Auctioning Used-Car Classifier

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## Blog Post Inspiration and Objectives

In this blog post, I was hoping to look into using Machine Learning to make a prediction system. In particular, I was hoping to imitate ones used for stock prediction. However, since there were too many tutorials on this topic, I decided to investigate into another global, financial factor that governs trade internationally: international currency rates. In the news recently, I have heard rumors of how the international standard of utilizing the US dollar could be compromised with other global powers such as China and India rise in global dominance. Thus, I focused my efforts on analyzing the US currency conversion rates to other countries. With that said, let’s try to analyze this topic with some Machine Learning:

## Data Preprocessing - Cleaning and Analytics

```{python}  
# Import needed libraries  
import numpy as np  
import pandas as pd  
import matplotlib.pyplot as plt  
from tensorflow.keras.models import Sequential  
from tensorflow.keras.optimizers import Adam  
from tensorflow.keras import layers  
from copy import deepcopy  
import datetime as dt  
plt.style.use("fivethirtyeight")  
```

First, we will read and display the initial dataset in our file system for this blog post, downloaded from Kaggle. This dataset contains loads of valuable information such as almost every major world power’s international US currency conversion rate.

```{python}  
# Reading and displaying the initial dataset  
df = pd.read\_csv("datasets/foreign\_exchange\_rates.csv")  
df  
```

|  | Unnamed: 0 | Time Serie | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | EURO AREA - EURO/US$ | NEW ZEALAND - NEW ZELAND DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | BRAZIL - REAL/US$ | CANADA - CANADIAN DOLLAR/US$ | CHINA - YUAN/US$ | HONG KONG - HONG KONG DOLLAR/US$ | ... | SINGAPORE - SINGAPORE DOLLAR/US$ | DENMARK - DANISH KRONE/US$ | JAPAN - YEN/US$ | MALAYSIA - RINGGIT/US$ | NORWAY - NORWEGIAN KRONE/US$ | SWEDEN - KRONA/US$ | SRI LANKA - SRI LANKAN RUPEE/US$ | SWITZERLAND - FRANC/US$ | TAIWAN - NEW TAIWAN DOLLAR/US$ | THAILAND - BAHT/US$ |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 2000-01-03 | 1.5172 | 0.9847 | 1.9033 | 0.6146 | 1.805 | 1.4465 | 8.2798 | 7.7765 | ... | 1.6563 | 7.329 | 101.7 | 3.8 | 7.964 | 8.443 | 72.3 | 1.5808 | 31.38 | 36.97 |
| 1 | 1 | 2000-01-04 | 1.5239 | 0.97 | 1.9238 | 0.6109 | 1.8405 | 1.4518 | 8.2799 | 7.7775 | ... | 1.6535 | 7.218 | 103.09 | 3.8 | 7.934 | 8.36 | 72.65 | 1.5565 | 30.6 | 37.13 |
| 2 | 2 | 2000-01-05 | 1.5267 | 0.9676 | 1.9339 | 0.6092 | 1.856 | 1.4518 | 8.2798 | 7.778 | ... | 1.656 | 7.208 | 103.77 | 3.8 | 7.935 | 8.353 | 72.95 | 1.5526 | 30.8 | 37.1 |
| 3 | 3 | 2000-01-06 | 1.5291 | 0.9686 | 1.9436 | 0.607 | 1.84 | 1.4571 | 8.2797 | 7.7785 | ... | 1.6655 | 7.2125 | 105.19 | 3.8 | 7.94 | 8.3675 | 72.95 | 1.554 | 31.75 | 37.62 |
| 4 | 4 | 2000-01-07 | 1.5272 | 0.9714 | 1.938 | 0.6104 | 1.831 | 1.4505 | 8.2794 | 7.7783 | ... | 1.6625 | 7.2285 | 105.17 | 3.8 | 7.966 | 8.415 | 73.15 | 1.5623 | 30.85 | 37.3 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 5212 | 5212 | 2019-12-25 | ND | ND | ND | ND | ND | ND | ND | ND | ... | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 5213 | 5213 | 2019-12-26 | 1.4411 | 0.9007 | 1.5002 | 0.7688 | 4.0602 | 1.3124 | 6.9949 | 7.788 | ... | 1.354 | 6.7295 | 109.67 | 4.1337 | 8.8799 | 9.4108 | 181.3 | 0.9808 | 30.11 | 30.15 |
| 5214 | 5214 | 2019-12-27 | 1.4331 | 0.8949 | 1.4919 | 0.7639 | 4.0507 | 1.3073 | 6.9954 | 7.7874 | ... | 1.352 | 6.6829 | 109.47 | 4.126 | 8.8291 | 9.3405 | 181.35 | 0.9741 | 30.09 | 30.14 |
| 5215 | 5215 | 2019-12-30 | 1.4278 | 0.8915 | 1.4846 | 0.761 | 4.0152 | 1.3058 | 6.9864 | 7.7857 | ... | 1.3483 | 6.6589 | 108.85 | 4.1053 | 8.7839 | 9.3145 | 181.6 | 0.9677 | 30.04 | 29.94 |
| 5216 | 5216 | 2019-12-31 | 1.4225 | 0.8907 | 1.4826 | 0.7536 | 4.019 | 1.2962 | 6.9618 | 7.7894 | ... | 1.3446 | 6.6554 | 108.67 | 4.0918 | 8.7823 | 9.3425 | 181.3 | 0.9677 | 29.91 | 29.75 |

For clarity on the constraints and parameters of the working datasets, I went to find high-level exploratory statistics on all of the datasets: shape, information about all of the entries, etc.

```{python}  
# Determining the shape of the initial dataset  
df.shape  
```

(5217, 24)

```{python}  
# Getting a sample of the initial dataset through the seeing the first 10 entries  
# completely in the dataset  
df.head()  
```

|  | Unnamed: 0 | Time Serie | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | EURO AREA - EURO/US$ | NEW ZEALAND - NEW ZELAND DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | BRAZIL - REAL/US$ | CANADA - CANADIAN DOLLAR/US$ | CHINA - YUAN/US$ | HONG KONG - HONG KONG DOLLAR/US$ | ... | SINGAPORE - SINGAPORE DOLLAR/US$ | DENMARK - DANISH KRONE/US$ | JAPAN - YEN/US$ | MALAYSIA - RINGGIT/US$ | NORWAY - NORWEGIAN KRONE/US$ | SWEDEN - KRONA/US$ | SRI LANKA - SRI LANKAN RUPEE/US$ | SWITZERLAND - FRANC/US$ | TAIWAN - NEW TAIWAN DOLLAR/US$ | THAILAND - BAHT/US$ |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 2000-01-03 | 1.5172 | 0.9847 | 1.9033 | 0.6146 | 1.805 | 1.4465 | 8.2798 | 7.7765 | ... | 1.6563 | 7.329 | 101.7 | 3.8 | 7.964 | 8.443 | 72.3 | 1.5808 | 31.38 | 36.97 |
| 1 | 1 | 2000-01-04 | 1.5239 | 0.97 | 1.9238 | 0.6109 | 1.8405 | 1.4518 | 8.2799 | 7.7775 | ... | 1.6535 | 7.218 | 103.09 | 3.8 | 7.934 | 8.36 | 72.65 | 1.5565 | 30.6 | 37.13 |
| 2 | 2 | 2000-01-05 | 1.5267 | 0.9676 | 1.9339 | 0.6092 | 1.856 | 1.4518 | 8.2798 | 7.778 | ... | 1.656 | 7.208 | 103.77 | 3.8 | 7.935 | 8.353 | 72.95 | 1.5526 | 30.8 | 37.1 |
| 3 | 3 | 2000-01-06 | 1.5291 | 0.9686 | 1.9436 | 0.607 | 1.84 | 1.4571 | 8.2797 | 7.7785 | ... | 1.6655 | 7.2125 | 105.19 | 3.8 | 7.94 | 8.3675 | 72.95 | 1.554 | 31.75 | 37.62 |
| 4 | 4 | 2000-01-07 | 1.5272 | 0.9714 | 1.938 | 0.6104 | 1.831 | 1.4505 | 8.2794 | 7.7783 | ... | 1.6625 | 7.2285 | 105.17 | 3.8 | 7.966 | 8.415 | 73.15 | 1.5623 | 30.85 | 37.3 |

```{python}  
# Figuring out all of the columns (and their names) available for me to use in the dataset  
df.columns  
```

Index(['Unnamed: 0', 'Time Serie', 'AUSTRALIA - AUSTRALIAN DOLLAR/US$',  
 'EURO AREA - EURO/US$', 'NEW ZEALAND - NEW ZELAND DOLLAR/US$',  
 'UNITED KINGDOM - UNITED KINGDOM POUND/US$', 'BRAZIL - REAL/US$',  
 'CANADA - CANADIAN DOLLAR/US$', 'CHINA - YUAN/US$',  
 'HONG KONG - HONG KONG DOLLAR/US$', 'INDIA - INDIAN RUPEE/US$',  
 'KOREA - WON/US$', 'MEXICO - MEXICAN PESO/US$',  
 'SOUTH AFRICA - RAND/US$', 'SINGAPORE - SINGAPORE DOLLAR/US$',  
 'DENMARK - DANISH KRONE/US$', 'JAPAN - YEN/US$',  
 'MALAYSIA - RINGGIT/US$', 'NORWAY - NORWEGIAN KRONE/US$',  
 'SWEDEN - KRONA/US$', 'SRI LANKA - SRI LANKAN RUPEE/US$',  
 'SWITZERLAND - FRANC/US$', 'TAIWAN - NEW TAIWAN DOLLAR/US$',  
 'THAILAND - BAHT/US$'],  
 dtype='object')

```{python}  
# Figuring out the number of duplicated elements in the dataset  
# (could be problematic if not resolved)  
df.duplicated().sum()  
```

0

```{python}  
# Figuring out the number of 'null'/'NaN' elements in the dataset   
# (if NaN filling is needed or not)  
(df.isnull().sum() / df.shape[0]) \* 100  
```

Unnamed: 0 0.0  
Time Serie 0.0  
AUSTRALIA - AUSTRALIAN DOLLAR/US$ 0.0  
EURO AREA - EURO/US$ 0.0  
NEW ZEALAND - NEW ZELAND DOLLAR/US$ 0.0  
UNITED KINGDOM - UNITED KINGDOM POUND/US$ 0.0  
BRAZIL - REAL/US$ 0.0  
CANADA - CANADIAN DOLLAR/US$ 0.0  
CHINA - YUAN/US$ 0.0  
HONG KONG - HONG KONG DOLLAR/US$ 0.0  
INDIA - INDIAN RUPEE/US$ 0.0  
KOREA - WON/US$ 0.0  
MEXICO - MEXICAN PESO/US$ 0.0  
SOUTH AFRICA - RAND/US$ 0.0  
SINGAPORE - SINGAPORE DOLLAR/US$ 0.0  
DENMARK - DANISH KRONE/US$ 0.0  
JAPAN - YEN/US$ 0.0  
MALAYSIA - RINGGIT/US$ 0.0  
NORWAY - NORWEGIAN KRONE/US$ 0.0  
SWEDEN - KRONA/US$ 0.0  
SRI LANKA - SRI LANKAN RUPEE/US$ 0.0  
SWITZERLAND - FRANC/US$ 0.0  
TAIWAN - NEW TAIWAN DOLLAR/US$ 0.0  
THAILAND - BAHT/US$ 0.0  
dtype: float64

```{python}  
# Getting basic information about the dataset  
df.info()  
```

<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 5217 entries, 0 to 5216  
Data columns (total 24 columns):  
 # Column Non-Null Count Dtype   
--- ------ -------------- -----   
 0 Unnamed: 0 5217 non-null int64   
 1 Time Serie 5217 non-null object  
 2 AUSTRALIA - AUSTRALIAN DOLLAR/US$ 5217 non-null object  
 3 EURO AREA - EURO/US$ 5217 non-null object  
 4 NEW ZEALAND - NEW ZELAND DOLLAR/US$ 5217 non-null object  
 5 UNITED KINGDOM - UNITED KINGDOM POUND/US$ 5217 non-null object  
 6 BRAZIL - REAL/US$ 5217 non-null object  
 7 CANADA - CANADIAN DOLLAR/US$ 5217 non-null object  
 8 CHINA - YUAN/US$ 5217 non-null object  
 9 HONG KONG - HONG KONG DOLLAR/US$ 5217 non-null object  
 10 INDIA - INDIAN RUPEE/US$ 5217 non-null object  
 11 KOREA - WON/US$ 5217 non-null object  
 12 MEXICO - MEXICAN PESO/US$ 5217 non-null object  
 13 SOUTH AFRICA - RAND/US$ 5217 non-null object  
 14 SINGAPORE - SINGAPORE DOLLAR/US$ 5217 non-null object  
 15 DENMARK - DANISH KRONE/US$ 5217 non-null object  
 16 JAPAN - YEN/US$ 5217 non-null object  
 17 MALAYSIA - RINGGIT/US$ 5217 non-null object  
 18 NORWAY - NORWEGIAN KRONE/US$ 5217 non-null object  
 19 SWEDEN - KRONA/US$ 5217 non-null object  
 20 SRI LANKA - SRI LANKAN RUPEE/US$ 5217 non-null object  
 21 SWITZERLAND - FRANC/US$ 5217 non-null object  
 22 TAIWAN - NEW TAIWAN DOLLAR/US$ 5217 non-null object  
 23 THAILAND - BAHT/US$ 5217 non-null object  
dtypes: int64(1), object(23)  
memory usage: 978.3+ KB

Additionally, before handing my combined Book dataset over for Machine Learning training and prediction, I need to clean the data prior to the analysis stage: removing duplicates, deleting null/NaN vales, fixing types of columns, filling invalid values with suitable alternatives, etc.

```{python}  
# Removing unnecessary/unnamed columns in the dataset  
df = df.drop("Unnamed: 0", axis=1)  
df  
```

|  | Time Serie | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | EURO AREA - EURO/US$ | NEW ZEALAND - NEW ZELAND DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | BRAZIL - REAL/US$ | CANADA - CANADIAN DOLLAR/US$ | CHINA - YUAN/US$ | HONG KONG - HONG KONG DOLLAR/US$ | INDIA - INDIAN RUPEE/US$ | ... | SINGAPORE - SINGAPORE DOLLAR/US$ | DENMARK - DANISH KRONE/US$ | JAPAN - YEN/US$ | MALAYSIA - RINGGIT/US$ | NORWAY - NORWEGIAN KRONE/US$ | SWEDEN - KRONA/US$ | SRI LANKA - SRI LANKAN RUPEE/US$ | SWITZERLAND - FRANC/US$ | TAIWAN - NEW TAIWAN DOLLAR/US$ | THAILAND - BAHT/US$ |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2000-01-03 | 1.5172 | 0.9847 | 1.9033 | 0.6146 | 1.805 | 1.4465 | 8.2798 | 7.7765 | 43.55 | ... | 1.6563 | 7.329 | 101.7 | 3.8 | 7.964 | 8.443 | 72.3 | 1.5808 | 31.38 | 36.97 |
| 1 | 2000-01-04 | 1.5239 | 0.97 | 1.9238 | 0.6109 | 1.8405 | 1.4518 | 8.2799 | 7.7775 | 43.55 | ... | 1.6535 | 7.218 | 103.09 | 3.8 | 7.934 | 8.36 | 72.65 | 1.5565 | 30.6 | 37.13 |
| 2 | 2000-01-05 | 1.5267 | 0.9676 | 1.9339 | 0.6092 | 1.856 | 1.4518 | 8.2798 | 7.778 | 43.55 | ... | 1.656 | 7.208 | 103.77 | 3.8 | 7.935 | 8.353 | 72.95 | 1.5526 | 30.8 | 37.1 |
| 3 | 2000-01-06 | 1.5291 | 0.9686 | 1.9436 | 0.607 | 1.84 | 1.4571 | 8.2797 | 7.7785 | 43.55 | ... | 1.6655 | 7.2125 | 105.19 | 3.8 | 7.94 | 8.3675 | 72.95 | 1.554 | 31.75 | 37.62 |
| 4 | 2000-01-07 | 1.5272 | 0.9714 | 1.938 | 0.6104 | 1.831 | 1.4505 | 8.2794 | 7.7783 | 43.55 | ... | 1.6625 | 7.2285 | 105.17 | 3.8 | 7.966 | 8.415 | 73.15 | 1.5623 | 30.85 | 37.3 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 5212 | 2019-12-25 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ... | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 5213 | 2019-12-26 | 1.4411 | 0.9007 | 1.5002 | 0.7688 | 4.0602 | 1.3124 | 6.9949 | 7.788 | 71.28 | ... | 1.354 | 6.7295 | 109.67 | 4.1337 | 8.8799 | 9.4108 | 181.3 | 0.9808 | 30.11 | 30.15 |
| 5214 | 2019-12-27 | 1.4331 | 0.8949 | 1.4919 | 0.7639 | 4.0507 | 1.3073 | 6.9954 | 7.7874 | 71.45 | ... | 1.352 | 6.6829 | 109.47 | 4.126 | 8.8291 | 9.3405 | 181.35 | 0.9741 | 30.09 | 30.14 |
| 5215 | 2019-12-30 | 1.4278 | 0.8915 | 1.4846 | 0.761 | 4.0152 | 1.3058 | 6.9864 | 7.7857 | 71.3 | ... | 1.3483 | 6.6589 | 108.85 | 4.1053 | 8.7839 | 9.3145 | 181.6 | 0.9677 | 30.04 | 29.94 |
| 5216 | 2019-12-31 | 1.4225 | 0.8907 | 1.4826 | 0.7536 | 4.019 | 1.2962 | 6.9618 | 7.7894 | 71.36 | ... | 1.3446 | 6.6554 | 108.67 | 4.0918 | 8.7823 | 9.3425 | 181.3 | 0.9677 | 29.91 | 29.75 |

```{python}  
# Converting the date column into a string representation to a parsable  
# Datetime object (needed for later)  
df = df.rename(columns={"Time Serie": "DATE"})  
  
def str\_to\_datetime(date\_str: str):  
 split = tuple(date\_str.split("-"))  
 year, month, day = int(split[0]), int(split[1]), int(split[2])  
 return dt.datetime(year, month, day)  
  
df["DATE"] = df["DATE"].apply(str\_to\_datetime)  
df["DATE"]  
```

0 2000-01-03  
1 2000-01-04  
2 2000-01-05  
3 2000-01-06  
4 2000-01-07  
 ...   
5212 2019-12-25  
5213 2019-12-26  
5214 2019-12-27  
5215 2019-12-30  
5216 2019-12-31  
Name: DATE, Length: 5217, dtype: datetime64[ns]

