epoch 968/1000
460/460 [==============================] - 1s 1ms/step - loss: 2395.0825 - mse
: 2355.2346 - val_loss: 67.5914 - val_mse: 27.8942
Epoch 969/1000
460/460 [==============================] - 0s 1ms/step - loss: 99.3744 - mse:
59.8355 - val_loss: 482.4589 - val_mse: 443.0247
Epoch 970/1000
460/460 [==============================] - 0s 1ms/step - loss: 239.7126 - mse:
200.4577 - val_loss: 66.4887 - val_mse: 27.3826
Epoch 971/1000
460/460 [==============================] - 0s 1ms/step - loss: 506.6677 - mse:
467.4444 - val_loss: 115.2120 - val_mse: 76.1722
Epoch 972/1000
460/460 [==============================] - 0s 1ms/step - loss: 221.8165 - mse:
182.9819 - val_loss: 71.5391 - val_mse: 32.6673
Epoch 973/1000
460/460 [==============================] - 1s 1ms/step - loss: 2259.1104 - mse
: 2219.8923 - val_loss: 113.4463 - val_mse: 74.2425
Epoch 974/1000
460/460 [==============================] - 1s 1ms/step - loss: 113.1421 - mse:
74.2280 - val_loss: 100.0037 - val_mse: 61.2826
Epoch 975/1000
460/460 [==============================] - 0s 1ms/step - loss: 377.8853 - mse:
339.3423 - val_loss: 183.6350 - val_mse: 145.4097
Epoch 976/1000
460/460 [==============================] - 0s 1ms/step - loss: 477.1460 - mse:
438.8578 - val_loss: 767.8154 - val_mse: 728.6188
Epoch 977/1000
460/460 [==============================] - 0s 1ms/step - loss: 545.6704 - mse:
506.7739 - val_loss: 281.9064 - val_mse: 243.2408
Epoch 978/1000
460/460 [==============================] - 0s 1ms/step - loss: 162.0500 - mse:
123.4316 - val_loss: 151.5421 - val_mse: 113.0016
Epoch 979/1000
460/460 [==============================] - 0s 1ms/step - loss: 656.2691 - mse:
617.7108 - val_loss: 71.5989 - val_mse: 33.1122
Epoch 980/1000
460/460 [==============================] - 0s 1ms/step - loss: 649.2120 - mse:
610.4622 - val_loss: 136.8685 - val_mse: 97.2862
Epoch 981/1000
460/460 [==============================] - 0s 1ms/step - loss: 430.5237 - mse:
391.2620 - val_loss: 75.8231 - val_mse: 36.7299
Epoch 982/1000
460/460 [==============================] - 0s 1ms/step - loss: 444.2814 - mse:
405.2554 - val_loss: 75.8405 - val_mse: 37.1111
Epoch 983/1000
460/460 [==============================] - 0s 1ms/step - loss: 92.6771 - mse:
53.9386 - val_loss: 75.2766 - val_mse: 36.5223
```

```
Epoch 984/1000
460/460 [==============================] - 0s 1ms/step - loss: 1108.6985 - mse
: 1069.6677 - val_loss: 95.4683 - val_mse: 56.3172
Epoch 985/1000
460/460 [==============================] - 0s 1ms/step - loss: 1260.3710 - mse
: 1221.5792 - val_loss: 110.4247 - val_mse: 71.8384
Epoch 986/1000
460/460 [==============================] - 0s 1ms/step - loss: 141.2184 - mse:
102.6620 - val_loss: 122.8185 - val_mse: 84.4096
Epoch 987/1000
460/460 [==============================] - 0s 1ms/step - loss: 496.7100 - mse:
458.1534 - val_loss: 112.9518 - val_mse: 74.2129
Epoch 988/1000
460/460 [==============================] - 0s 1ms/step - loss: 220.1531 - mse:
181.4094 - val_loss: 218.4552 - val_mse: 179.6421
Epoch 989/1000
460/460 [==============================] - 0s 1ms/step - loss: 1990.3939 - mse
: 1951.4618 - val_loss: 80.3585 - val_mse: 41.4684
Epoch 990/1000
460/460 [==============================] - 0s 1ms/step - loss: 171.6225 - mse:
132.7480 - val_loss: 73.5617 - val_mse: 34.9539
Epoch 991/1000
460/460 [==============================] - 0s 1ms/step - loss: 119.2053 - mse:
80.4816 - val_loss: 98.8374 - val_mse: 60.0255
Epoch 992/1000
460/460 [==============================] - 0s 1ms/step - loss: 2586.6262 - mse
: 2548.1533 - val_loss: 70.8902 - val_mse: 32.4599
Epoch 993/1000
460/460 [==============================] - 0s 1ms/step - loss: 85.7812 - mse:
47.4482 - val_loss: 97.2551 - val_mse: 59.0100
Epoch 994/1000
460/460 [==============================] - 0s 1ms/step - loss: 93.3608 - mse:
55.0049 - val_loss: 702.2338 - val_mse: 663.5891
Epoch 995/1000
460/460 [==============================] - 0s 1ms/step - loss: 171.5643 - mse:
133.0251 - val_loss: 79.4218 - val_mse: 40.9616
Epoch 996/1000
460/460 [==============================] - 0s 1ms/step - loss: 318.9357 - mse:
280.2671 - val_loss: 174.8932 - val_mse: 136.2465
Epoch 997/1000
460/460 [==============================] - 0s 1ms/step - loss: 601.9382 - mse:
562.9774 - val_loss: 81.7137 - val_mse: 42.9752
Epoch 998/1000
460/460 [==============================] - 0s 1ms/step - loss: 1086.5962 - mse
: 1048.1473 - val_loss: 66.5185 - val_mse: 28.1874
Epoch 999/1000
460/460 [==============================] - 0s 1ms/step - loss: 88.3138 - mse:
49.8686 - val_loss: 114.4537 - val_mse: 75.8210
Epoch 1000/1000
460/460 [==============================] - 0s 1ms/step - loss: 1281.7517 - mse
: 1243.1416 - val_loss: 107.8623 - val_mse: 69.3026
```

Out[208…