As shown below, I had decided to filter out all of the countries except Austrailia, Canada, the United Kingdom, and Switzerland because those countries had the most stable and consistent international currency rates as well as the most comparable (1:1) currency rates with the United States. One additional reason that these countries were selected for this blog post was do the geographical diversity covered most landmass continents across the world, representative of the global market interactions that the United States deals with on a day-to-day basis.

```{python}  
# Making the "Date" column the new index (better identifer/key in dataset)  
# Taking out other countries except Austrailia, Canada, UK, and   
# Switzerland from dataset for Machine Learning blog post  
df.index = df.pop("DATE")  
df = df[["AUSTRALIA - AUSTRALIAN DOLLAR/US$",   
 "CANADA - CANADIAN DOLLAR/US$",  
 "UNITED KINGDOM - UNITED KINGDOM POUND/US$",  
 "SWITZERLAND - FRANC/US$"]]  
df  
```

|  | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | CANADA - CANADIAN DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | SWITZERLAND - FRANC/US$ |
| --- | --- | --- | --- | --- |
| DATE |  |  |  |  |
| 2000-01-03 | 1.5172 | 1.4465 | 0.6146 | 1.5808 |
| 2000-01-04 | 1.5239 | 1.4518 | 0.6109 | 1.5565 |
| 2000-01-05 | 1.5267 | 1.4518 | 0.6092 | 1.5526 |
| 2000-01-06 | 1.5291 | 1.4571 | 0.607 | 1.554 |
| 2000-01-07 | 1.5272 | 1.4505 | 0.6104 | 1.5623 |
| ... | ... | ... | ... | ... |
| 2019-12-25 | ND | ND | ND | ND |
| 2019-12-26 | 1.4411 | 1.3124 | 0.7688 | 0.9808 |
| 2019-12-27 | 1.4331 | 1.3073 | 0.7639 | 0.9741 |
| 2019-12-30 | 1.4278 | 1.3058 | 0.761 | 0.9677 |
| 2019-12-31 | 1.4225 | 1.2962 | 0.7536 | 0.9677 |

```{python}  
# Converting of all numerical international currency rates to 2-decimal   
# rates (easier to work with for later)  
for col in df:  
 df[col] = df[col].map(lambda entry: entry if entry == "ND" else round(float(entry), 2))  
df  
```

|  | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | CANADA - CANADIAN DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | SWITZERLAND - FRANC/US$ |
| --- | --- | --- | --- | --- |
| DATE |  |  |  |  |
| 2000-01-03 | 1.52 | 1.45 | 0.61 | 1.58 |
| 2000-01-04 | 1.52 | 1.45 | 0.61 | 1.56 |
| 2000-01-05 | 1.53 | 1.45 | 0.61 | 1.55 |
| 2000-01-06 | 1.53 | 1.46 | 0.61 | 1.55 |
| 2000-01-07 | 1.53 | 1.45 | 0.61 | 1.56 |
| ... | ... | ... | ... | ... |
| 2019-12-25 | ND | ND | ND | ND |
| 2019-12-26 | 1.44 | 1.31 | 0.77 | 0.98 |
| 2019-12-27 | 1.43 | 1.31 | 0.76 | 0.97 |
| 2019-12-30 | 1.43 | 1.31 | 0.76 | 0.97 |
| 2019-12-31 | 1.42 | 1.3 | 0.75 | 0.97 |

```{python}  
# Removing all of the dated rows that contains "ND" as a way to avoid problems   
# when trying to interlay Machine Learning algorithms that require only  
# quantitative data with categorical entries  
nd\_index\_list: set[str] = set()  
for row\_index, \_ in df.iterrows():  
 for col\_entry in df.loc[row\_index]:  
 if col\_entry == "ND":  
 nd\_index\_list.add(row\_index)  
  
df = df.drop(labels=list(nd\_index\_list), axis=0)  
df  
```

|  | AUSTRALIA - AUSTRALIAN DOLLAR/US$ | CANADA - CANADIAN DOLLAR/US$ | UNITED KINGDOM - UNITED KINGDOM POUND/US$ | SWITZERLAND - FRANC/US$ |
| --- | --- | --- | --- | --- |
| DATE |  |  |  |  |
| 2000-01-03 | 1.52 | 1.45 | 0.61 | 1.58 |
| 2000-01-04 | 1.52 | 1.45 | 0.61 | 1.56 |
| 2000-01-05 | 1.53 | 1.45 | 0.61 | 1.55 |
| 2000-01-06 | 1.53 | 1.46 | 0.61 | 1.55 |
| 2000-01-07 | 1.53 | 1.45 | 0.61 | 1.56 |
| ... | ... | ... | ... | ... |
| 2019-12-24 | 1.44 | 1.32 | 0.77 | 0.98 |
| 2019-12-26 | 1.44 | 1.31 | 0.77 | 0.98 |
| 2019-12-27 | 1.43 | 1.31 | 0.76 | 0.97 |
| 2019-12-30 | 1.43 | 1.31 | 0.76 | 0.97 |
| 2019-12-31 | 1.42 | 1.3 | 0.75 | 0.97 |

As shown in the code snippet below, with some online references, the df\_to\_windowed\_df function describes a way to use prediction values. A new international currency rate dataframe is created which includes the rows encompassing the 3 previous dates prior to the current date of when the international currency rate was reported as well as the current rate that day. This would be helpful for later Machine Learning predictions because the previous 3 dates and the current will provide it enough context to make more insightful predictions on the future of the international currency rates between that respective country specified and the United States. Later, as you will see, the 3 previous days are going to be the input and the current currency rate (Target) will be our output.

```{python}  
def df\_to\_windowed\_df(data\_frame: pd.DataFrame, first\_date\_str: str, last\_date\_str: str, n: int, col\_name: str):  
 first\_date = str\_to\_datetime(first\_date\_str)  
 last\_date = str\_to\_datetime(last\_date\_str)  
   
 target\_date = first\_date  
   
 dates: list = []  
 X: list = []  
 Y: list = []  
   
 last\_time = False  
 while True:  
 df\_subset = data\_frame.loc[:target\_date].tail(n + 1)  
   
 if (len(df\_subset) != n + 1):  
 print("Error: Window of size " + str(n) + " is too large for date " + str(target\_date))  
 return  
   
 values = df\_subset[col\_name].to\_numpy()  
 x, y = values[:-1], values[-1]  
   
 dates.append(target\_date)  
 X.append(x)  
 Y.append(y)  
   
 next\_week = data\_frame.loc[target\_date:target\_date + dt.timedelta(days=7)]  
 next\_datetime\_str = str(next\_week.head(2).tail(1).index.values[0])  
 next\_date\_str = next\_datetime\_str.split("T")[0]  
 year\_month\_day = next\_date\_str.split("-")  
 year, month, day = year\_month\_day  
 next\_date = dt.datetime(year=int(year), month=int(month), day=int(day))  
   
 if last\_time:  
 break  
   
 target\_date = next\_date  
 if (target\_date == last\_date):  
 last\_time = True  
   
 returned\_df = pd.DataFrame({})  
 returned\_df["Target Date"] = dates  
   
 X = np.array(X)  
 for i in range(0, n):  
 X[:, i]  
 returned\_df["Target-" + str(n - i)] = X[:, i]  
 returned\_df["Target"] = Y  
   
 return returned\_df   
```

Thus, with the df\_to\_windowed\_df function created, we created one for every country to later use for Machine Learning model training and eventual predictions of future rates: Austrailia, Canada, the United Kingdom, and Switzerland.

```{python}  
# Convert Austrailia's dataframe to a windowed dataframe  
windowed\_df\_austrailia = df\_to\_windowed\_df(data\_frame=df,   
 first\_date\_str="2000-01-06",  
 last\_date\_str="2019-12-31",  
 n=3,  
 col\_name="AUSTRALIA - AUSTRALIAN DOLLAR/US$")  
windowed\_df\_austrailia   
```

|  | Target Date | Target-3 | Target-2 | Target-1 | Target |
| --- | --- | --- | --- | --- | --- |
| 0 | 2000-01-06 | 1.52 | 1.52 | 1.53 | 1.53 |
| 1 | 2000-01-07 | 1.52 | 1.53 | 1.53 | 1.53 |
| 2 | 2000-01-10 | 1.53 | 1.53 | 1.53 | 1.52 |
| 3 | 2000-01-11 | 1.53 | 1.53 | 1.52 | 1.52 |
| 4 | 2000-01-12 | 1.53 | 1.52 | 1.52 | 1.52 |
| ... | ... | ... | ... | ... | ... |
| 5011 | 2019-12-24 | 1.45 | 1.45 | 1.45 | 1.44 |
| 5012 | 2019-12-26 | 1.45 | 1.45 | 1.44 | 1.44 |
| 5013 | 2019-12-27 | 1.45 | 1.44 | 1.44 | 1.43 |
| 5014 | 2019-12-30 | 1.44 | 1.44 | 1.43 | 1.43 |
| 5015 | 2019-12-31 | 1.44 | 1.43 | 1.43 | 1.42 |

```{python}  
# Convert Canada's dataframe to a windowed dataframe  
windowed\_df\_canada = df\_to\_windowed\_df(data\_frame=df,   
 first\_date\_str="2000-01-06",  
 last\_date\_str="2019-12-31",  
 n=3,  
 col\_name="CANADA - CANADIAN DOLLAR/US$")  
windowed\_df\_canada  
```

|  | Target Date | Target-3 | Target-2 | Target-1 | Target |
| --- | --- | --- | --- | --- | --- |
| 0 | 2000-01-06 | 1.45 | 1.45 | 1.45 | 1.46 |
| 1 | 2000-01-07 | 1.45 | 1.45 | 1.46 | 1.45 |
| 2 | 2000-01-10 | 1.45 | 1.46 | 1.45 | 1.46 |
| 3 | 2000-01-11 | 1.46 | 1.45 | 1.46 | 1.46 |
| 4 | 2000-01-12 | 1.45 | 1.46 | 1.46 | 1.46 |
| ... | ... | ... | ... | ... | ... |
| 5011 | 2019-12-24 | 1.31 | 1.32 | 1.32 | 1.32 |
| 5012 | 2019-12-26 | 1.32 | 1.32 | 1.32 | 1.31 |
| 5013 | 2019-12-27 | 1.32 | 1.32 | 1.31 | 1.31 |
| 5014 | 2019-12-30 | 1.32 | 1.31 | 1.31 | 1.31 |
| 5015 | 2019-12-31 | 1.31 | 1.31 | 1.31 | 1.30 |

```{python}  
# Convert United Kingdom's dataframe to a windowed dataframe  
windowed\_df\_united\_kingdom = df\_to\_windowed\_df(data\_frame=df,   
 first\_date\_str="2000-01-06",  
 last\_date\_str="2019-12-31",  
 n=3,  
 col\_name="UNITED KINGDOM - UNITED KINGDOM POUND/US$")  
windowed\_df\_united\_kingdom  
```

|  | Target Date | Target-3 | Target-2 | Target-1 | Target |
| --- | --- | --- | --- | --- | --- |
| 0 | 2000-01-06 | 0.61 | 0.61 | 0.61 | 0.61 |
| 1 | 2000-01-07 | 0.61 | 0.61 | 0.61 | 0.61 |
| 2 | 2000-01-10 | 0.61 | 0.61 | 0.61 | 0.61 |
| 3 | 2000-01-11 | 0.61 | 0.61 | 0.61 | 0.61 |
| 4 | 2000-01-12 | 0.61 | 0.61 | 0.61 | 0.61 |
| ... | ... | ... | ... | ... | ... |
| 5011 | 2019-12-24 | 0.77 | 0.77 | 0.77 | 0.77 |
| 5012 | 2019-12-26 | 0.77 | 0.77 | 0.77 | 0.77 |
| 5013 | 2019-12-27 | 0.77 | 0.77 | 0.77 | 0.76 |
| 5014 | 2019-12-30 | 0.77 | 0.77 | 0.76 | 0.76 |
| 5015 | 2019-12-31 | 0.77 | 0.76 | 0.76 | 0.75 |

```{python}  
# Convert Switzerland's dataframe to a windowed dataframe  
windowed\_df\_switzerland = df\_to\_windowed\_df(data\_frame=df,   
 first\_date\_str="2000-01-06",  
 last\_date\_str="2019-12-31",  
 n=3,  
 col\_name="SWITZERLAND - FRANC/US$")  
windowed\_df\_switzerland  
```

|  | Target Date | Target-3 | Target-2 | Target-1 | Target |
| --- | --- | --- | --- | --- | --- |
| 0 | 2000-01-06 | 1.58 | 1.56 | 1.55 | 1.55 |
| 1 | 2000-01-07 | 1.56 | 1.55 | 1.55 | 1.56 |
| 2 | 2000-01-10 | 1.55 | 1.55 | 1.56 | 1.57 |
| 3 | 2000-01-11 | 1.55 | 1.56 | 1.57 | 1.56 |
| 4 | 2000-01-12 | 1.56 | 1.57 | 1.56 | 1.57 |
| ... | ... | ... | ... | ... | ... |
| 5011 | 2019-12-24 | 0.98 | 0.98 | 0.98 | 0.98 |
| 5012 | 2019-12-26 | 0.98 | 0.98 | 0.98 | 0.98 |
| 5013 | 2019-12-27 | 0.98 | 0.98 | 0.98 | 0.97 |
| 5014 | 2019-12-30 | 0.98 | 0.98 | 0.97 | 0.97 |
| 5015 | 2019-12-31 | 0.98 | 0.97 | 0.97 | 0.97 |

As the Machine Learning model that will be used later in this blog post only accepts numpy arrays, we need to extract each of the following quantities from each respective country’s dataframe: the dates as an np.array, the X-values for input as an 3-dimensional np.array, and the Y-values for output as an np.array. Thus, with some online references, our codebase now has a function called windowed\_df\_to\_date\_X\_y as shown below to account for this needed transformation.

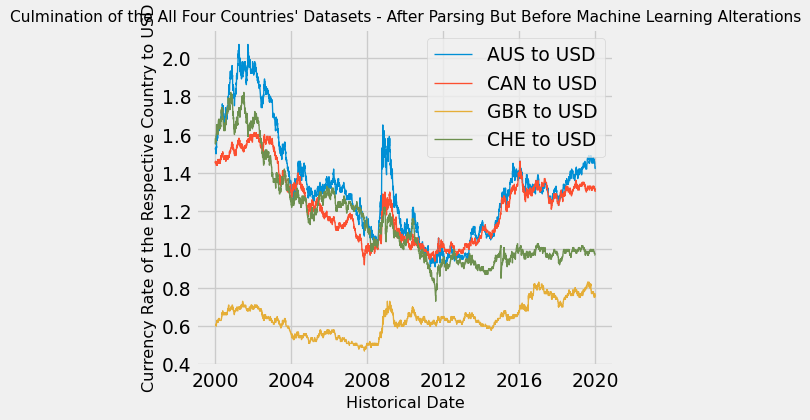
```{python}  
def windowed\_df\_to\_date\_X\_y(windowed\_dataframe: pd.DataFrame):  
 df\_as\_np = windowed\_dataframe.to\_numpy()  
   
 dates = df\_as\_np[:, 0]  
   
 middle\_matrix = df\_as\_np[:, 1:-1]  
 X = middle\_matrix.reshape((len(dates), middle\_matrix.shape[1], 1))  
 Y = df\_as\_np[:, -1]  
   
 return dates, X.astype(np.float32), Y.astype(np.float32)  
  
dates\_austrailia, X\_austrailia, y\_austrailia = windowed\_df\_to\_date\_X\_y(windowed\_dataframe=windowed\_df\_austrailia)  
dates\_canada, X\_canada, y\_canada = windowed\_df\_to\_date\_X\_y(windowed\_dataframe=windowed\_df\_canada)  
dates\_united\_kingdom, X\_united\_kingdom, y\_united\_kingdom = windowed\_df\_to\_date\_X\_y(windowed\_dataframe=windowed\_df\_united\_kingdom)  
dates\_switzerland, X\_switzerland, y\_switzerland = windowed\_df\_to\_date\_X\_y(windowed\_dataframe=windowed\_df\_switzerland)  
  
print(dates\_austrailia.shape, X\_austrailia.shape, y\_austrailia.shape)  
print(dates\_canada.shape, X\_canada.shape, y\_canada.shape)  
print(dates\_united\_kingdom.shape, X\_united\_kingdom.shape, y\_united\_kingdom.shape)  
print(dates\_switzerland.shape, X\_switzerland.shape, y\_switzerland.shape)  
len(windowed\_df\_austrailia), len(windowed\_df\_canada), len(windowed\_df\_united\_kingdom), len(windowed\_df\_switzerland)  
```

(5016,) (5016, 3, 1) (5016,)  
(5016,) (5016, 3, 1) (5016,)  
(5016,) (5016, 3, 1) (5016,)  
(5016,) (5016, 3, 1) (5016,)

(5016, 5016, 5016, 5016)

Here, I am trying to a visualization of the cleaned dataset before we pass it over for Machine Learning training and prediction. To show the rate of change for the International Currency Rates for Austrailia, Canada, the United Kingdom, and Switzerland over the 20-year period as collected in the data set, I put together a line graph as shown below.

```{python}  
# Plotting the each four countries currency rates (per US dollar) from   
# 2000 - 2020  
plt.plot(df.index, df["AUSTRALIA - AUSTRALIAN DOLLAR/US$"], label="AUS to USD", linewidth=1)  
plt.plot(df.index, df[ "CANADA - CANADIAN DOLLAR/US$"], label="CAN to USD", linewidth=1)  
plt.plot(df.index, df["UNITED KINGDOM - UNITED KINGDOM POUND/US$"], label="GBR to USD", linewidth=1)  
plt.plot(df.index, df["SWITZERLAND - FRANC/US$"], label="CHE to USD", linewidth=1)  
  
plt.legend(loc="upper right")  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date", fontsize=12)  
plt.ylabel("Currency Rate of the Respective Country to USD", fontsize=12)  
plt.title("Culmination of the All Four Countries' Datasets - After Parsing But Before Machine Learning Alterations")  
plt.show()  
```



## Machine Learning - Model Training and Evaluation

Great, now we are onto the Machine Learning part of the blog post!

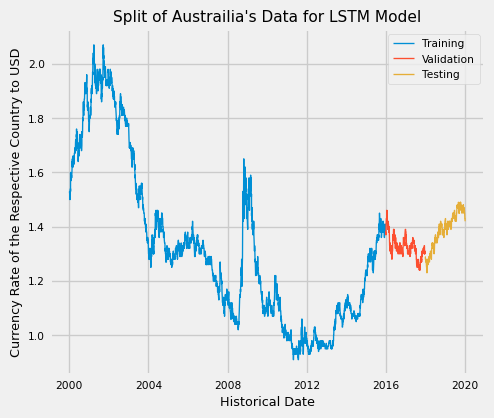
For this blog post, I worked to create Machine Learning models for each country’s dataset separately. I started with Austrailia’s data first (as shown below):

```{python}  
# Getting the location of the 80th and 90th percentile of the number of points   
# in the dataset for later train, vailidation, and test category splitting  
percentile\_80 = int(len(windowed\_df\_austrailia) \* 0.8)  
percentile\_90 = int(len(windowed\_df\_austrailia) \* 0.9)  
percentile\_80, percentile\_90  
```

(4012, 4514)

Since the data (date, X, and y) is split into three np.arrays and to be more efficient, I will manually split Austrailia’s data into train, test, and validation datasets for the Machine Learning model with 80% going to the training dataset, the next 10% going to the validation dataset, and the last 10% going to the test dataset for each np.array respectively. This split should be acceptable because I did not mix-and-match training & validation datasets with my testing datasets, wihch would invalidate my entire Machine Learning model. Additionally, looking at the presented in the validation and testing datasets, the range of these respective datasets have been reached before in my training dataset, meaning I anticipated my model should be able to reasonably predict these expected ranges with considerable accuracy.

```{python}  
# Splitting Austrailia's data into train, test, and validation sets on 3   
# mediums: the X-axis, the y-axis, and the indices (represented by dates)  
dates\_austrailia\_train, X\_austrailia\_train, y\_austrailia\_train = dates\_austrailia[:percentile\_80], X\_austrailia[:percentile\_80], y\_austrailia[:percentile\_80]  
dates\_austrailia\_val, X\_austrailia\_val, y\_austrailia\_val = dates\_austrailia[percentile\_80:percentile\_90], X\_austrailia[percentile\_80:percentile\_90], y\_austrailia[percentile\_80:percentile\_90]  
dates\_austrailia\_test, X\_austrailia\_test, y\_austrailia\_test = dates\_austrailia[percentile\_90:], X\_austrailia[percentile\_90:], y\_austrailia[percentile\_90:]  
  
plt.plot(dates\_austrailia\_train, y\_austrailia\_train, linewidth=1)  
plt.plot(dates\_austrailia\_val, y\_austrailia\_val, linewidth=1)  
plt.plot(dates\_austrailia\_test, y\_austrailia\_test, linewidth=1)  
  
plt.legend(["Training", "Validation", "Testing"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Split of Austrailia's Data for LSTM Model")  
plt.show()  
```



Now, I began to configure the Machine Learning model. We added Sequential layers: an Input layer 3 by 1 because we will have 3 np.arrays of Input and 1 np.array as output, utilize a LSTM (Long Short-Term Memory) layer of 64 neurons, apply 2 levels of dense layers with 32 neurons and folliowing recommendations online to use the RELU (Rectified Linear Unit) Activiation Function, and I followed up with one last dense layer of 1 neuron as our output layer since we are just trying to linearly-predict the next currency-rate on a near-future date. Once I configured the Sequential layers, we are ready to compile the model, utilzing the mean\_square\_error as our minimizing loss function, using the Adam optimizer, and comparing our trained model against our data with the mean\_absolute\_error metric. Lastly, I fitted our model, utilzing our X\_train and Y\_train datasets for fitting with validation from our X\_valid and Y\_valid datasets at 100 epochs.

```{python}  
# Configuring the Machine Learning Tensorflow Model for Austrailia  
austrailia\_model = Sequential([layers.Input((3, 1)),  
 layers.LSTM(64),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(1)])  
  
austrailia\_model.compile(loss="mse",  
 optimizer=Adam(learning\_rate=0.001),  
 metrics=["mean\_absolute\_error"])  
  
austrailia\_model.fit(X\_austrailia\_train, y\_austrailia\_train, validation\_data=(X\_austrailia\_val, y\_austrailia\_val), epochs=100)  
```