```
<keras.callbacks.History at 0x7fb058731e80>
```

Evaluate the Model with Test Data

Below you will evaluate the performance of your model using the test data.

In [209…
```
test_lbl = np.array(test_df["vehicle_CO2"])
test_df = test_df.drop(columns=["vehicle_CO2"])
test_ft = {key:np.array(value) for key, value in test_df.items()}
# test_lbl = np.array(test_ft.pop(label_name))
print("Model evaluation: \n")
model.evaluate(x=test_ft, y=test_lbl, batch_size=batch_size)
```

```
Model evaluation:

64/64 [==============================] - 0s 976us/step - loss: 95.0243 - mse:
56.4646
```

Out[209…
```
[95.02432250976562, 56.46455383300781]
```

In [210…
```
#Get a summary of your model
model.summary()
```

```
Model: "sequential_35"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
Features (DenseFeatures)     multiple                  0
_________________________________________________________________
Hidden1 (Dense)              multiple                  80
_________________________________________________________________
Hidden2 (Dense)              multiple                  77
_________________________________________________________________
Hidden3 (Dense)              multiple                  32
_________________________________________________________________
Output (Dense)               multiple                  5
=================================================================
Total params: 194
Trainable params: 194
Non-trainable params: 0
_________________________________________________________________
```

Use the Trained-Model and Visualize the results

Below we provide you with tables and figures for you to visualize your training results.

TensorBoard

From TensorBoard, you can see the loss and mse curve of your training. Go to graph and under "Tag", select "keras". You can see your network. Note that you will see error under "Tag: Default". You can ignore the warning.

In [211…
```
logdir = "./logs/fit/" + datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [212…
```
%tensorboard --logdir logs
```

```
Reusing TensorBoard on port 6006 (pid 53704), started 0:51:50 ago. (Use '!kill
53704' to kill it.)
```

Predict CO_2 From Trained-Model

Below, your trained-model is used to make prediction on the test set. Remember, test set is not used in training the model so it would give you a nice indication of how your model is doing.

- `.predict()` : predicts the output values from features given.
- `predicted_labels` : contains the values (CO_2) our model predicts. After the predicted and actual values are obtained. We create a plot for you to visualize the results. The dots show the predicted values and the line shows the targeted values.