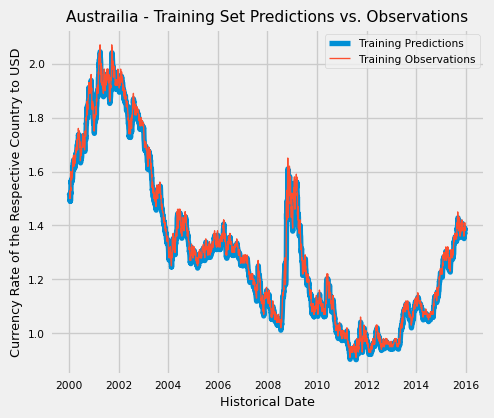
Epoch 1/100  
 1/126 [..............................] - ETA: 3:54 - loss: 1.7504 - mean\_absolute\_error: 1.2989 22/126 [====>.........................] - ETA: 0s - loss: 0.7051 - mean\_absolute\_error: 0.7393 44/126 [=========>....................] - ETA: 0s - loss: 0.3690 - mean\_absolute\_error: 0.4469 65/126 [==============>...............] - ETA: 0s - loss: 0.2531 - mean\_absolute\_error: 0.3281 85/126 [===================>..........] - ETA: 0s - loss: 0.1946 - mean\_absolute\_error: 0.2636105/126 [========================>.....] - ETA: 0s - loss: 0.1581 - mean\_absolute\_error: 0.2223124/126 [============================>.] - ETA: 0s - loss: 0.1342 - mean\_absolute\_error: 0.1945126/126 [==============================] - 3s 6ms/step - loss: 0.1328 - mean\_absolute\_error: 0.1928 - val\_loss: 3.1801e-04 - val\_mean\_absolute\_error: 0.0154  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0022 - mean\_absolute\_error: 0.0414 23/126 [====>.........................] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0383 46/126 [=========>....................] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0358 68/126 [===============>..............] - ETA: 0s - loss: 0.0016 - mean\_absolute\_error: 0.0332 89/126 [====================>.........] - ETA: 0s - loss: 0.0014 - mean\_absolute\_error: 0.0311110/126 [=========================>....] - ETA: 0s - loss: 0.0013 - mean\_absolute\_error: 0.0292126/126 [==============================] - 0s 3ms/step - loss: 0.0012 - mean\_absolute\_error: 0.0278 - val\_loss: 1.2740e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0274e-04 - mean\_absolute\_error: 0.0178 22/126 [====>.........................] - ETA: 0s - loss: 3.9816e-04 - mean\_absolute\_error: 0.0157 44/126 [=========>....................] - ETA: 0s - loss: 3.9253e-04 - mean\_absolute\_error: 0.0156 65/126 [==============>...............] - ETA: 0s - loss: 3.5873e-04 - mean\_absolute\_error: 0.0147 86/126 [===================>..........] - ETA: 0s - loss: 3.3910e-04 - mean\_absolute\_error: 0.0141107/126 [========================>.....] - ETA: 0s - loss: 3.2320e-04 - mean\_absolute\_error: 0.0138126/126 [==============================] - 0s 3ms/step - loss: 3.1817e-04 - mean\_absolute\_error: 0.0136 - val\_loss: 1.2212e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8386e-04 - mean\_absolute\_error: 0.0155 22/126 [====>.........................] - ETA: 0s - loss: 2.4411e-04 - mean\_absolute\_error: 0.0116 43/126 [=========>....................] - ETA: 0s - loss: 2.2498e-04 - mean\_absolute\_error: 0.0112 65/126 [==============>...............] - ETA: 0s - loss: 2.3937e-04 - mean\_absolute\_error: 0.0114 86/126 [===================>..........] - ETA: 0s - loss: 2.3879e-04 - mean\_absolute\_error: 0.0114107/126 [========================>.....] - ETA: 0s - loss: 2.4218e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4877e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.2806e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9977e-04 - mean\_absolute\_error: 0.0101 22/126 [====>.........................] - ETA: 0s - loss: 2.3389e-04 - mean\_absolute\_error: 0.0108 43/126 [=========>....................] - ETA: 0s - loss: 2.2013e-04 - mean\_absolute\_error: 0.0109 64/126 [==============>...............] - ETA: 0s - loss: 2.2760e-04 - mean\_absolute\_error: 0.0110 85/126 [===================>..........] - ETA: 0s - loss: 2.3006e-04 - mean\_absolute\_error: 0.0111107/126 [========================>.....] - ETA: 0s - loss: 2.3241e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4414e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.2255e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0122e-04 - mean\_absolute\_error: 0.0134 22/126 [====>.........................] - ETA: 0s - loss: 2.2784e-04 - mean\_absolute\_error: 0.0112 43/126 [=========>....................] - ETA: 0s - loss: 2.4462e-04 - mean\_absolute\_error: 0.0115 64/126 [==============>...............] - ETA: 0s - loss: 2.4737e-04 - mean\_absolute\_error: 0.0114 83/126 [==================>...........] - ETA: 0s - loss: 2.4734e-04 - mean\_absolute\_error: 0.0115104/126 [=======================>......] - ETA: 0s - loss: 2.5410e-04 - mean\_absolute\_error: 0.0115125/126 [============================>.] - ETA: 0s - loss: 2.5084e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5104e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.4902e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1151e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 2.7809e-04 - mean\_absolute\_error: 0.0118 43/126 [=========>....................] - ETA: 0s - loss: 2.6031e-04 - mean\_absolute\_error: 0.0116 63/126 [==============>...............] - ETA: 0s - loss: 2.4190e-04 - mean\_absolute\_error: 0.0113 83/126 [==================>...........] - ETA: 0s - loss: 2.3715e-04 - mean\_absolute\_error: 0.0112104/126 [=======================>......] - ETA: 0s - loss: 2.4216e-04 - mean\_absolute\_error: 0.0113125/126 [============================>.] - ETA: 0s - loss: 2.5071e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.5007e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.3574e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4671e-04 - mean\_absolute\_error: 0.0106 22/126 [====>.........................] - ETA: 0s - loss: 2.0948e-04 - mean\_absolute\_error: 0.0107 44/126 [=========>....................] - ETA: 0s - loss: 2.2387e-04 - mean\_absolute\_error: 0.0110 65/126 [==============>...............] - ETA: 0s - loss: 2.2529e-04 - mean\_absolute\_error: 0.0109 86/126 [===================>..........] - ETA: 0s - loss: 2.4422e-04 - mean\_absolute\_error: 0.0112107/126 [========================>.....] - ETA: 0s - loss: 2.4547e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4196e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.2080e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4492e-04 - mean\_absolute\_error: 0.0098 21/126 [====>.........................] - ETA: 0s - loss: 2.3564e-04 - mean\_absolute\_error: 0.0112 42/126 [=========>....................] - ETA: 0s - loss: 2.4667e-04 - mean\_absolute\_error: 0.0114 63/126 [==============>...............] - ETA: 0s - loss: 2.5094e-04 - mean\_absolute\_error: 0.0114 84/126 [===================>..........] - ETA: 0s - loss: 2.5751e-04 - mean\_absolute\_error: 0.0114105/126 [========================>.....] - ETA: 0s - loss: 2.5068e-04 - mean\_absolute\_error: 0.0114125/126 [============================>.] - ETA: 0s - loss: 2.4752e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4757e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1567e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6637e-04 - mean\_absolute\_error: 0.0112 23/126 [====>.........................] - ETA: 0s - loss: 2.3138e-04 - mean\_absolute\_error: 0.0111 43/126 [=========>....................] - ETA: 0s - loss: 2.5564e-04 - mean\_absolute\_error: 0.0114 64/126 [==============>...............] - ETA: 0s - loss: 2.4970e-04 - mean\_absolute\_error: 0.0113 86/126 [===================>..........] - ETA: 0s - loss: 2.5309e-04 - mean\_absolute\_error: 0.0114107/126 [========================>.....] - ETA: 0s - loss: 2.4696e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4625e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.3239e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2852e-04 - mean\_absolute\_error: 0.0155 22/126 [====>.........................] - ETA: 0s - loss: 2.4579e-04 - mean\_absolute\_error: 0.0115 42/126 [=========>....................] - ETA: 0s - loss: 2.5356e-04 - mean\_absolute\_error: 0.0112 63/126 [==============>...............] - ETA: 0s - loss: 2.5119e-04 - mean\_absolute\_error: 0.0113 84/126 [===================>..........] - ETA: 0s - loss: 2.4731e-04 - mean\_absolute\_error: 0.0112106/126 [========================>.....] - ETA: 0s - loss: 2.4907e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4592e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.3087e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3959e-04 - mean\_absolute\_error: 0.0095 21/126 [====>.........................] - ETA: 0s - loss: 2.1966e-04 - mean\_absolute\_error: 0.0113 41/126 [========>.....................] - ETA: 0s - loss: 2.1576e-04 - mean\_absolute\_error: 0.0110 62/126 [=============>................] - ETA: 0s - loss: 2.3059e-04 - mean\_absolute\_error: 0.0112 83/126 [==================>...........] - ETA: 0s - loss: 2.2695e-04 - mean\_absolute\_error: 0.0110104/126 [=======================>......] - ETA: 0s - loss: 2.3343e-04 - mean\_absolute\_error: 0.0111125/126 [============================>.] - ETA: 0s - loss: 2.3996e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4026e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.4499e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6429e-04 - mean\_absolute\_error: 0.0124 22/126 [====>.........................] - ETA: 0s - loss: 2.3896e-04 - mean\_absolute\_error: 0.0110 43/126 [=========>....................] - ETA: 0s - loss: 2.2269e-04 - mean\_absolute\_error: 0.0110 64/126 [==============>...............] - ETA: 0s - loss: 2.3635e-04 - mean\_absolute\_error: 0.0112 85/126 [===================>..........] - ETA: 0s - loss: 2.4706e-04 - mean\_absolute\_error: 0.0112105/126 [========================>.....] - ETA: 0s - loss: 2.4379e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4657e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.6922e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7364e-04 - mean\_absolute\_error: 0.0121 22/126 [====>.........................] - ETA: 0s - loss: 2.5326e-04 - mean\_absolute\_error: 0.0113 43/126 [=========>....................] - ETA: 0s - loss: 2.4760e-04 - mean\_absolute\_error: 0.0112 65/126 [==============>...............] - ETA: 0s - loss: 2.7446e-04 - mean\_absolute\_error: 0.0116 86/126 [===================>..........] - ETA: 0s - loss: 2.5721e-04 - mean\_absolute\_error: 0.0114107/126 [========================>.....] - ETA: 0s - loss: 2.4832e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4541e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.1932e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0091e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 2.6561e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 2.5043e-04 - mean\_absolute\_error: 0.0113 65/126 [==============>...............] - ETA: 0s - loss: 2.4393e-04 - mean\_absolute\_error: 0.0112 86/126 [===================>..........] - ETA: 0s - loss: 2.4863e-04 - mean\_absolute\_error: 0.0113106/126 [========================>.....] - ETA: 0s - loss: 2.4328e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4205e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 2.1312e-04 - val\_mean\_absolute\_error: 0.0118  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0087e-04 - mean\_absolute\_error: 0.0122 22/126 [====>.........................] - ETA: 0s - loss: 2.4965e-04 - mean\_absolute\_error: 0.0114 43/126 [=========>....................] - ETA: 0s - loss: 2.5825e-04 - mean\_absolute\_error: 0.0117 64/126 [==============>...............] - ETA: 0s - loss: 2.4517e-04 - mean\_absolute\_error: 0.0112 85/126 [===================>..........] - ETA: 0s - loss: 2.4124e-04 - mean\_absolute\_error: 0.0111106/126 [========================>.....] - ETA: 0s - loss: 2.4242e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - ETA: 0s - loss: 2.3869e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3869e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.4025e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8252e-04 - mean\_absolute\_error: 0.0106 22/126 [====>.........................] - ETA: 0s - loss: 2.0055e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 2.5170e-04 - mean\_absolute\_error: 0.0116 64/126 [==============>...............] - ETA: 0s - loss: 2.4613e-04 - mean\_absolute\_error: 0.0112 86/126 [===================>..........] - ETA: 0s - loss: 2.3946e-04 - mean\_absolute\_error: 0.0111107/126 [========================>.....] - ETA: 0s - loss: 2.4732e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.5263e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 2.4092e-04 - val\_mean\_absolute\_error: 0.0127  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1486e-04 - mean\_absolute\_error: 0.0118 22/126 [====>.........................] - ETA: 0s - loss: 2.2794e-04 - mean\_absolute\_error: 0.0110 42/126 [=========>....................] - ETA: 0s - loss: 2.2834e-04 - mean\_absolute\_error: 0.0109 65/126 [==============>...............] - ETA: 0s - loss: 2.2694e-04 - mean\_absolute\_error: 0.0109 86/126 [===================>..........] - ETA: 0s - loss: 2.2713e-04 - mean\_absolute\_error: 0.0109107/126 [========================>.....] - ETA: 0s - loss: 2.3281e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3754e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 2.0635e-04 - val\_mean\_absolute\_error: 0.0115  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9661e-04 - mean\_absolute\_error: 0.0108 22/126 [====>.........................] - ETA: 0s - loss: 2.1978e-04 - mean\_absolute\_error: 0.0112 43/126 [=========>....................] - ETA: 0s - loss: 2.1695e-04 - mean\_absolute\_error: 0.0110 63/126 [==============>...............] - ETA: 0s - loss: 2.3072e-04 - mean\_absolute\_error: 0.0110 84/126 [===================>..........] - ETA: 0s - loss: 2.2825e-04 - mean\_absolute\_error: 0.0110105/126 [========================>.....] - ETA: 0s - loss: 2.5577e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5436e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2020e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0830e-04 - mean\_absolute\_error: 0.0110 21/126 [====>.........................] - ETA: 0s - loss: 1.9617e-04 - mean\_absolute\_error: 0.0105 43/126 [=========>....................] - ETA: 0s - loss: 2.3246e-04 - mean\_absolute\_error: 0.0112 64/126 [==============>...............] - ETA: 0s - loss: 2.3494e-04 - mean\_absolute\_error: 0.0111 84/126 [===================>..........] - ETA: 0s - loss: 2.2969e-04 - mean\_absolute\_error: 0.0111105/126 [========================>.....] - ETA: 0s - loss: 2.3585e-04 - mean\_absolute\_error: 0.0110125/126 [============================>.] - ETA: 0s - loss: 2.3571e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3541e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.1644e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8067e-04 - mean\_absolute\_error: 0.0107 22/126 [====>.........................] - ETA: 0s - loss: 2.2160e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 2.5234e-04 - mean\_absolute\_error: 0.0112 64/126 [==============>...............] - ETA: 0s - loss: 2.3405e-04 - mean\_absolute\_error: 0.0109 85/126 [===================>..........] - ETA: 0s - loss: 2.3759e-04 - mean\_absolute\_error: 0.0111106/126 [========================>.....] - ETA: 0s - loss: 2.3035e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.4432e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 2.0067e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4467e-04 - mean\_absolute\_error: 0.0150 22/126 [====>.........................] - ETA: 0s - loss: 2.6571e-04 - mean\_absolute\_error: 0.0122 42/126 [=========>....................] - ETA: 0s - loss: 2.6019e-04 - mean\_absolute\_error: 0.0120 63/126 [==============>...............] - ETA: 0s - loss: 2.6892e-04 - mean\_absolute\_error: 0.0118 83/126 [==================>...........] - ETA: 0s - loss: 2.5753e-04 - mean\_absolute\_error: 0.0115103/126 [=======================>......] - ETA: 0s - loss: 2.5221e-04 - mean\_absolute\_error: 0.0115124/126 [============================>.] - ETA: 0s - loss: 2.4129e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4264e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.3172e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6559e-04 - mean\_absolute\_error: 0.0099 21/126 [====>.........................] - ETA: 0s - loss: 2.4900e-04 - mean\_absolute\_error: 0.0116 42/126 [=========>....................] - ETA: 0s - loss: 2.3703e-04 - mean\_absolute\_error: 0.0111 63/126 [==============>...............] - ETA: 0s - loss: 2.1927e-04 - mean\_absolute\_error: 0.0109 83/126 [==================>...........] - ETA: 0s - loss: 2.3142e-04 - mean\_absolute\_error: 0.0111103/126 [=======================>......] - ETA: 0s - loss: 2.5015e-04 - mean\_absolute\_error: 0.0114124/126 [============================>.] - ETA: 0s - loss: 2.5035e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5102e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.3082e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2485e-04 - mean\_absolute\_error: 0.0115 23/126 [====>.........................] - ETA: 0s - loss: 2.1178e-04 - mean\_absolute\_error: 0.0108 43/126 [=========>....................] - ETA: 0s - loss: 2.2287e-04 - mean\_absolute\_error: 0.0111 63/126 [==============>...............] - ETA: 0s - loss: 2.3043e-04 - mean\_absolute\_error: 0.0114 85/126 [===================>..........] - ETA: 0s - loss: 2.4929e-04 - mean\_absolute\_error: 0.0117105/126 [========================>.....] - ETA: 0s - loss: 2.5486e-04 - mean\_absolute\_error: 0.0118125/126 [============================>.] - ETA: 0s - loss: 2.5195e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5168e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.3175e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0120e-04 - mean\_absolute\_error: 0.0120 22/126 [====>.........................] - ETA: 0s - loss: 2.0813e-04 - mean\_absolute\_error: 0.0108 43/126 [=========>....................] - ETA: 0s - loss: 2.1474e-04 - mean\_absolute\_error: 0.0108 64/126 [==============>...............] - ETA: 0s - loss: 2.3176e-04 - mean\_absolute\_error: 0.0111 86/126 [===================>..........] - ETA: 0s - loss: 2.5574e-04 - mean\_absolute\_error: 0.0116107/126 [========================>.....] - ETA: 0s - loss: 2.5780e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.4453e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1519e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8898e-04 - mean\_absolute\_error: 0.0103 22/126 [====>.........................] - ETA: 0s - loss: 2.4889e-04 - mean\_absolute\_error: 0.0112 43/126 [=========>....................] - ETA: 0s - loss: 2.4790e-04 - mean\_absolute\_error: 0.0112 64/126 [==============>...............] - ETA: 0s - loss: 2.3322e-04 - mean\_absolute\_error: 0.0110 85/126 [===================>..........] - ETA: 0s - loss: 2.3924e-04 - mean\_absolute\_error: 0.0110105/126 [========================>.....] - ETA: 0s - loss: 2.3446e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - ETA: 0s - loss: 2.4304e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4304e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.2386e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5635e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 2.9717e-04 - mean\_absolute\_error: 0.0121 43/126 [=========>....................] - ETA: 0s - loss: 3.0112e-04 - mean\_absolute\_error: 0.0121 64/126 [==============>...............] - ETA: 0s - loss: 2.8139e-04 - mean\_absolute\_error: 0.0120 85/126 [===================>..........] - ETA: 0s - loss: 2.6135e-04 - mean\_absolute\_error: 0.0116106/126 [========================>.....] - ETA: 0s - loss: 2.5728e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5136e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.3859e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2987e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 2.4952e-04 - mean\_absolute\_error: 0.0112 44/126 [=========>....................] - ETA: 0s - loss: 2.5777e-04 - mean\_absolute\_error: 0.0115 65/126 [==============>...............] - ETA: 0s - loss: 2.4830e-04 - mean\_absolute\_error: 0.0112 86/126 [===================>..........] - ETA: 0s - loss: 2.4163e-04 - mean\_absolute\_error: 0.0112108/126 [========================>.....] - ETA: 0s - loss: 2.3408e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3380e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.1242e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 6.0985e-04 - mean\_absolute\_error: 0.0121 21/126 [====>.........................] - ETA: 0s - loss: 2.7714e-04 - mean\_absolute\_error: 0.0111 42/126 [=========>....................] - ETA: 0s - loss: 2.6699e-04 - mean\_absolute\_error: 0.0112 62/126 [=============>................] - ETA: 0s - loss: 2.5124e-04 - mean\_absolute\_error: 0.0111 82/126 [==================>...........] - ETA: 0s - loss: 2.3696e-04 - mean\_absolute\_error: 0.0109103/126 [=======================>......] - ETA: 0s - loss: 2.3025e-04 - mean\_absolute\_error: 0.0109124/126 [============================>.] - ETA: 0s - loss: 2.4005e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.4036e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.6606e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8111e-04 - mean\_absolute\_error: 0.0117 22/126 [====>.........................] - ETA: 0s - loss: 3.0846e-04 - mean\_absolute\_error: 0.0130 42/126 [=========>....................] - ETA: 0s - loss: 2.6602e-04 - mean\_absolute\_error: 0.0119 62/126 [=============>................] - ETA: 0s - loss: 2.3805e-04 - mean\_absolute\_error: 0.0113 83/126 [==================>...........] - ETA: 0s - loss: 2.3791e-04 - mean\_absolute\_error: 0.0112104/126 [=======================>......] - ETA: 0s - loss: 2.3831e-04 - mean\_absolute\_error: 0.0113124/126 [============================>.] - ETA: 0s - loss: 2.3479e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3494e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.1295e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4955e-04 - mean\_absolute\_error: 0.0132 22/126 [====>.........................] - ETA: 0s - loss: 2.2430e-04 - mean\_absolute\_error: 0.0110 43/126 [=========>....................] - ETA: 0s - loss: 2.2348e-04 - mean\_absolute\_error: 0.0111 64/126 [==============>...............] - ETA: 0s - loss: 2.3246e-04 - mean\_absolute\_error: 0.0113 85/126 [===================>..........] - ETA: 0s - loss: 2.5038e-04 - mean\_absolute\_error: 0.0115106/126 [========================>.....] - ETA: 0s - loss: 2.5945e-04 - mean\_absolute\_error: 0.0117125/126 [============================>.] - ETA: 0s - loss: 2.5389e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5340e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 2.8083e-04 - val\_mean\_absolute\_error: 0.0143  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9763e-04 - mean\_absolute\_error: 0.0164 22/126 [====>.........................] - ETA: 0s - loss: 2.6724e-04 - mean\_absolute\_error: 0.0119 42/126 [=========>....................] - ETA: 0s - loss: 2.4635e-04 - mean\_absolute\_error: 0.0111 62/126 [=============>................] - ETA: 0s - loss: 2.5661e-04 - mean\_absolute\_error: 0.0116 82/126 [==================>...........] - ETA: 0s - loss: 2.6193e-04 - mean\_absolute\_error: 0.0118103/126 [=======================>......] - ETA: 0s - loss: 2.7812e-04 - mean\_absolute\_error: 0.0120124/126 [============================>.] - ETA: 0s - loss: 2.7269e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.7434e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.1141e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5885e-05 - mean\_absolute\_error: 0.0076 22/126 [====>.........................] - ETA: 0s - loss: 3.0687e-04 - mean\_absolute\_error: 0.0126 43/126 [=========>....................] - ETA: 0s - loss: 2.9361e-04 - mean\_absolute\_error: 0.0124 64/126 [==============>...............] - ETA: 0s - loss: 2.8197e-04 - mean\_absolute\_error: 0.0122 85/126 [===================>..........] - ETA: 0s - loss: 2.7089e-04 - mean\_absolute\_error: 0.0120106/126 [========================>.....] - ETA: 0s - loss: 2.5840e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5841e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.2061e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8978e-04 - mean\_absolute\_error: 0.0154 22/126 [====>.........................] - ETA: 0s - loss: 3.0440e-04 - mean\_absolute\_error: 0.0128 43/126 [=========>....................] - ETA: 0s - loss: 2.7492e-04 - mean\_absolute\_error: 0.0121 64/126 [==============>...............] - ETA: 0s - loss: 2.5397e-04 - mean\_absolute\_error: 0.0116 85/126 [===================>..........] - ETA: 0s - loss: 2.3811e-04 - mean\_absolute\_error: 0.0113106/126 [========================>.....] - ETA: 0s - loss: 2.5013e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4635e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.4028e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6348e-04 - mean\_absolute\_error: 0.0127 21/126 [====>.........................] - ETA: 0s - loss: 2.2275e-04 - mean\_absolute\_error: 0.0109 42/126 [=========>....................] - ETA: 0s - loss: 2.1367e-04 - mean\_absolute\_error: 0.0108 62/126 [=============>................] - ETA: 0s - loss: 2.2015e-04 - mean\_absolute\_error: 0.0110 83/126 [==================>...........] - ETA: 0s - loss: 2.3533e-04 - mean\_absolute\_error: 0.0114103/126 [=======================>......] - ETA: 0s - loss: 2.4916e-04 - mean\_absolute\_error: 0.0118124/126 [============================>.] - ETA: 0s - loss: 2.6265e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6298e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.5360e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5110e-04 - mean\_absolute\_error: 0.0099 22/126 [====>.........................] - ETA: 0s - loss: 2.0879e-04 - mean\_absolute\_error: 0.0108 43/126 [=========>....................] - ETA: 0s - loss: 2.1206e-04 - mean\_absolute\_error: 0.0111 64/126 [==============>...............] - ETA: 0s - loss: 2.4691e-04 - mean\_absolute\_error: 0.0116 85/126 [===================>..........] - ETA: 0s - loss: 2.8639e-04 - mean\_absolute\_error: 0.0124105/126 [========================>.....] - ETA: 0s - loss: 2.6590e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - ETA: 0s - loss: 2.7379e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.7379e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.6206e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4770e-04 - mean\_absolute\_error: 0.0120 22/126 [====>.........................] - ETA: 0s - loss: 2.9988e-04 - mean\_absolute\_error: 0.0127 43/126 [=========>....................] - ETA: 0s - loss: 2.9544e-04 - mean\_absolute\_error: 0.0128 63/126 [==============>...............] - ETA: 0s - loss: 2.9665e-04 - mean\_absolute\_error: 0.0128 83/126 [==================>...........] - ETA: 0s - loss: 2.8561e-04 - mean\_absolute\_error: 0.0127103/126 [=======================>......] - ETA: 0s - loss: 2.7141e-04 - mean\_absolute\_error: 0.0123122/126 [============================>.] - ETA: 0s - loss: 2.6503e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.6861e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.0950e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3600e-05 - mean\_absolute\_error: 0.0070 20/126 [===>..........................] - ETA: 0s - loss: 2.3272e-04 - mean\_absolute\_error: 0.0108 40/126 [========>.....................] - ETA: 0s - loss: 2.7930e-04 - mean\_absolute\_error: 0.0122 61/126 [=============>................] - ETA: 0s - loss: 2.6190e-04 - mean\_absolute\_error: 0.0117 82/126 [==================>...........] - ETA: 0s - loss: 2.5205e-04 - mean\_absolute\_error: 0.0114103/126 [=======================>......] - ETA: 0s - loss: 2.4779e-04 - mean\_absolute\_error: 0.0113124/126 [============================>.] - ETA: 0s - loss: 2.4886e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.5094e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.1547e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5812e-05 - mean\_absolute\_error: 0.0069 22/126 [====>.........................] - ETA: 0s - loss: 3.0238e-04 - mean\_absolute\_error: 0.0128 43/126 [=========>....................] - ETA: 0s - loss: 2.8560e-04 - mean\_absolute\_error: 0.0124 63/126 [==============>...............] - ETA: 0s - loss: 3.0499e-04 - mean\_absolute\_error: 0.0130 84/126 [===================>..........] - ETA: 0s - loss: 2.8507e-04 - mean\_absolute\_error: 0.0126104/126 [=======================>......] - ETA: 0s - loss: 2.7306e-04 - mean\_absolute\_error: 0.0122125/126 [============================>.] - ETA: 0s - loss: 2.7281e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.7394e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.6004e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6095e-04 - mean\_absolute\_error: 0.0148 22/126 [====>.........................] - ETA: 0s - loss: 2.4059e-04 - mean\_absolute\_error: 0.0119 42/126 [=========>....................] - ETA: 0s - loss: 2.2827e-04 - mean\_absolute\_error: 0.0112 63/126 [==============>...............] - ETA: 0s - loss: 2.4070e-04 - mean\_absolute\_error: 0.0112 82/126 [==================>...........] - ETA: 0s - loss: 2.3977e-04 - mean\_absolute\_error: 0.0113102/126 [=======================>......] - ETA: 0s - loss: 2.3456e-04 - mean\_absolute\_error: 0.0112122/126 [============================>.] - ETA: 0s - loss: 2.3283e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3857e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.4494e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7848e-04 - mean\_absolute\_error: 0.0128 22/126 [====>.........................] - ETA: 0s - loss: 3.1548e-04 - mean\_absolute\_error: 0.0137 42/126 [=========>....................] - ETA: 0s - loss: 3.0900e-04 - mean\_absolute\_error: 0.0134 62/126 [=============>................] - ETA: 0s - loss: 3.1104e-04 - mean\_absolute\_error: 0.0131 82/126 [==================>...........] - ETA: 0s - loss: 2.9786e-04 - mean\_absolute\_error: 0.0127103/126 [=======================>......] - ETA: 0s - loss: 2.7987e-04 - mean\_absolute\_error: 0.0123123/126 [============================>.] - ETA: 0s - loss: 2.6667e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.6609e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 2.7533e-04 - val\_mean\_absolute\_error: 0.0142  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4000e-04 - mean\_absolute\_error: 0.0165 23/126 [====>.........................] - ETA: 0s - loss: 2.6756e-04 - mean\_absolute\_error: 0.0128 44/126 [=========>....................] - ETA: 0s - loss: 2.9732e-04 - mean\_absolute\_error: 0.0131 65/126 [==============>...............] - ETA: 0s - loss: 2.6770e-04 - mean\_absolute\_error: 0.0124 86/126 [===================>..........] - ETA: 0s - loss: 2.6380e-04 - mean\_absolute\_error: 0.0121107/126 [========================>.....] - ETA: 0s - loss: 2.9260e-04 - mean\_absolute\_error: 0.0127126/126 [==============================] - 0s 3ms/step - loss: 2.8637e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.2653e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6022e-05 - mean\_absolute\_error: 0.0080 22/126 [====>.........................] - ETA: 0s - loss: 2.7365e-04 - mean\_absolute\_error: 0.0114 41/126 [========>.....................] - ETA: 0s - loss: 2.5215e-04 - mean\_absolute\_error: 0.0112 62/126 [=============>................] - ETA: 0s - loss: 2.3880e-04 - mean\_absolute\_error: 0.0110 83/126 [==================>...........] - ETA: 0s - loss: 2.5134e-04 - mean\_absolute\_error: 0.0114104/126 [=======================>......] - ETA: 0s - loss: 2.4820e-04 - mean\_absolute\_error: 0.0113124/126 [============================>.] - ETA: 0s - loss: 2.3620e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3548e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.5099e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2565e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 2.8969e-04 - mean\_absolute\_error: 0.0123 43/126 [=========>....................] - ETA: 0s - loss: 3.2195e-04 - mean\_absolute\_error: 0.0133 64/126 [==============>...............] - ETA: 0s - loss: 3.3940e-04 - mean\_absolute\_error: 0.0138 85/126 [===================>..........] - ETA: 0s - loss: 3.0472e-04 - mean\_absolute\_error: 0.0131106/126 [========================>.....] - ETA: 0s - loss: 2.9156e-04 - mean\_absolute\_error: 0.0127126/126 [==============================] - 0s 3ms/step - loss: 3.0325e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 8.9295e-04 - val\_mean\_absolute\_error: 0.0280  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0012 - mean\_absolute\_error: 0.0326 22/126 [====>.........................] - ETA: 0s - loss: 4.6540e-04 - mean\_absolute\_error: 0.0162 43/126 [=========>....................] - ETA: 0s - loss: 3.6127e-04 - mean\_absolute\_error: 0.0139 64/126 [==============>...............] - ETA: 0s - loss: 3.0998e-04 - mean\_absolute\_error: 0.0128 85/126 [===================>..........] - ETA: 0s - loss: 2.9623e-04 - mean\_absolute\_error: 0.0125107/126 [========================>.....] - ETA: 0s - loss: 2.8425e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.9122e-04 - mean\_absolute\_error: 0.0124 - val\_loss: 1.0734e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1182e-04 - mean\_absolute\_error: 0.0123 21/126 [====>.........................] - ETA: 0s - loss: 4.6452e-04 - mean\_absolute\_error: 0.0173 42/126 [=========>....................] - ETA: 0s - loss: 3.8712e-04 - mean\_absolute\_error: 0.0153 63/126 [==============>...............] - ETA: 0s - loss: 3.4784e-04 - mean\_absolute\_error: 0.0146 84/126 [===================>..........] - ETA: 0s - loss: 3.5587e-04 - mean\_absolute\_error: 0.0145103/126 [=======================>......] - ETA: 0s - loss: 3.3172e-04 - mean\_absolute\_error: 0.0139122/126 [============================>.] - ETA: 0s - loss: 3.1276e-04 - mean\_absolute\_error: 0.0133126/126 [==============================] - 0s 3ms/step - loss: 3.1416e-04 - mean\_absolute\_error: 0.0133 - val\_loss: 1.2077e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7837e-04 - mean\_absolute\_error: 0.0109 17/126 [===>..........................] - ETA: 0s - loss: 2.1774e-04 - mean\_absolute\_error: 0.0105 32/126 [======>.......................] - ETA: 0s - loss: 2.3210e-04 - mean\_absolute\_error: 0.0109 47/126 [==========>...................] - ETA: 0s - loss: 2.3878e-04 - mean\_absolute\_error: 0.0112 62/126 [=============>................] - ETA: 0s - loss: 2.4613e-04 - mean\_absolute\_error: 0.0114 78/126 [=================>............] - ETA: 0s - loss: 2.3841e-04 - mean\_absolute\_error: 0.0112 94/126 [=====================>........] - ETA: 0s - loss: 2.3679e-04 - mean\_absolute\_error: 0.0113111/126 [=========================>....] - ETA: 0s - loss: 2.3040e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 4ms/step - loss: 2.3665e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 3.3494e-04 - val\_mean\_absolute\_error: 0.0157  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9740e-04 - mean\_absolute\_error: 0.0141 19/126 [===>..........................] - ETA: 0s - loss: 3.2958e-04 - mean\_absolute\_error: 0.0140 37/126 [=======>......................] - ETA: 0s - loss: 3.3981e-04 - mean\_absolute\_error: 0.0141 56/126 [============>.................] - ETA: 0s - loss: 2.9691e-04 - mean\_absolute\_error: 0.0129 75/126 [================>.............] - ETA: 0s - loss: 2.6994e-04 - mean\_absolute\_error: 0.0122 93/126 [=====================>........] - ETA: 0s - loss: 2.6447e-04 - mean\_absolute\_error: 0.0120111/126 [=========================>....] - ETA: 0s - loss: 2.6178e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6377e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 5.5865e-04 - val\_mean\_absolute\_error: 0.0215  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8229e-04 - mean\_absolute\_error: 0.0195 19/126 [===>..........................] - ETA: 0s - loss: 3.9936e-04 - mean\_absolute\_error: 0.0157 37/126 [=======>......................] - ETA: 0s - loss: 3.6841e-04 - mean\_absolute\_error: 0.0147 55/126 [============>.................] - ETA: 0s - loss: 3.3537e-04 - mean\_absolute\_error: 0.0139 75/126 [================>.............] - ETA: 0s - loss: 3.2229e-04 - mean\_absolute\_error: 0.0137 91/126 [====================>.........] - ETA: 0s - loss: 3.0995e-04 - mean\_absolute\_error: 0.0134105/126 [========================>.....] - ETA: 0s - loss: 3.0199e-04 - mean\_absolute\_error: 0.0131117/126 [==========================>...] - ETA: 0s - loss: 2.9828e-04 - mean\_absolute\_error: 0.0130126/126 [==============================] - 0s 4ms/step - loss: 2.9401e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 2.4341e-04 - val\_mean\_absolute\_error: 0.0132  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6852e-04 - mean\_absolute\_error: 0.0168 9/126 [=>............................] - ETA: 0s - loss: 2.5844e-04 - mean\_absolute\_error: 0.0125 15/126 [==>...........................] - ETA: 0s - loss: 3.1864e-04 - mean\_absolute\_error: 0.0133 26/126 [=====>........................] - ETA: 0s - loss: 3.2997e-04 - mean\_absolute\_error: 0.0135 36/126 [=======>......................] - ETA: 0s - loss: 3.2553e-04 - mean\_absolute\_error: 0.0132 48/126 [==========>...................] - ETA: 0s - loss: 3.2091e-04 - mean\_absolute\_error: 0.0132 62/126 [=============>................] - ETA: 0s - loss: 2.9558e-04 - mean\_absolute\_error: 0.0127 81/126 [==================>...........] - ETA: 0s - loss: 3.0529e-04 - mean\_absolute\_error: 0.0129 98/126 [======================>.......] - ETA: 0s - loss: 3.0664e-04 - mean\_absolute\_error: 0.0131113/126 [=========================>....] - ETA: 0s - loss: 3.0375e-04 - mean\_absolute\_error: 0.0132126/126 [==============================] - 1s 5ms/step - loss: 3.0231e-04 - mean\_absolute\_error: 0.0131 - val\_loss: 1.3309e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3150e-04 - mean\_absolute\_error: 0.0100 17/126 [===>..........................] - ETA: 0s - loss: 2.7172e-04 - mean\_absolute\_error: 0.0124 33/126 [======>.......................] - ETA: 0s - loss: 2.5493e-04 - mean\_absolute\_error: 0.0121 47/126 [==========>...................] - ETA: 0s - loss: 2.4760e-04 - mean\_absolute\_error: 0.0119 64/126 [==============>...............] - ETA: 0s - loss: 2.5223e-04 - mean\_absolute\_error: 0.0117 83/126 [==================>...........] - ETA: 0s - loss: 2.4654e-04 - mean\_absolute\_error: 