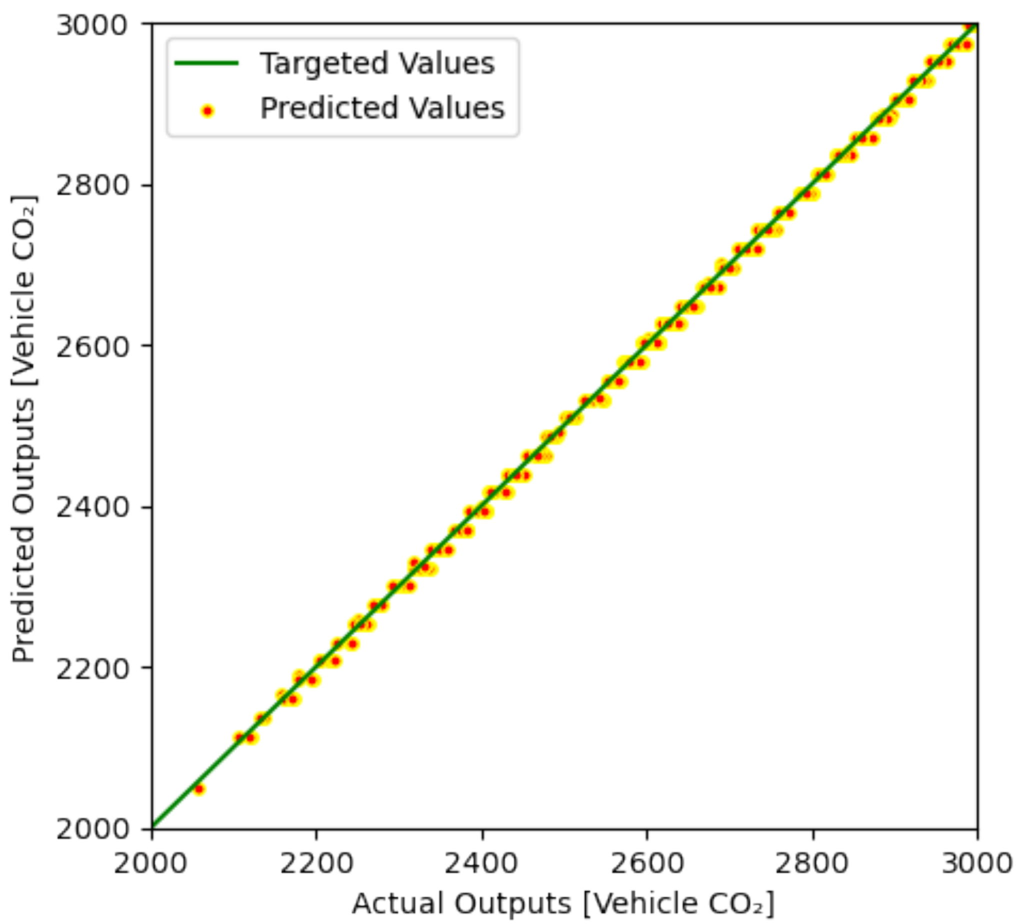
In [213…

```
%%time
# Get the features from the test set
test_features = test_ft
# Get the actual CO2 output for the test set
actual_labels = test_lbl

# Make prediction on the test set
predicted_labels = model.predict(x=test_features).flatten()

# Define the graph
Figure1 = plt.figure(figsize=(5,5), dpi=100)
plt.xlabel('Actual Outputs [Vehicle CO\u2082]')
plt.ylabel('Predicted Outputs [Vehicle CO\u2082]')
plt.scatter(actual_labels, predicted_labels, s=15, c='Red', edgecolors='Yello

# Take the output data from 2000 to 3000 as an instance to visualize
lims = [2000, 3000]
plt.xlim(lims)
plt.ylim(lims)
plt.plot(lims, lims, color='Green', label='Targeted Values')
plt.legend()
```

```
WARNING:tensorflow:Layers in a Sequential model should only have a single inpu
t tensor, but we receive a <class 'dict'> input: {'vehicle_angle': <tf.Tensor
'ExpandDims:0' shape=(None, 1) dtype=float32>, 'vehicle_eclass': <tf.Tensor 'E
xpandDims_1:0' shape=(None, 1) dtype=string>, 'vehicle_fuel': <tf.Tensor 'Expa
ndDims_2:0' shape=(None, 1) dtype=float32>, 'vehicle_noise': <tf.Tensor 'Expan
dDims_3:0' shape=(None, 1) dtype=float32>, 'vehicle_pos': <tf.Tensor 'ExpandDi
ms_4:0' shape=(None, 1) dtype=float32>, 'vehicle_speed': <tf.Tensor 'ExpandDim
s_5:0' shape=(None, 1) dtype=float32>, 'vehicle_type': <tf.Tensor 'ExpandDims_
6:0' shape=(None, 1) dtype=string>, 'vehicle_waiting': <tf.Tensor 'ExpandDims_
7:0' shape=(None, 1) dtype=float32>, 'vehicle_x': <tf.Tensor 'ExpandDims_8:0'
shape=(None, 1) dtype=float32>, 'vehicle_y': <tf.Tensor 'ExpandDims_9:0' shape
=(None, 1) dtype=float32>}
Consider rewriting this model with the Functional API.
CPU times: user 327 ms, sys: 48.6 ms, total: 375 ms
Wall time: 269 ms
```

Out[213…

```
<matplotlib.legend.Legend at 0x7fb0aca2e640>
```



Error Count Histogram

Below, the graph shows a Histogram of errors between predicted and actual values. If the error counts locate mostly around 0, the trained-model is pretty accurate.

In [214…

```
error = actual_labels - predicted_labels
Figure2 = plt.figure(figsize=(8,3), dpi=100)
plt.hist(error, bins=50, color='Red', edgecolor='Green')
plt.xlabel('Prediction Error [Vehicle CO\u2082]')
plt.ylabel('Count')
```

Out[214…

```
Text(0, 0.5, 'Count')
```

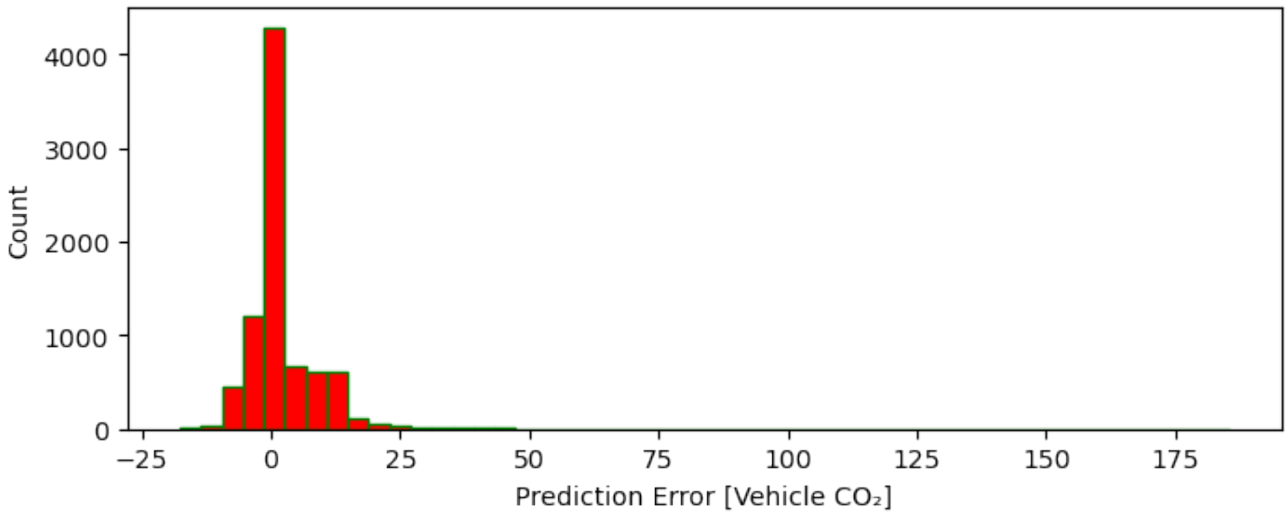


Table of Actual and Predicted Values

Below, a table puts the actual and predicted values side by side. Html is used in this case.

In [215…

```
from IPython.display import HTML, display

def display_table(data_x, data_y):
    html = "<table>"
    html += "<tr>"
    html += "<td><h3>%s</h3><td>"%"Actual Vehicle CO\u2082"
    html += "<td><h3>%s</h3><td>"%"Predicted Vehicle CO\u2082"
    html += "</tr>"
    for i in range(len(data_x)):
        html += "<tr>"
        html += "<td><h4>%s</h4><td>"%(int(data_x[i]))
        html += "<td><h4>%s</h4><td>"%(int(data_y[i]))
        html += "</tr>"
    html += "</table>"
    display(HTML(html))

display_table(actual_labels[0:100], predicted_labels[0:100])
```

Actual Vehicle CO_2	Predicted Vehicle CO_2
5286	5287
4156	4161

0	0
0	0
0	0
0	0
6581	6568
0	0
2934	2928
2624	2626
2386	2393
0	0
0	0
0	0
0	0
2624	2626
3953	3951
0	0
0	0
10442	10441
2262	2254
0	0
0	0
0	0

0	0
0	0
0	0
2624	2626
2624	2626
26520	26494
0	0
0	0
0	0
8700	8696
0	0
2624	2626
0	0
2886	2881
17291	17279
3738	3742
0	0
0	0
0	0
2624	2626
5587	5580
2715	2719
4079	4068

2624	2626
9403	9394
37472	37424
6228	6231
10682	10674
0	0
5286	5287
0	0
5286	5284
7064	7068
0	0
0	0
0	0
0	0
0	0
0	0
17717	17712
8188	8185
6146	6138
19318	19297
0	0
44813	44805
5718	5719

5286	5287
0	0
5226	5231
2624	2626
9754	9743
0	0
5286	5287
0	0
32506	32503
5839	5835
6064	6068
0	0
0	0
24658	24659
5286	5287
2624	2626
9048	9045
4125	4114
5888	5882
12903	12906
5547	5533
2624	2626

3469	3463
0	0
10266	10255
3176	3184
34858	34819
6043	6045
0	0
0	0

Well Done!

Congradulation on finishing the lab. Please click on "File -> Print Preview" and a separate page should open. Press Cmd/Ctrl + p to print. Select "Save as PDF". Submit this .ipnyb Notebook file, the PDF, and loss graph screenshots to the link specified in the Google Doc.