0.0115103/126 [=======================>......] - ETA: 0s - loss: 2.4839e-04 - mean\_absolute\_error: 0.0116123/126 [============================>.] - ETA: 0s - loss: 2.4339e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4666e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.0562e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2931e-04 - mean\_absolute\_error: 0.0102 17/126 [===>..........................] - ETA: 0s - loss: 1.8342e-04 - mean\_absolute\_error: 0.0100 34/126 [=======>......................] - ETA: 0s - loss: 2.0938e-04 - mean\_absolute\_error: 0.0104 53/126 [===========>..................] - ETA: 0s - loss: 2.0490e-04 - mean\_absolute\_error: 0.0103 72/126 [================>.............] - ETA: 0s - loss: 2.1710e-04 - mean\_absolute\_error: 0.0105 88/126 [===================>..........] - ETA: 0s - loss: 2.2088e-04 - mean\_absolute\_error: 0.0107103/126 [=======================>......] - ETA: 0s - loss: 2.2958e-04 - mean\_absolute\_error: 0.0109118/126 [===========================>..] - ETA: 0s - loss: 2.3290e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3237e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.1641e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3970e-04 - mean\_absolute\_error: 0.0090 19/126 [===>..........................] - ETA: 0s - loss: 2.4599e-04 - mean\_absolute\_error: 0.0115 38/126 [========>.....................] - ETA: 0s - loss: 2.5730e-04 - mean\_absolute\_error: 0.0119 57/126 [============>.................] - ETA: 0s - loss: 2.7447e-04 - mean\_absolute\_error: 0.0125 75/126 [================>.............] - ETA: 0s - loss: 2.7754e-04 - mean\_absolute\_error: 0.0124 94/126 [=====================>........] - ETA: 0s - loss: 2.5939e-04 - mean\_absolute\_error: 0.0120113/126 [=========================>....] - ETA: 0s - loss: 2.6114e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.5341e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.0587e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4700e-04 - mean\_absolute\_error: 0.0122 19/126 [===>..........................] - ETA: 0s - loss: 1.9310e-04 - mean\_absolute\_error: 0.0102 35/126 [=======>......................] - ETA: 0s - loss: 2.0552e-04 - mean\_absolute\_error: 0.0105 53/126 [===========>..................] - ETA: 0s - loss: 2.1799e-04 - mean\_absolute\_error: 0.0104 71/126 [===============>..............] - ETA: 0s - loss: 2.2294e-04 - mean\_absolute\_error: 0.0106 90/126 [====================>.........] - ETA: 0s - loss: 2.1835e-04 - mean\_absolute\_error: 0.0106109/126 [========================>.....] - ETA: 0s - loss: 2.2555e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.2487e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.1468e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3272e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 2.5936e-04 - mean\_absolute\_error: 0.0115 42/126 [=========>....................] - ETA: 0s - loss: 2.5415e-04 - mean\_absolute\_error: 0.0115 63/126 [==============>...............] - ETA: 0s - loss: 2.5104e-04 - mean\_absolute\_error: 0.0115 83/126 [==================>...........] - ETA: 0s - loss: 2.5661e-04 - mean\_absolute\_error: 0.0117100/126 [======================>.......] - ETA: 0s - loss: 2.6916e-04 - mean\_absolute\_error: 0.0121117/126 [==========================>...] - ETA: 0s - loss: 2.6304e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.6134e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 2.2589e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9256e-04 - mean\_absolute\_error: 0.0142 19/126 [===>..........................] - ETA: 0s - loss: 3.2479e-04 - mean\_absolute\_error: 0.0140 35/126 [=======>......................] - ETA: 0s - loss: 2.9270e-04 - mean\_absolute\_error: 0.0127 51/126 [===========>..................] - ETA: 0s - loss: 2.7807e-04 - mean\_absolute\_error: 0.0125 68/126 [===============>..............] - ETA: 0s - loss: 2.7659e-04 - mean\_absolute\_error: 0.0125 86/126 [===================>..........] - ETA: 0s - loss: 2.6648e-04 - mean\_absolute\_error: 0.0123105/126 [========================>.....] - ETA: 0s - loss: 2.6772e-04 - mean\_absolute\_error: 0.0123125/126 [============================>.] - ETA: 0s - loss: 2.6412e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.6436e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.3691e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9986e-04 - mean\_absolute\_error: 0.0113 22/126 [====>.........................] - ETA: 0s - loss: 2.4948e-04 - mean\_absolute\_error: 0.0114 43/126 [=========>....................] - ETA: 0s - loss: 2.2669e-04 - mean\_absolute\_error: 0.0110 64/126 [==============>...............] - ETA: 0s - loss: 2.7181e-04 - mean\_absolute\_error: 0.0122 83/126 [==================>...........] - ETA: 0s - loss: 2.7666e-04 - mean\_absolute\_error: 0.0124103/126 [=======================>......] - ETA: 0s - loss: 2.7747e-04 - mean\_absolute\_error: 0.0123122/126 [============================>.] - ETA: 0s - loss: 2.6255e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6644e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 3.8733e-04 - val\_mean\_absolute\_error: 0.0172  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9470e-04 - mean\_absolute\_error: 0.0189 21/126 [====>.........................] - ETA: 0s - loss: 2.7335e-04 - mean\_absolute\_error: 0.0126 41/126 [========>.....................] - ETA: 0s - loss: 2.5953e-04 - mean\_absolute\_error: 0.0120 61/126 [=============>................] - ETA: 0s - loss: 2.4112e-04 - mean\_absolute\_error: 0.0115 81/126 [==================>...........] - ETA: 0s - loss: 2.3513e-04 - mean\_absolute\_error: 0.0114101/126 [=======================>......] - ETA: 0s - loss: 2.4352e-04 - mean\_absolute\_error: 0.0114121/126 [===========================>..] - ETA: 0s - loss: 2.6411e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6171e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.2633e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2720e-04 - mean\_absolute\_error: 0.0101 21/126 [====>.........................] - ETA: 0s - loss: 2.0312e-04 - mean\_absolute\_error: 0.0107 40/126 [========>.....................] - ETA: 0s - loss: 2.3227e-04 - mean\_absolute\_error: 0.0111 61/126 [=============>................] - ETA: 0s - loss: 2.5317e-04 - mean\_absolute\_error: 0.0114 81/126 [==================>...........] - ETA: 0s - loss: 2.4982e-04 - mean\_absolute\_error: 0.0113102/126 [=======================>......] - ETA: 0s - loss: 2.4746e-04 - mean\_absolute\_error: 0.0114122/126 [============================>.] - ETA: 0s - loss: 2.6175e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6518e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 4.1618e-04 - val\_mean\_absolute\_error: 0.0182  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0364e-04 - mean\_absolute\_error: 0.0202 22/126 [====>.........................] - ETA: 0s - loss: 2.2810e-04 - mean\_absolute\_error: 0.0116 42/126 [=========>....................] - ETA: 0s - loss: 2.2148e-04 - mean\_absolute\_error: 0.0111 62/126 [=============>................] - ETA: 0s - loss: 2.2942e-04 - mean\_absolute\_error: 0.0109 82/126 [==================>...........] - ETA: 0s - loss: 2.3876e-04 - mean\_absolute\_error: 0.0113103/126 [=======================>......] - ETA: 0s - loss: 2.3920e-04 - mean\_absolute\_error: 0.0114123/126 [============================>.] - ETA: 0s - loss: 2.4023e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4143e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1195e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8150e-04 - mean\_absolute\_error: 0.0102 21/126 [====>.........................] - ETA: 0s - loss: 2.7077e-04 - mean\_absolute\_error: 0.0112 41/126 [========>.....................] - ETA: 0s - loss: 2.3017e-04 - mean\_absolute\_error: 0.0108 61/126 [=============>................] - ETA: 0s - loss: 2.1341e-04 - mean\_absolute\_error: 0.0107 80/126 [==================>...........] - ETA: 0s - loss: 2.1203e-04 - mean\_absolute\_error: 0.0107100/126 [======================>.......] - ETA: 0s - loss: 2.2228e-04 - mean\_absolute\_error: 0.0107119/126 [===========================>..] - ETA: 0s - loss: 2.2059e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.2103e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.2445e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8964e-04 - mean\_absolute\_error: 0.0111 21/126 [====>.........................] - ETA: 0s - loss: 2.5583e-04 - mean\_absolute\_error: 0.0113 41/126 [========>.....................] - ETA: 0s - loss: 2.2612e-04 - mean\_absolute\_error: 0.0107 60/126 [=============>................] - ETA: 0s - loss: 2.4421e-04 - mean\_absolute\_error: 0.0111 80/126 [==================>...........] - ETA: 0s - loss: 2.4143e-04 - mean\_absolute\_error: 0.0112101/126 [=======================>......] - ETA: 0s - loss: 2.3369e-04 - mean\_absolute\_error: 0.0111121/126 [===========================>..] - ETA: 0s - loss: 2.3738e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3612e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.2093e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6039e-04 - mean\_absolute\_error: 0.0107 21/126 [====>.........................] - ETA: 0s - loss: 2.2440e-04 - mean\_absolute\_error: 0.0114 42/126 [=========>....................] - ETA: 0s - loss: 2.4791e-04 - mean\_absolute\_error: 0.0120 62/126 [=============>................] - ETA: 0s - loss: 2.5059e-04 - mean\_absolute\_error: 0.0119 82/126 [==================>...........] - ETA: 0s - loss: 2.4788e-04 - mean\_absolute\_error: 0.0117102/126 [=======================>......] - ETA: 0s - loss: 2.4081e-04 - mean\_absolute\_error: 0.0114122/126 [============================>.] - ETA: 0s - loss: 2.4014e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4061e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.0665e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2234e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 2.6008e-04 - mean\_absolute\_error: 0.0119 42/126 [=========>....................] - ETA: 0s - loss: 2.6654e-04 - mean\_absolute\_error: 0.0117 63/126 [==============>...............] - ETA: 0s - loss: 2.5047e-04 - mean\_absolute\_error: 0.0115 84/126 [===================>..........] - ETA: 0s - loss: 2.4346e-04 - mean\_absolute\_error: 0.0114104/126 [=======================>......] - ETA: 0s - loss: 2.4312e-04 - mean\_absolute\_error: 0.0113124/126 [============================>.] - ETA: 0s - loss: 2.3081e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.2965e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.1619e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4699e-04 - mean\_absolute\_error: 0.0109 22/126 [====>.........................] - ETA: 0s - loss: 1.8958e-04 - mean\_absolute\_error: 0.0099 42/126 [=========>....................] - ETA: 0s - loss: 2.0452e-04 - mean\_absolute\_error: 0.0102 62/126 [=============>................] - ETA: 0s - loss: 2.2501e-04 - mean\_absolute\_error: 0.0110 82/126 [==================>...........] - ETA: 0s - loss: 2.2716e-04 - mean\_absolute\_error: 0.0111102/126 [=======================>......] - ETA: 0s - loss: 2.3538e-04 - mean\_absolute\_error: 0.0112123/126 [============================>.] - ETA: 0s - loss: 2.4299e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4205e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 2.0654e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5664e-04 - mean\_absolute\_error: 0.0133 21/126 [====>.........................] - ETA: 0s - loss: 3.3919e-04 - mean\_absolute\_error: 0.0143 41/126 [========>.....................] - ETA: 0s - loss: 2.8036e-04 - mean\_absolute\_error: 0.0125 62/126 [=============>................] - ETA: 0s - loss: 2.4953e-04 - mean\_absolute\_error: 0.0116 81/126 [==================>...........] - ETA: 0s - loss: 2.4798e-04 - mean\_absolute\_error: 0.0116100/126 [======================>.......] - ETA: 0s - loss: 2.4953e-04 - mean\_absolute\_error: 0.0116121/126 [===========================>..] - ETA: 0s - loss: 2.4328e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4605e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 2.2690e-04 - val\_mean\_absolute\_error: 0.0124  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1326e-04 - mean\_absolute\_error: 0.0085 21/126 [====>.........................] - ETA: 0s - loss: 2.0033e-04 - mean\_absolute\_error: 0.0099 41/126 [========>.....................] - ETA: 0s - loss: 2.0548e-04 - mean\_absolute\_error: 0.0105 61/126 [=============>................] - ETA: 0s - loss: 2.1834e-04 - mean\_absolute\_error: 0.0106 82/126 [==================>...........] - ETA: 0s - loss: 2.5209e-04 - mean\_absolute\_error: 0.0115102/126 [=======================>......] - ETA: 0s - loss: 2.3830e-04 - mean\_absolute\_error: 0.0112123/126 [============================>.] - ETA: 0s - loss: 2.3002e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3222e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.2926e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5847e-04 - mean\_absolute\_error: 0.0095 21/126 [====>.........................] - ETA: 0s - loss: 1.8268e-04 - mean\_absolute\_error: 0.0099 42/126 [=========>....................] - ETA: 0s - loss: 1.9135e-04 - mean\_absolute\_error: 0.0103 63/126 [==============>...............] - ETA: 0s - loss: 2.3123e-04 - mean\_absolute\_error: 0.0113 84/126 [===================>..........] - ETA: 0s - loss: 2.4692e-04 - mean\_absolute\_error: 0.0115105/126 [========================>.....] - ETA: 0s - loss: 2.4433e-04 - mean\_absolute\_error: 0.0114125/126 [============================>.] - ETA: 0s - loss: 2.3374e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3402e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1185e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5247e-05 - mean\_absolute\_error: 0.0077 21/126 [====>.........................] - ETA: 0s - loss: 2.0733e-04 - mean\_absolute\_error: 0.0100 42/126 [=========>....................] - ETA: 0s - loss: 2.0290e-04 - mean\_absolute\_error: 0.0101 64/126 [==============>...............] - ETA: 0s - loss: 2.0413e-04 - mean\_absolute\_error: 0.0102 85/126 [===================>..........] - ETA: 0s - loss: 2.1601e-04 - mean\_absolute\_error: 0.0104105/126 [========================>.....] - ETA: 0s - loss: 2.1184e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - ETA: 0s - loss: 2.1087e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.1087e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 1.0919e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2950e-04 - mean\_absolute\_error: 0.0116 23/126 [====>.........................] - ETA: 0s - loss: 2.1900e-04 - mean\_absolute\_error: 0.0109 44/126 [=========>....................] - ETA: 0s - loss: 1.9459e-04 - mean\_absolute\_error: 0.0105 64/126 [==============>...............] - ETA: 0s - loss: 2.2101e-04 - mean\_absolute\_error: 0.0110 85/126 [===================>..........] - ETA: 0s - loss: 2.9821e-04 - mean\_absolute\_error: 0.0127106/126 [========================>.....] - ETA: 0s - loss: 3.0633e-04 - mean\_absolute\_error: 0.0129126/126 [==============================] - 0s 3ms/step - loss: 2.9161e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.0983e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1276e-04 - mean\_absolute\_error: 0.0142 22/126 [====>.........................] - ETA: 0s - loss: 2.1030e-04 - mean\_absolute\_error: 0.0108 42/126 [=========>....................] - ETA: 0s - loss: 2.4465e-04 - mean\_absolute\_error: 0.0109 63/126 [==============>...............] - ETA: 0s - loss: 2.2795e-04 - mean\_absolute\_error: 0.0109 83/126 [==================>...........] - ETA: 0s - loss: 2.3926e-04 - mean\_absolute\_error: 0.0110105/126 [========================>.....] - ETA: 0s - loss: 2.4334e-04 - mean\_absolute\_error: 0.0114125/126 [============================>.] - ETA: 0s - loss: 2.5671e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5750e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.8980e-04 - val\_mean\_absolute\_error: 0.0115  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8413e-04 - mean\_absolute\_error: 0.0114 18/126 [===>..........................] - ETA: 0s - loss: 2.6426e-04 - mean\_absolute\_error: 0.0127 34/126 [=======>......................] - ETA: 0s - loss: 2.4005e-04 - mean\_absolute\_error: 0.0117 50/126 [==========>...................] - ETA: 0s - loss: 2.7562e-04 - mean\_absolute\_error: 0.0120 66/126 [==============>...............] - ETA: 0s - loss: 2.5195e-04 - mean\_absolute\_error: 0.0116 81/126 [==================>...........] - ETA: 0s - loss: 2.5460e-04 - mean\_absolute\_error: 0.0116101/126 [=======================>......] - ETA: 0s - loss: 2.7019e-04 - mean\_absolute\_error: 0.0122122/126 [============================>.] - ETA: 0s - loss: 2.6603e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.6329e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.5158e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8036e-04 - mean\_absolute\_error: 0.0103 21/126 [====>.........................] - ETA: 0s - loss: 1.9314e-04 - mean\_absolute\_error: 0.0100 41/126 [========>.....................] - ETA: 0s - loss: 1.8898e-04 - mean\_absolute\_error: 0.0100 62/126 [=============>................] - ETA: 0s - loss: 2.0457e-04 - mean\_absolute\_error: 0.0102 82/126 [==================>...........] - ETA: 0s - loss: 2.1545e-04 - mean\_absolute\_error: 0.0104103/126 [=======================>......] - ETA: 0s - loss: 2.1522e-04 - mean\_absolute\_error: 0.0105124/126 [============================>.] - ETA: 0s - loss: 2.0640e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 3ms/step - loss: 2.0499e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.0502e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6354e-04 - mean\_absolute\_error: 0.0103 22/126 [====>.........................] - ETA: 0s - loss: 2.6143e-04 - mean\_absolute\_error: 0.0120 42/126 [=========>....................] - ETA: 0s - loss: 2.3603e-04 - mean\_absolute\_error: 0.0113 63/126 [==============>...............] - ETA: 0s - loss: 2.1130e-04 - mean\_absolute\_error: 0.0107 83/126 [==================>...........] - ETA: 0s - loss: 2.2402e-04 - mean\_absolute\_error: 0.0110104/126 [=======================>......] - ETA: 0s - loss: 2.3302e-04 - mean\_absolute\_error: 0.0110125/126 [============================>.] - ETA: 0s - loss: 2.2773e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2878e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.2080e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7641e-04 - mean\_absolute\_error: 0.0106 18/126 [===>..........................] - ETA: 0s - loss: 2.3202e-04 - mean\_absolute\_error: 0.0113 38/126 [========>.....................] - ETA: 0s - loss: 2.1619e-04 - mean\_absolute\_error: 0.0108 59/126 [=============>................] - ETA: 0s - loss: 2.1031e-04 - mean\_absolute\_error: 0.0106 80/126 [==================>...........] - ETA: 0s - loss: 2.0987e-04 - mean\_absolute\_error: 0.0106101/126 [=======================>......] - ETA: 0s - loss: 2.2188e-04 - mean\_absolute\_error: 0.0109119/126 [===========================>..] - ETA: 0s - loss: 2.2560e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2126e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.1684e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2739e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 1.4536e-04 - mean\_absolute\_error: 0.0090 43/126 [=========>....................] - ETA: 0s - loss: 1.7425e-04 - mean\_absolute\_error: 0.0096 64/126 [==============>...............] - ETA: 0s - loss: 1.9596e-04 - mean\_absolute\_error: 0.0101 85/126 [===================>..........] - ETA: 0s - loss: 1.9703e-04 - mean\_absolute\_error: 0.0103105/126 [========================>.....] - ETA: 0s - loss: 2.1517e-04 - mean\_absolute\_error: 0.0107125/126 [============================>.] - ETA: 0s - loss: 2.1894e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1876e-04 - mean\_absolute\_error: 0.0107 - val\_loss: 1.0225e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5372e-04 - mean\_absolute\_error: 0.0089 22/126 [====>.........................] - ETA: 0s - loss: 1.9879e-04 - mean\_absolute\_error: 0.0100 42/126 [=========>....................] - ETA: 0s - loss: 1.8842e-04 - mean\_absolute\_error: 0.0101 63/126 [==============>...............] - ETA: 0s - loss: 2.1212e-04 - mean\_absolute\_error: 0.0106 83/126 [==================>...........] - ETA: 0s - loss: 2.2225e-04 - mean\_absolute\_error: 0.0108102/126 [=======================>......] - ETA: 0s - loss: 2.2928e-04 - mean\_absolute\_error: 0.0111122/126 [============================>.] - ETA: 0s - loss: 2.3448e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3337e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.9810e-04 - val\_mean\_absolute\_error: 0.0118  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2047e-04 - mean\_absolute\_error: 0.0123 22/126 [====>.........................] - ETA: 0s - loss: 2.5545e-04 - mean\_absolute\_error: 0.0124 44/126 [=========>....................] - ETA: 0s - loss: 2.2287e-04 - mean\_absolute\_error: 0.0113 66/126 [==============>...............] - ETA: 0s - loss: 2.2960e-04 - mean\_absolute\_error: 0.0112 86/126 [===================>..........] - ETA: 0s - loss: 2.2773e-04 - mean\_absolute\_error: 0.0111106/126 [========================>.....] - ETA: 0s - loss: 2.2850e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3049e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.6767e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8597e-04 - mean\_absolute\_error: 0.0102 21/126 [====>.........................] - ETA: 0s - loss: 3.2142e-04 - mean\_absolute\_error: 0.0136 42/126 [=========>....................] - ETA: 0s - loss: 2.8730e-04 - mean\_absolute\_error: 0.0127 62/126 [=============>................] - ETA: 0s - loss: 2.6779e-04 - mean\_absolute\_error: 0.0122 82/126 [==================>...........] - ETA: 0s - loss: 2.4351e-04 - mean\_absolute\_error: 0.0116103/126 [=======================>......] - ETA: 0s - loss: 2.6057e-04 - mean\_absolute\_error: 0.0120125/126 [============================>.] - ETA: 0s - loss: 2.7808e-04 - mean\_absolute\_error: 0.0125126/126 [==============================] - 0s 3ms/step - loss: 2.7773e-04 - mean\_absolute\_error: 0.0125 - val\_loss: 1.0578e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2026e-04 - mean\_absolute\_error: 0.0081 21/126 [====>.........................] - ETA: 0s - loss: 2.2484e-04 - mean\_absolute\_error: 0.0108 41/126 [========>.....................] - ETA: 0s - loss: 2.3407e-04 - mean\_absolute\_error: 0.0111 62/126 [=============>................] - ETA: 0s - loss: 2.3373e-04 - mean\_absolute\_error: 0.0114 84/126 [===================>..........] - ETA: 0s - loss: 2.3841e-04 - mean\_absolute\_error: 0.0114105/126 [========================>.....] - ETA: 0s - loss: 2.2992e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - ETA: 0s - loss: 2.3567e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3567e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.0123e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2979e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 1.9133e-04 - mean\_absolute\_error: 0.0099 43/126 [=========>....................] - ETA: 0s - loss: 1.9344e-04 - mean\_absolute\_error: 0.0100 63/126 [==============>...............] - ETA: 0s - loss: 1.9335e-04 - mean\_absolute\_error: 0.0100 83/126 [==================>...........] - ETA: 0s - loss: 1.9844e-04 - mean\_absolute\_error: 0.0102103/126 [=======================>......] - ETA: 0s - loss: 2.2251e-04 - mean\_absolute\_error: 0.0108123/126 [============================>.] - ETA: 0s - loss: 2.2761e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2625e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.1984e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0556e-04 - mean\_absolute\_error: 0.0085 23/126 [====>.........................] - ETA: 0s - loss: 1.8791e-04 - mean\_absolute\_error: 0.0098 44/126 [=========>....................] - ETA: 0s - loss: 1.9223e-04 - mean\_absolute\_error: 0.0099 64/126 [==============>...............] - ETA: 0s - loss: 2.0467e-04 - mean\_absolute\_error: 0.0103 85/126 [===================>..........] - ETA: 0s - loss: 2.1514e-04 - mean\_absolute\_error: 0.0106106/126 [========================>.....] - ETA: 0s - loss: 2.4458e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.3936e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1482e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1721e-04 - mean\_absolute\_error: 0.0126 22/126 [====>.........................] - ETA: 0s - loss: 1.8962e-04 - mean\_absolute\_error: 0.0101 42/126 [=========>....................] - ETA: 0s - loss: 2.1396e-04 - mean\_absolute\_error: 0.0107 62/126 [=============>................] - ETA: 0s - loss: 2.2763e-04 - mean\_absolute\_error: 0.0110 83/126 [==================>...........] - ETA: 0s - loss: 2.1668e-04 - mean\_absolute\_error: 0.0107102/126 [=======================>......] - ETA: 0s - loss: 2.1144e-04 - mean\_absolute\_error: 0.0105123/126 [============================>.] - ETA: 0s - loss: 2.1463e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1452e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 1.0813e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6400e-05 - mean\_absolute\_error: 0.0075 23/126 [====>.........................] - ETA: 0s - loss: 1.8464e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 2.0220e-04 - mean\_absolute\_error: 0.0101 65/126 [==============>...............] - ETA: 0s - loss: 2.0124e-04 - mean\_absolute\_error: 0.0103 86/126 [===================>..........] - ETA: 0s - loss: 2.2068e-04 - mean\_absolute\_error: 0.0107107/126 [========================>.....] - ETA: 0s - loss: 2.1495e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0990e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 1.0244e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0041e-04 - mean\_absolute\_error: 0.0079 22/126 [====>.........................] - ETA: 0s - loss: 2.4241e-04 - mean\_absolute\_error: 0.0115 43/126 [=========>....................] - ETA: 0s - loss: 2.5042e-04 - mean\_absolute\_error: 0.0118 63/126 [==============>...............] - ETA: 0s - loss: 2.4380e-04 - mean\_absolute\_error: 0.0116 84/126 [===================>..........] - ETA: 0s - loss: 2.2750e-04 - mean\_absolute\_error: 0.0112104/126 [=======================>......] - ETA: 0s - loss: 2.2759e-04 - mean\_absolute\_error: 0.0111125/126 [============================>.] - ETA: 0s - loss: 2.2336e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.2358e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.9866e-04 - val\_mean\_absolute\_error: 0.0116  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1382e-04 - mean\_absolute\_error: 0.0107 21/126 [====>.........................] - ETA: 0s - loss: 2.2813e-04 - mean\_absolute\_error: 0.0111 40/126 [========>.....................] - ETA: 0s - loss: 2.2141e-04 - mean\_absolute\_error: 0.0109 61/126 [=============>................] - ETA: 0s - loss: 2.1540e-04 - mean\_absolute\_error: 0.0108 82/126 [==================>...........] - ETA: 0s - loss: 2.1626e-04 - mean\_absolute\_error: 0.0107103/126 [=======================>......] - ETA: 0s - loss: 2.1450e-04 - mean\_absolute\_error: 0.0106124/126 [============================>.] - ETA: 0s - loss: 2.0666e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0595e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 9.7548e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2681e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 1.8026e-04 - mean\_absolute\_error: 0.0100 43/126 [=========>....................] - ETA: 0s - loss: 2.1486e-04 - mean\_absolute\_error: 0.0110 64/126 [==============>...............] - ETA: 0s - loss: 2.1389e-04 - mean\_absolute\_error: 0.0108 85/126 [===================>..........] - ETA: 0s - loss: 2.2669e-04 - mean\_absolute\_error: 0.0112106/126 [========================>.....] - ETA: 0s - loss: 2.2582e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - ETA: 0s - loss: 2.2036e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2036e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.8236e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0975e-04 - mean\_absolute\_error: 0.0150 21/126 [====>.........................] - ETA: 0s - loss: 3.6219e-04 - mean\_absolute\_error: 0.0151 41/126 [========>.....................] - ETA: 0s - loss: 2.8799e-04 - mean\_absolute\_error: 0.0128 61/126 [=============>................] - ETA: 0s - loss: 2.6374e-04 - mean\_absolute\_error: 0.0120 82/126 [==================>...........] - ETA: 0s - loss: 2.4335e-04 - mean\_absolute\_error: 0.0115103/126 [=======================>......] - ETA: 0s - loss: 2.3774e-04 - mean\_absolute\_error: 0.0114124/126 [============================>.] - ETA: 0s - loss: 2.3619e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3562e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 9.3128e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4935e-04 - mean\_absolute\_error: 0.0105 22/126 [====>.........................] - ETA: 0s - loss: 2.0232e-04 - mean\_absolute\_error: 0.0103 41/126 [========>.....................] - ETA: 0s - loss: 2.3021e-04 - mean\_absolute\_error: 0.0109 62/126 [=============>................] - ETA: 0s - loss: 2.3209e-04 - mean\_absolute\_error: 0.0109 83/126 [==================>...........] - ETA: 0s - loss: 2.2754e-04 - mean\_absolute\_error: 0.0109104/126 [=======================>......] - ETA: 0s - loss: 2.2589e-04 - mean\_absolute\_error: 0.0108125/126 [============================>.] - ETA: 0s - loss: 2.1552e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1523e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 9.3065e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2835e-04 - mean\_absolute\_error: 0.0084 21/126 [====>.........................] - ETA: 0s - loss: 1.8625e-04 - mean\_absolute\_error: 0.0100 43/126 [=========>....................] - ETA: 0s - loss: 1.7915e-04 - mean\_absolute\_error: 0.0098 65/126 [==============>...............] - ETA: 0s - loss: 2.1181e-04 - mean\_absolute\_error: 0.0104 86/126 [===================>..........] - ETA: 0s - loss: 2.1540e-04 - mean\_absolute\_error: 0.0106107/126 [========================>.....] - ETA: 0s - loss: 2.0542e-04 - mean\_absolute\_error: 0.0104126/126 [==============================] - 0s 3ms/step - loss: 2.0288e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.4074e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2063e-04 - mean\_absolute\_error: 0.0118 22/126 [====>.........................] - ETA: 0s - loss: 2.3211e-04 - mean\_absolute\_error: 0.0107 42/126 [=========>....................] - ETA: 0s - loss: 2.3513e-04 - mean\_absolute\_error: 0.0112 62/126 [=============>................] - ETA: 0s - loss: 2.3945e-04 - mean\_absolute\_error: 0.0112 82/126 [==================>...........] - ETA: 0s - loss: 2.3592e-04 - mean\_absolute\_error: 0.0113102/126 [=======================>......] - ETA: 0s - loss: 2.4081e-04 - mean\_absolute\_error: 0.0115122/126 [============================>.] - ETA: 0s - loss: 2.3932e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.3971e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.3826e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5649e-04 - mean\_absolute\_error: 0.0095 21/126 [====>.........................] - ETA: 0s - loss: 2.1436e-04 - mean\_absolute\_error: 0.0104 41/126 [========>.....................] - ETA: 0s - loss: 2.3450e-04 - mean\_absolute\_error: 0.0111 62/126 [=============>................] - ETA: 0s - loss: 2.3973e-04 - mean\_absolute\_error: 0.0115 83/126 [==================>...........] - ETA: 0s - loss: 2.4457e-04 - mean\_absolute\_error: 0.0116104/126 [=======================>......] - ETA: 0s - loss: 2.4740e-04 - mean\_absolute\_error: 0.0117125/126 [============================>.] - ETA: 0s - loss: 2.5233e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.5324e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.2282e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1866e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 2.5037e-04 - mean\_absolute\_error: 0.0120 42/126 [=========>....................] - ETA: 0s - loss: 2.2928e-04 - mean\_absolute\_error: 0.0112 63/126 [==============>...............] - ETA: 0s - loss: 2.1161e-04 - mean\_absolute\_error: 0.0106 83/126 [==================>...........] - ETA: 0s - loss: 2.3185e-04 - mean\_absolute\_error: 0.0112104/126 [=======================>......] - ETA: 0s - loss: 2.2660e-04 - mean\_absolute\_error: 0.0110124/126 [============================>.] - ETA: 0s - loss: 2.2205e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2194e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 9.1456e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3979e-05 - mean\_absolute\_error: 0.0073 21/126 [====>.........................] - ETA: 0s - loss: 2.0145e-04 - mean\_absolute\_error: 0.0107 42/126 [=========>....................] - ETA: 0s - loss: 2.2683e-04 - mean\_absolute\_error: 0.0114 62/126 [=============>................] - ETA: 0s - loss: 2.0609e-04 - mean\_absolute\_error: 0.0107 82/126 [==================>...........] - ETA: 0s - loss: 2.0018e-04 - mean\_absolute\_error: 0.0106103/126 [=======================>......] - ETA: 0s - loss: 2.1017e-04 - mean\_absolute\_error: 0.0107123/126 [============================>.] - ETA: 0s - loss: 2.0485e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0640e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 9.3644e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2217e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 1.4087e-04 - mean\_absolute\_error: 0.0090 43/126 [=========>....................] - ETA: 0s - loss: 1.9860e-04 - mean\_absolute\_error: 0.0102 64/126 [==============>...............] - ETA: 0s - loss: 2.0007e-04 - mean\_absolute\_error: 0.0103 84/126 [===================>..........] - ETA: 0s - loss: 2.0219e-04 - mean\_absolute\_error: 0.0102105/126 [========================>.....] - ETA: 0s - loss: 1.9673e-04 - mean\_absolute\_error: 0.0102125/126 [============================>.] - ETA: 0s - loss: 2.0068e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 3ms/step - loss: 2.0052e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.8362e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2933e-04 - mean\_absolute\_error: 0.0126 22/126 [====>.........................] - ETA: 0s - loss: 1.8482e-04 - mean\_absolute\_error: 0.0100 43/126 [=========>....................] - ETA: 0s - loss: 1.8967e-04 - mean\_absolute\_error: 0.0101 63/126 [==============>...............] - ETA: 0s - loss: 1.9261e-04 - mean\_absolute\_error: 0.0102 84/126 [===================>..........] - ETA: 0s - loss: 2.1420e-04 - mean\_absolute\_error: 0.0107105/126 [========================>.....] - ETA: 0s - loss: 2.3003e-04 - mean\_absolute\_error: 0.0112125/126 [============================>.] - ETA: 0s - loss: 2.2304e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.2258e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 9.2796e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5596e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 1.9877e-04 - mean\_absolute\_error: 0.0105 43/126 [=========>....................] - ETA: 0s - loss: 1.8140e-04 - mean\_absolute\_error: 0.0101 63/126 [==============>...............] - ETA: 0s - loss: 1.8206e-04 - mean\_absolute\_error: 0.0099 84/126 [===================>..........] - ETA: 0s - loss: 1.8046e-04 - mean\_absolute\_error: 0.0098104/126 [=======================>......] - ETA: 0s - loss: 1.9798e-04 - mean\_absolute\_error: 0.0102123/126 [============================>.] - ETA: 0s - loss: 1.9934e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9850e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.3734e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0533e-04 - mean\_absolute\_error: 0.0126 22/126 [====>.........................] - ETA: 0s - loss: 2.3799e-04 - mean\_absolute\_error: 0.0108 42/126 [=========>....................] - ETA: 0s - loss: 2.2210e-04 - mean\_absolute\_error: 0.0106 63/126 [==============>...............] - ETA: 0s - loss: 1.9709e-04 - mean\_absolute\_error: 0.0100 83/126 [==================>...........] - ETA: 0s - loss: 1.9801e-04 - mean\_absolute\_error: 0.0101104/126 [=======================>......] - ETA: 0s - loss: 2.0114e-04 - mean\_absolute\_error: 0.0102125/126 [============================>.] - ETA: 0s - loss: 1.9820e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9799e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.0260e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1916e-04 - mean\_absolute\_error: 0.0116 22/126 [====>.........................] - ETA: 0s - loss: 2.0509e-04 - mean\_absolute\_error: 0.0108 43/126 [=========>....................] - ETA: 0s - loss: 1.9279e-04 - mean\_absolute\_error: 0.0103 63/126 [==============>...............] - ETA: 0s - loss: 1.9259e-04 - mean\_absolute\_error: 0.0100 84/126 [===================>..........] - ETA: 0s - loss: 1.9790e-04 - mean\_absolute\_error: 0.0103106/126 [========================>.....] - ETA: 0s - loss: 1.9699e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 3ms/step - loss: 1.9875e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.3164e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9490e-04 - mean\_absolute\_error: 0.0136 21/126 [====>.........................] - ETA: 0s - loss: 1.9187e-04 - mean\_absolute\_error: 0.0107 42/126 [=========>....................] - ETA: 0s - loss: 1.7853e-04 - mean\_absolute\_error: 0.0100 63/126 [==============>...............] - ETA: 0s - loss: 1.7962e-04 - mean\_absolute\_error: 0.0099 83/126 [==================>...........] - ETA: 0s - loss: 1.8938e-04 - mean\_absolute\_error: 0.0100103/126 [=======================>......] - ETA: 0s - loss: 1.8461e-04 - mean\_absolute\_error: 0.0100124/126 [============================>.] - ETA: 0s - loss: 1.8756e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.8945e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 2.2966e-04 - val\_mean\_absolute\_error: 0.0128

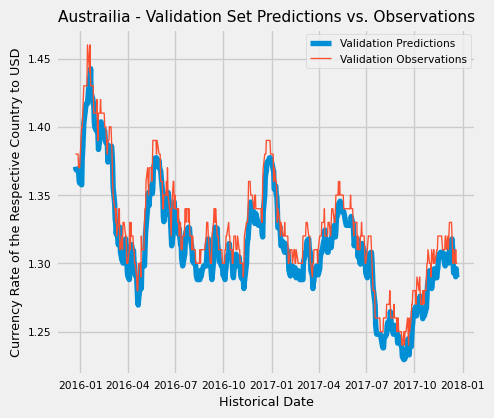
<keras.src.callbacks.History at 0x24c48ea6450>

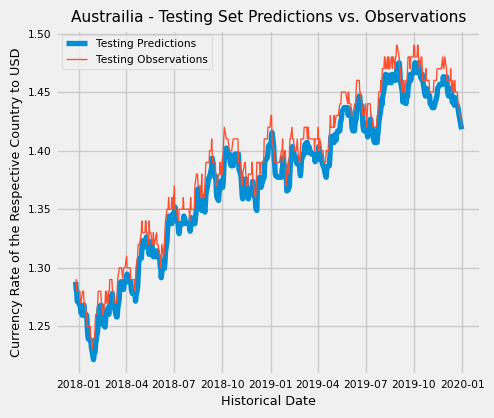
After the training and fitting of the Machine Learning model for Austrailia, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue lines represent the prediction model’s projections and the thinner red lines is the observed/gathered data.

```{python}  
# Testing the Machine Learning Model prediction for Austrailia with the train,   
# validation, and test sets  
# Most important is the test set prediction as this tests the effectiveness  
# of the Machine Learning model on data it has not seen before   
austrailia\_train\_pred = austrailia\_model.predict(X\_austrailia\_train).flatten()  
  
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_train, y\_austrailia\_train, linewidth=1)  
plt.legend(["Training Predictions", "Training Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Austrailia - Training Set Predictions vs. Observations")  
plt.show()  
  
austrailia\_val\_pred = austrailia\_model.predict(X\_austrailia\_val).flatten()  
  
plt.plot(dates\_austrailia\_val, austrailia\_val\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_val, y\_austrailia\_val, linewidth=1)  
plt.legend(["Validation Predictions", "Validation Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Austrailia - Validation Set Predictions vs. Observations")  
plt.show()  
  
austrailia\_test\_pred = austrailia\_model.predict(X\_austrailia\_test).flatten()  
  
plt.plot(dates\_austrailia\_test, austrailia\_test\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_test, y\_austrailia\_test, linewidth=1)  
plt.legend(["Testing Predictions", "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Austrailia - Testing Set Predictions vs. Observations")  
plt.show()  
```

1/126 [..............................] - ETA: 45s 43/126 [=========>....................] - ETA: 0s 85/126 [===================>..........] - ETA: 0s125/126 [============================>.] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

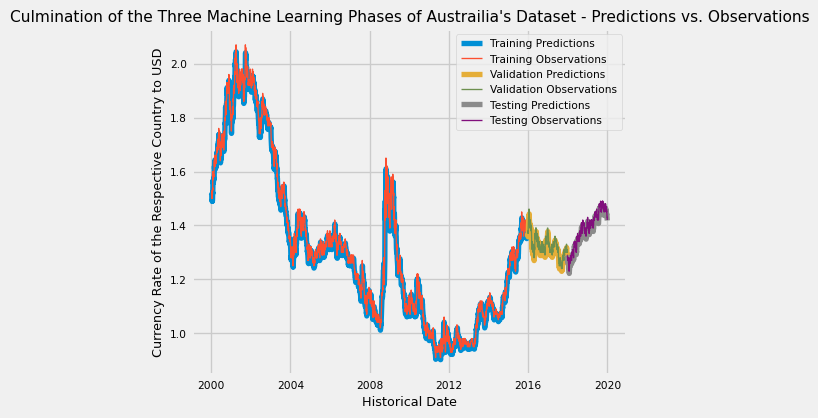






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and fitting towards predicting Austrailia’s international currency rate with the United States.

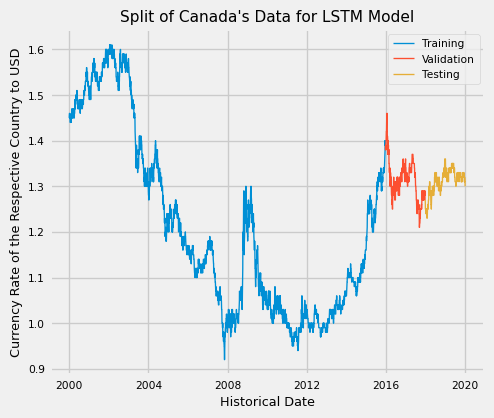
```{python}  
# Plotting Austrailia's observational (reference) data with the predictions of   
# its Machine Learning Model (as a way to visually inspect the effectiveness of   
# the model)   
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_train, y\_austrailia\_train, linewidth=1)  
plt.plot(dates\_austrailia\_val, austrailia\_val\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_val, y\_austrailia\_val, linewidth=1)  
plt.plot(dates\_austrailia\_test, austrailia\_test\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_test, y\_austrailia\_test, linewidth=1)  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of Austrailia's Dataset - Predictions vs. Observations")  
plt.show()  
```



Once Austraila’s data was completely trained and visualized, I worked on Canada’s data (as shown below):

Since the data (date, X, and y) is split into three np.arrays and to be more efficient, I will manually split Canada’s data into train, test, and validation datasets for the Machine Learning model with 80% going to the training dataset, the next 10% going to the validation dataset, and the last 10% going to the test dataset for each np.array respectively.

```{python}  
# Splitting Canada's data into train, test, and validation sets on 3 mediums:   
# the X-axis, the y-axis, and the indices (represented by dates)  
dates\_canada\_train, X\_canada\_train, y\_canada\_train = dates\_canada[:percentile\_80], X\_canada[:percentile\_80], y\_canada[:percentile\_80]  
dates\_canada\_val, X\_canada\_val, y\_canada\_val = dates\_canada[percentile\_80:percentile\_90], X\_canada[percentile\_80:percentile\_90], y\_canada[percentile\_80:percentile\_90]  
dates\_canada\_test, X\_canada\_test, y\_canada\_test = dates\_canada[percentile\_90:], X\_canada[percentile\_90:], y\_canada[percentile\_90:]  
  
plt.plot(dates\_canada\_train, y\_canada\_train, linewidth=1)  
plt.plot(dates\_canada\_val, y\_canada\_val, linewidth=1)  
plt.plot(dates\_canada\_test, y\_canada\_test, linewidth=1)  
  
plt.legend(["Training", "Validation", "Testing"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Split of Canada's Data for LSTM Model")  
plt.show()  
```



Now, I began to configure the Machine Learning model. We added Sequential layers: an Input layer 3 by 1 because we will have 3 np.arrays of Input and 1 np.array as output, utilize a LSTM (Long Short-Term Memory) layer of 64 neurons, apply 2 levels of dense layers with 32 neurons and folliowing recommendations online to use the RELU (Rectified Linear Unit) Activiation Function, and I followed up with one last dense layer of 1 neuron as our output layer since we are just trying to linearly-predict the next currency-rate on a near-future date. Once I configured the Sequential layers, we are ready to compile the model, utilzing the mean\_square\_error as our minimizing loss function, using the Adam optimizer, and comparing our trained model against our data with the mean\_absolute\_error metric. Lastly, I fitted our model, utilzing our X\_train and Y\_train datasets for fitting with validation from our X\_valid and Y\_valid datasets at 100 epochs.

```{python}  
# Configuring the Machine Learning Tensorflow Model for Canada  
canada\_model = Sequential([layers.Input((3, 1)),  
 layers.LSTM(64),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(1)])  
  
canada\_model.compile(loss="mse",  
 optimizer=Adam(learning\_rate=0.001),  
 metrics=["mean\_absolute\_error"])  
  
canada\_model.fit(X\_canada\_train, y\_canada\_train, validation\_data=(X\_canada\_val, y\_canada\_val), epochs=100)  
```

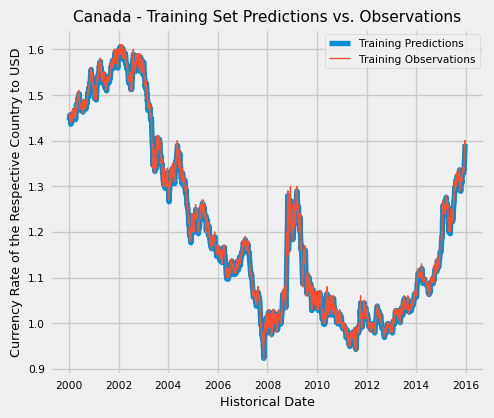
Epoch 1/100  
 1/126 [..............................] - ETA: 3:53 - loss: 1.5412 - mean\_absolute\_error: 1.2234 22/126 [====>.........................] - ETA: 0s - loss: 1.0653 - mean\_absolute\_error: 1.0118 43/126 [=========>....................] - ETA: 0s - loss: 0.6498 - mean\_absolute\_error: 0.7052 63/126 [==============>...............] - ETA: 0s - loss: 0.4506 - mean\_absolute\_error: 0.5210 84/126 [===================>..........] - ETA: 0s - loss: 0.3391 - mean\_absolute\_error: 0.4045105/126 [========================>.....] - ETA: 0s - loss: 0.2717 - mean\_absolute\_error: 0.3313126/126 [==============================] - ETA: 0s - loss: 0.2279 - mean\_absolute\_error: 0.2838126/126 [==============================] - 3s 6ms/step - loss: 0.2279 - mean\_absolute\_error: 0.2838 - val\_loss: 2.8127e-04 - val\_mean\_absolute\_error: 0.0134  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0020 - mean\_absolute\_error: 0.0384 24/126 [====>.........................] - ETA: 0s - loss: 0.0018 - mean\_absolute\_error: 0.0368 45/126 [=========>....................] - ETA: 0s - loss: 0.0017 - mean\_absolute\_error: 0.0354 67/126 [==============>...............] - ETA: 0s - loss: 0.0016 - mean\_absolute\_error: 0.0344 88/126 [===================>..........] - ETA: 0s - loss: 0.0015 - mean\_absolute\_error: 0.0335110/126 [=========================>....] - ETA: 0s - loss: 0.0014 - mean\_absolute\_error: 0.0327126/126 [==============================] - 0s 3ms/step - loss: 0.0014 - mean\_absolute\_error: 0.0320 - val\_loss: 1.5896e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7669e-04 - mean\_absolute\_error: 0.0252 23/126 [====>.........................] - ETA: 0s - loss: 8.5118e-04 - mean\_absolute\_error: 0.0255 45/126 [=========>....................] - ETA: 0s - loss: 7.8094e-04 - mean\_absolute\_error: 0.0243 65/126 [==============>...............] - ETA: 0s - loss: 7.4566e-04 - mean\_absolute\_error: 0.0237 86/126 [===================>..........] - ETA: 0s - loss: 6.9475e-04 - mean\_absolute\_error: 0.0227108/126 [========================>.....] - ETA: 0s - loss: 6.4029e-04 - mean\_absolute\_error: 0.0218126/126 [==============================] - 0s 3ms/step - loss: 6.0345e-04 - mean\_absolute\_error: 0.0211 - val\_loss: 1.5751e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8962e-04 - mean\_absolute\_error: 0.0174 23/126 [====>.........................] - ETA: 0s - loss: 3.6616e-04 - mean\_absolute\_error: 0.0161 45/126 [=========>....................] - ETA: 0s - loss: 3.1712e-04 - mean\_absolute\_error: 0.0149 67/126 [==============>...............] - ETA: 0s - loss: 2.9269e-04 - mean\_absolute\_error: 0.0142 88/126 [===================>..........] - ETA: 0s - loss: 2.7080e-04 - mean\_absolute\_error: 0.0137110/126 [=========================>....] - ETA: 0s - loss: 2.5202e-04 - mean\_absolute\_error: 0.0131126/126 [==============================] - 0s 3ms/step - loss: 2.4132e-04 - mean\_absolute\_error: 0.0128 - val\_loss: 1.3081e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3977e-04 - mean\_absolute\_error: 0.0100 22/126 [====>.........................] - ETA: 0s - loss: 1.4107e-04 - mean\_absolute\_error: 0.0097 43/126 [=========>....................] - ETA: 0s - loss: 1.3814e-04 - mean\_absolute\_error: 0.0095 64/126 [==============>...............] - ETA: 0s - loss: 1.3024e-04 - mean\_absolute\_error: 0.0092 85/126 [===================>..........] - ETA: 0s - loss: 1.2596e-04 - mean\_absolute\_error: 0.0089106/126 [========================>.....] - ETA: 0s - loss: 1.2643e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.2524e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 1.0882e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7555e-05 - mean\_absolute\_error: 0.0064 20/126 [===>..........................] - ETA: 0s - loss: 1.0147e-04 - mean\_absolute\_error: 0.0077 41/126 [========>.....................] - ETA: 0s - loss: 1.0354e-04 - mean\_absolute\_error: 0.0078 62/126 [=============>................] - ETA: 0s - loss: 1.0283e-04 - mean\_absolute\_error: 0.0078 83/126 [==================>...........] - ETA: 0s - loss: 1.0418e-04 - mean\_absolute\_error: 0.0078104/126 [=======================>......] - ETA: 0s - loss: 9.9981e-05 - mean\_absolute\_error: 0.0076125/126 [============================>.] - ETA: 0s - loss: 9.9924e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9791e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1362e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5870e-04 - mean\_absolute\_error: 0.0098 22/126 [====>.........................] - ETA: 0s - loss: 9.1392e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 9.7573e-05 - mean\_absolute\_error: 0.0075 64/126 [==============>...............] - ETA: 0s - loss: 9.7478e-05 - mean\_absolute\_error: 0.0075 86/126 [===================>..........] - ETA: 0s - loss: 9.6288e-05 - mean\_absolute\_error: 0.0074106/126 [========================>.....] - ETA: 0s - loss: 9.5030e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - ETA: 0s - loss: 9.6863e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.6863e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.2705e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3021e-04 - mean\_absolute\_error: 0.0082 23/126 [====>.........................] - ETA: 0s - loss: 1.0845e-04 - mean\_absolute\_error: 0.0077 45/126 [=========>....................] - ETA: 0s - loss: 9.9910e-05 - mean\_absolute\_error: 0.0075 67/126 [==============>...............] - ETA: 0s - loss: 9.9216e-05 - mean\_absolute\_error: 0.0075 88/126 [===================>..........] - ETA: 0s - loss: 9.5343e-05 - mean\_absolute\_error: 0.0074110/126 [=========================>....] - ETA: 0s - loss: 9.8399e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8924e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1007e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1814e-05 - mean\_absolute\_error: 0.0068 22/126 [====>.........................] - ETA: 0s - loss: 9.8426e-05 - mean\_absolute\_error: 0.0075 42/126 [=========>....................] - ETA: 0s - loss: 9.5068e-05 - mean\_absolute\_error: 0.0074 63/126 [==============>...............] - ETA: 0s - loss: 9.7420e-05 - mean\_absolute\_error: 0.0075 85/126 [===================>..........] - ETA: 0s - loss: 9.6639e-05 - mean\_absolute\_error: 0.0075107/126 [========================>.....] - ETA: 0s - loss: 9.7955e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.6568e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0770e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3237e-05 - mean\_absolute\_error: 0.0078 22/126 [====>.........................] - ETA: 0s - loss: 9.3353e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 1.0250e-04 - mean\_absolute\_error: 0.0076 64/126 [==============>...............] - ETA: 0s - loss: 9.9689e-05 - mean\_absolute\_error: 0.0076 85/126 [===================>..........] - ETA: 0s - loss: 1.0155e-04 - mean\_absolute\_error: 0.0077106/126 [========================>.....] - ETA: 0s - loss: 1.0167e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9925e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0789e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2482e-05 - mean\_absolute\_error: 0.0074 23/126 [====>.........................] - ETA: 0s - loss: 9.7018e-05 - mean\_absolute\_error: 0.0072 45/126 [=========>....................] - ETA: 0s - loss: 9.6947e-05 - mean\_absolute\_error: 0.0074 66/126 [==============>...............] - ETA: 0s - loss: 9.7561e-05 - mean\_absolute\_error: 0.0074 88/126 [===================>..........] - ETA: 0s - loss: 9.7813e-05 - mean\_absolute\_error: 0.0074109/126 [========================>.....] - ETA: 0s - loss: 9.9860e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9505e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1111e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3128e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 1.1094e-04 - mean\_absolute\_error: 0.0077 44/126 [=========>....................] - ETA: 0s - loss: 1.0299e-04 - mean\_absolute\_error: 0.0076 65/126 [==============>...............] - ETA: 0s - loss: 9.9654e-05 - mean\_absolute\_error: 0.0075 86/126 [===================>..........] - ETA: 0s - loss: 9.7811e-05 - mean\_absolute\_error: 0.0074107/126 [========================>.....] - ETA: 0s - loss: 9.7755e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.8108e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0773e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0229e-05 - mean\_absolute\_error: 0.0069 21/126 [====>.........................] - ETA: 0s - loss: 9.8822e-05 - mean\_absolute\_error: 0.0074 41/126 [========>.....................] - ETA: 0s - loss: 9.2438e-05 - mean\_absolute\_error: 0.0073 63/126 [==============>...............] - ETA: 0s - loss: 1.0069e-04 - mean\_absolute\_error: 0.0075 84/126 [===================>..........] - ETA: 0s - loss: 1.0041e-04 - mean\_absolute\_error: 0.0075105/126 [========================>.....] - ETA: 0s - loss: 1.0043e-04 - mean\_absolute\_error: 0.0075126/126 [==============================] - ETA: 0s - loss: 9.8475e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8475e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1143e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0748e-05 - mean\_absolute\_error: 0.0064 23/126 [====>.........................] - ETA: 0s - loss: 9.5498e-05 - mean\_absolute\_error: 0.0074 45/126 [=========>....................] - ETA: 0s - loss: 9.6510e-05 - mean\_absolute\_error: 0.0074 65/126 [==============>...............] - ETA: 0s - loss: 9.8121e-05 - mean\_absolute\_error: 0.0074 87/126 [===================>..........] - ETA: 0s - loss: 9.7938e-05 - mean\_absolute\_error: 0.0074107/126 [========================>.....] - ETA: 0s - loss: 9.8518e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8838e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.3577e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1149e-04 - mean\_absolute\_error: 0.0084 23/126 [====>.........................] - ETA: 0s - loss: 9.4923e-05 - mean\_absolute\_error: 0.0077 43/126 [=========>....................] - ETA: 0s - loss: 9.7787e-05 - mean\_absolute\_error: 0.0077 65/126 [==============>...............] - ETA: 0s - loss: 1.0114e-04 - mean\_absolute\_error: 0.0078 87/126 [===================>..........] - ETA: 0s - loss: 9.9799e-05 - mean\_absolute\_error: 0.0077109/126 [========================>.....] - ETA: 0s - loss: 1.0130e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0089e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1120e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7675e-05 - mean\_absolute\_error: 0.0070 22/126 [====>.........................] - ETA: 0s - loss: 9.9352e-05 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 9.5238e-05 - mean\_absolute\_error: 0.0074 63/126 [==============>...............] - ETA: 0s - loss: 9.4846e-05 - mean\_absolute\_error: 0.0074 83/126 [==================>...........] - ETA: 0s - loss: 9.7098e-05 - mean\_absolute\_error: 0.0074104/126 [=======================>......] - ETA: 0s - loss: 9.8901e-05 - mean\_absolute\_error: 0.0075125/126 [============================>.] - ETA: 0s - loss: 9.8699e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9029e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2823e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4653e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 9.7059e-05 - mean\_absolute\_error: 0.0074 43/126 [=========>....................] - ETA: 0s - loss: 9.6790e-05 - mean\_absolute\_error: 0.0075 65/126 [==============>...............] - ETA: 0s - loss: 9.4850e-05 - mean\_absolute\_error: 0.0075 86/126 [===================>..........] - ETA: 0s - loss: 9.9089e-05 - mean\_absolute\_error: 0.0075107/126 [========================>.....] - ETA: 0s - loss: 9.8822e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9121e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0774e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7908e-05 - mean\_absolute\_error: 0.0073 20/126 [===>..........................] - ETA: 0s - loss: 9.5883e-05 - mean\_absolute\_error: 0.0077 40/126 [========>.....................] - ETA: 0s - loss: 1.0412e-04 - mean\_absolute\_error: 0.0079 61/126 [=============>................] - ETA: 0s - loss: 9.8955e-05 - mean\_absolute\_error: 0.0077 82/126 [==================>...........] - ETA: 0s - loss: 1.0464e-04 - mean\_absolute\_error: 0.0078103/126 [=======================>......] - ETA: 0s - loss: 1.1329e-04 - mean\_absolute\_error: 0.0082124/126 [============================>.] - ETA: 0s - loss: 1.1275e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1228e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.7439e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4872e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 1.1770e-04 - mean\_absolute\_error: 0.0082 43/126 [=========>....................] - ETA: 0s - loss: 1.0571e-04 - mean\_absolute\_error: 0.0077 63/126 [==============>...............] - ETA: 0s - loss: 1.0461e-04 - mean\_absolute\_error: 0.0077 83/126 [==================>...........] - ETA: 0s - loss: 1.0450e-04 - mean\_absolute\_error: 0.0078104/126 [=======================>......] - ETA: 0s - loss: 1.0414e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - ETA: 0s - loss: 1.0279e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0279e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0745e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5317e-05 - mean\_absolute\_error: 0.0057 23/126 [====>.........................] - ETA: 0s - loss: 1.0114e-04 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 1.0003e-04 - mean\_absolute\_error: 0.0075 65/126 [==============>...............] - ETA: 0s - loss: 9.4999e-05 - mean\_absolute\_error: 0.0074 86/126 [===================>..........] - ETA: 0s - loss: 9.6972e-05 - mean\_absolute\_error: 0.0075108/126 [========================>.....] - ETA: 0s - loss: 1.0241e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0453e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1138e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4261e-04 - mean\_absolute\_error: 0.0096 22/126 [====>.........................] - ETA: 0s - loss: 1.1076e-04 - mean\_absolute\_error: 0.0078 43/126 [=========>....................] - ETA: 0s - loss: 1.0573e-04 - mean\_absolute\_error: 0.0078 65/126 [==============>...............] - ETA: 0s - loss: 1.0828e-04 - mean\_absolute\_error: 0.0078 85/126 [===================>..........] - ETA: 0s - loss: 1.0438e-04 - mean\_absolute\_error: 0.0077107/126 [========================>.....] - ETA: 0s - loss: 1.0277e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0063e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.4762e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0214e-05 - mean\_absolute\_error: 0.0068 22/126 [====>.........................] - ETA: 0s - loss: 1.0601e-04 - mean\_absolute\_error: 0.0077 42/126 [=========>....................] - ETA: 0s - loss: 1.0810e-04 - mean\_absolute\_error: 0.0079 63/126 [==============>...............] - ETA: 0s - loss: 1.0049e-04 - mean\_absolute\_error: 0.0076 84/126 [===================>..........] - ETA: 0s - loss: 9.9768e-05 - mean\_absolute\_error: 0.0075105/126 [========================>.....] - ETA: 0s - loss: 1.0267e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - ETA: 0s - loss: 1.0469e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0469e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.6651e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5461e-05 - mean\_absolute\_error: 0.0075 22/126 [====>.........................] - ETA: 0s - loss: 9.9347e-05 - mean\_absolute\_error: 0.0078 42/126 [=========>....................] - ETA: 0s - loss: 1.0717e-04 - mean\_absolute\_error: 0.0081 64/126 [==============>...............] - ETA: 0s - loss: 1.0365e-04 - mean\_absolute\_error: 0.0079 84/126 [===================>..........] - ETA: 0s - loss: 1.0597e-04 - mean\_absolute\_error: 0.0078106/126 [========================>.....] - ETA: 0s - loss: 1.0331e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0247e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1551e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2281e-04 - mean\_absolute\_error: 0.0077 22/126 [====>.........................] - ETA: 0s - loss: 9.4311e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 9.6272e-05 - mean\_absolute\_error: 0.0074 64/126 [==============>...............] - ETA: 0s - loss: 9.7042e-05 - mean\_absolute\_error: 0.0074 85/126 [===================>..........] - ETA: 0s - loss: 9.8252e-05 - mean\_absolute\_error: 0.0075105/126 [========================>.....] - ETA: 0s - loss: 9.9243e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9599e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0969e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5356e-04 - mean\_absolute\_error: 0.0089 22/126 [====>.........................] - ETA: 0s - loss: 1.0441e-04 - mean\_absolute\_error: 0.0078 43/126 [=========>....................] - ETA: 0s - loss: 1.0258e-04 - mean\_absolute\_error: 0.0077 64/126 [==============>...............] - ETA: 0s - loss: 1.0228e-04 - mean\_absolute\_error: 0.0077 85/126 [===================>..........] - ETA: 0s - loss: 9.9785e-05 - mean\_absolute\_error: 0.0076105/126 [========================>.....] - ETA: 0s - loss: 1.0318e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - ETA: 0s - loss: 1.0077e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0077e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0686e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2638e-05 - mean\_absolute\_error: 0.0076 23/126 [====>.........................] - ETA: 0s - loss: 9.4307e-05 - mean\_absolute\_error: 0.0074 44/126 [=========>....................] - ETA: 0s - loss: 9.3437e-05 - mean\_absolute\_error: 0.0074 65/126 [==============>...............] - ETA: 0s - loss: 1.0472e-04 - mean\_absolute\_error: 0.0078 87/126 [===================>..........] - ETA: 0s - loss: 1.1143e-04 - mean\_absolute\_error: 0.0080109/126 [========================>.....] - ETA: 0s - loss: 1.0980e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0766e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1576e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4156e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 1.0469e-04 - mean\_absolute\_error: 0.0076 43/126 [=========>....................] - ETA: 0s - loss: 1.0251e-04 - mean\_absolute\_error: 0.0076 63/126 [==============>...............] - ETA: 0s - loss: 1.0065e-04 - mean\_absolute\_error: 0.0077 84/126 [===================>..........] - ETA: 0s - loss: 1.0491e-04 - mean\_absolute\_error: 0.0078105/126 [========================>.....] - ETA: 0s - loss: 1.0421e-04 - mean\_absolute\_error: 0.0078124/126 [============================>.] - ETA: 0s - loss: 1.0156e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0167e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.2579e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0459e-04 - mean\_absolute\_error: 0.0071 24/126 [====>.........................] - ETA: 0s - loss: 9.4786e-05 - mean\_absolute\_error: 0.0073 45/126 [=========>....................] - ETA: 0s - loss: 9.7035e-05 - mean\_absolute\_error: 0.0075 66/126 [==============>...............] - ETA: 0s - loss: 1.0735e-04 - mean\_absolute\_error: 0.0078 87/126 [===================>..........] - ETA: 0s - loss: 1.1215e-04 - mean\_absolute\_error: 0.0080108/126 [========================>.....] - ETA: 0s - loss: 1.1043e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.1137e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.4072e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4223e-05 - mean\_absolute\_error: 0.0057 23/126 [====>.........................] - ETA: 0s - loss: 8.9315e-05 - mean\_absolute\_error: 0.0074 44/126 [=========>....................] - ETA: 0s - loss: 9.8661e-05 - mean\_absolute\_error: 0.0076 64/126 [==============>...............] - ETA: 0s - loss: 1.0272e-04 - mean\_absolute\_error: 0.0077 85/126 [===================>..........] - ETA: 0s - loss: 1.0492e-04 - mean\_absolute\_error: 0.0078106/126 [========================>.....] - ETA: 0s - loss: 1.0192e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0146e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 2.1406e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6681e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 1.0996e-04 - mean\_absolute\_error: 0.0083 41/126 [========>.....................] - ETA: 0s - loss: 1.0479e-04 - mean\_absolute\_error: 0.0079 62/126 [=============>................] - ETA: 0s - loss: 1.0946e-04 - mean\_absolute\_error: 0.0080 84/126 [===================>..........] - ETA: 0s - loss: 1.0560e-04 - mean\_absolute\_error: 0.0079105/126 [========================>.....] - ETA: 0s - loss: 1.0489e-04 - mean\_absolute\_error: 0.0078124/126 [============================>.] - ETA: 0s - loss: 1.0422e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0467e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1845e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3210e-05 - mean\_absolute\_error: 0.0072 22/126 [====>.........................] - ETA: 0s - loss: 8.7779e-05 - mean\_absolute\_error: 0.0072 43/126 [=========>....................] - ETA: 0s - loss: 1.0589e-04 - mean\_absolute\_error: 0.0078 64/126 [==============>...............] - ETA: 0s - loss: 1.0476e-04 - mean\_absolute\_error: 0.0077 85/126 [===================>..........] - ETA: 0s - loss: 1.0304e-04 - mean\_absolute\_error: 0.0077107/126 [========================>.....] - ETA: 0s - loss: 1.0716e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0597e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.9205e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9457e-04 - mean\_absolute\_error: 0.0121 22/126 [====>.........................] - ETA: 0s - loss: 1.2450e-04 - mean\_absolute\_error: 0.0084 44/126 [=========>....................] - ETA: 0s - loss: 1.1283e-04 - mean\_absolute\_error: 0.0080 66/126 [==============>...............] - ETA: 0s - loss: 1.1121e-04 - mean\_absolute\_error: 0.0080 87/126 [===================>..........] - ETA: 0s - loss: 1.1337e-04 - mean\_absolute\_error: 0.0081109/126 [========================>.....] - ETA: 0s - loss: 1.1110e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1008e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.0650e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3160e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 1.0430e-04 - mean\_absolute\_error: 0.0078 43/126 [=========>....................] - ETA: 0s - loss: 1.0704e-04 - mean\_absolute\_error: 0.0079 64/126 [==============>...............] - ETA: 0s - loss: 1.0489e-04 - mean\_absolute\_error: 0.0078 84/126 [===================>..........] - ETA: 0s - loss: 1.0286e-04 - mean\_absolute\_error: 0.0077104/126 [=======================>......] - ETA: 0s - loss: 1.0490e-04 - mean\_absolute\_error: 0.0078125/126 [============================>.] - ETA: 0s - loss: 1.0471e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0470e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0651e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1180e-05 - mean\_absolute\_error: 0.0070 22/126 [====>.........................] - ETA: 0s - loss: 1.0602e-04 - mean\_absolute\_error: 0.0077 44/126 [=========>....................] - ETA: 0s - loss: 1.1305e-04 - mean\_absolute\_error: 0.0081 66/126 [==============>...............] - ETA: 0s - loss: 1.0803e-04 - mean\_absolute\_error: 0.0080 88/126 [===================>..........] - ETA: 0s - loss: 1.0774e-04 - mean\_absolute\_error: 0.0079110/126 [=========================>....] - ETA: 0s - loss: 1.0468e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0432e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1789e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8005e-05 - mean\_absolute\_error: 0.0070 22/126 [====>.........................] - ETA: 0s - loss: 8.6572e-05 - mean\_absolute\_error: 0.0072 43/126 [=========>....................] - ETA: 0s - loss: 9.9079e-05 - mean\_absolute\_error: 0.0075 64/126 [==============>...............] - ETA: 0s - loss: 1.1780e-04 - mean\_absolute\_error: 0.0083 85/126 [===================>..........] - ETA: 0s - loss: 1.2262e-04 - mean\_absolute\_error: 0.0085107/126 [========================>.....] - ETA: 0s - loss: 1.1911e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1439e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.1431e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6317e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 1.0833e-04 - mean\_absolute\_error: 0.0081 45/126 [=========>....................] - ETA: 0s - loss: 1.0593e-04 - mean\_absolute\_error: 0.0080 66/126 [==============>...............] - ETA: 0s - loss: 1.0608e-04 - mean\_absolute\_error: 0.0079 88/126 [===================>..........] - ETA: 0s - loss: 1.0606e-04 - mean\_absolute\_error: 0.0079108/126 [========================>.....] - ETA: 0s - loss: 1.1126e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1837e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.7731e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7395e-04 - mean\_absolute\_error: 0.0106 22/126 [====>.........................] - ETA: 0s - loss: 1.3058e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.2027e-04 - mean\_absolute\_error: 0.0083 65/126 [==============>...............] - ETA: 0s - loss: 1.1480e-04 - mean\_absolute\_error: 0.0082 85/126 [===================>..........] - ETA: 0s - loss: 1.1055e-04 - mean\_absolute\_error: 0.0080106/126 [========================>.....] - ETA: 0s - loss: 1.0783e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - ETA: 0s - loss: 1.1087e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1087e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.2771e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5599e-05 - mean\_absolute\_error: 0.0077 22/126 [====>.........................] - ETA: 0s - loss: 1.7042e-04 - mean\_absolute\_error: 0.0100 43/126 [=========>....................] - ETA: 0s - loss: 1.4954e-04 - mean\_absolute\_error: 0.0093 64/126 [==============>...............] - ETA: 0s - loss: 1.2649e-04 - mean\_absolute\_error: 0.0085 85/126 [===================>..........] - ETA: 0s - loss: 1.2197e-04 - mean\_absolute\_error: 0.0085104/126 [=======================>......] - ETA: 0s - loss: 1.1791e-04 - mean\_absolute\_error: 0.0083125/126 [============================>.] - ETA: 0s - loss: 1.1694e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1700e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 2.1533e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2705e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 9.1078e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 9.6800e-05 - mean\_absolute\_error: 0.0075 65/126 [==============>...............] - ETA: 0s - loss: 1.1496e-04 - mean\_absolute\_error: 0.0082 87/126 [===================>..........] - ETA: 0s - loss: 1.0997e-04 - mean\_absolute\_error: 0.0080107/126 [========================>.....] - ETA: 0s - loss: 1.1183e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1096e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.4334e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0300e-04 - mean\_absolute\_error: 0.0087 23/126 [====>.........................] - ETA: 0s - loss: 1.4672e-04 - mean\_absolute\_error: 0.0093 45/126 [=========>....................] - ETA: 0s - loss: 1.3133e-04 - mean\_absolute\_error: 0.0088 67/126 [==============>...............] - ETA: 0s - loss: 1.2124e-04 - mean\_absolute\_error: 0.0084 89/126 [====================>.........] - ETA: 0s - loss: 1.2947e-04 - mean\_absolute\_error: 0.0088109/126 [========================>.....] - ETA: 0s - loss: 1.3856e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.3290e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.2498e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3500e-05 - mean\_absolute\_error: 0.0072 23/126 [====>.........................] - ETA: 0s - loss: 1.0373e-04 - mean\_absolute\_error: 0.0078 43/126 [=========>....................] - ETA: 0s - loss: 1.0368e-04 - mean\_absolute\_error: 0.0077 64/126 [==============>...............] - ETA: 0s - loss: 1.0236e-04 - mean\_absolute\_error: 0.0077 85/126 [===================>..........] - ETA: 0s - loss: 1.0555e-04 - mean\_absolute\_error: 0.0079107/126 [========================>.....] - ETA: 0s - loss: 1.0507e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0507e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 2.7087e-04 - val\_mean\_absolute\_error: 0.0140  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1835e-04 - mean\_absolute\_error: 0.0142 23/126 [====>.........................] - ETA: 0s - loss: 1.5630e-04 - mean\_absolute\_error: 0.0096 45/126 [=========>....................] - ETA: 0s - loss: 1.3178e-04 - mean\_absolute\_error: 0.0090 66/126 [==============>...............] - ETA: 0s - loss: 1.3570e-04 - mean\_absolute\_error: 0.0090 88/126 [===================>..........] - ETA: 0s - loss: 1.3488e-04 - mean\_absolute\_error: 0.0090108/126 [========================>.....] - ETA: 0s - loss: 1.3034e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.2761e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.1408e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 7.4577e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 1.0051e-04 - mean\_absolute\_error: 0.0078 44/126 [=========>....................] - ETA: 0s - loss: 1.0120e-04 - mean\_absolute\_error: 0.0076 65/126 [==============>...............] - ETA: 0s - loss: 1.0593e-04 - mean\_absolute\_error: 0.0078 86/126 [===================>..........] - ETA: 0s - loss: 1.1056e-04 - mean\_absolute\_error: 0.0081107/126 [========================>.....] - ETA: 0s - loss: 1.1507e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1093e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0633e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3665e-05 - mean\_absolute\_error: 0.0071 22/126 [====>.........................] - ETA: 0s - loss: 1.0199e-04 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 1.0191e-04 - mean\_absolute\_error: 0.0076 63/126 [==============>...............] - ETA: 0s - loss: 1.0422e-04 - mean\_absolute\_error: 0.0077 84/126 [===================>..........] - ETA: 0s - loss: 1.0497e-04 - mean\_absolute\_error: 0.0078105/126 [========================>.....] - ETA: 0s - loss: 1.0841e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - ETA: 0s - loss: 1.1799e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1799e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 2.1348e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9315e-04 - mean\_absolute\_error: 0.0123 22/126 [====>.........................] - ETA: 0s - loss: 1.2968e-04 - mean\_absolute\_error: 0.0090 43/126 [=========>....................] - ETA: 0s - loss: 1.3337e-04 - mean\_absolute\_error: 0.0089 64/126 [==============>...............] - ETA: 0s - loss: 1.3196e-04 - mean\_absolute\_error: 0.0090 84/126 [===================>..........] - ETA: 0s - loss: 1.3354e-04 - mean\_absolute\_error: 0.0091104/126 [=======================>......] - ETA: 0s - loss: 1.4496e-04 - mean\_absolute\_error: 0.0094125/126 [============================>.] - ETA: 0s - loss: 1.4401e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.4416e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 3.0303e-04 - val\_mean\_absolute\_error: 0.0148  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3483e-04 - mean\_absolute\_error: 0.0133 22/126 [====>.........................] - ETA: 0s - loss: 1.7484e-04 - mean\_absolute\_error: 0.0104 43/126 [=========>....................] - ETA: 0s - loss: 1.4203e-04 - mean\_absolute\_error: 0.0092 65/126 [==============>...............] - ETA: 0s - loss: 1.2995e-04 - mean\_absolute\_error: 0.0088 85/126 [===================>..........] - ETA: 0s - loss: 1.2645e-04 - mean\_absolute\_error: 0.0087107/126 [========================>.....] - ETA: 0s - loss: 1.2530e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2991e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 3.6019e-04 - val\_mean\_absolute\_error: 0.0167  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3028e-04 - mean\_absolute\_error: 0.0157 20/126 [===>..........................] - ETA: 0s - loss: 1.6482e-04 - mean\_absolute\_error: 0.0103 40/126 [========>.....................] - ETA: 0s - loss: 1.2830e-04 - mean\_absolute\_error: 0.0088 62/126 [=============>................] - ETA: 0s - loss: 1.2333e-04 - mean\_absolute\_error: 0.0085 84/126 [===================>..........] - ETA: 0s - loss: 1.1710e-04 - mean\_absolute\_error: 0.0083106/126 [========================>.....] - ETA: 0s - loss: 1.1352e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.2111e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.1521e-04 - val\_mean\_absolute\_error: 0.0182  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2063e-04 - mean\_absolute\_error: 0.0152 22/126 [====>.........................] - ETA: 0s - loss: 1.7736e-04 - mean\_absolute\_error: 0.0106 43/126 [=========>....................] - ETA: 0s - loss: 1.6148e-04 - mean\_absolute\_error: 0.0102 64/126 [==============>...............] - ETA: 0s - loss: 1.5840e-04 - mean\_absolute\_error: 0.0100 84/126 [===================>..........] - ETA: 0s - loss: 1.4321e-04 - mean\_absolute\_error: 0.0093104/126 [=======================>......] - ETA: 0s - loss: 1.3476e-04 - mean\_absolute\_error: 0.0090125/126 [============================>.] - ETA: 0s - loss: 1.2823e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2809e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.4294e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8898e-05 - mean\_absolute\_error: 0.0077 22/126 [====>.........................] - ETA: 0s - loss: 9.3644e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 1.0294e-04 - mean\_absolute\_error: 0.0077 64/126 [==============>...............] - ETA: 0s - loss: 1.1206e-04 - mean\_absolute\_error: 0.0082 85/126 [===================>..........] - ETA: 0s - loss: 1.1837e-04 - mean\_absolute\_error: 0.0084106/126 [========================>.....] - ETA: 0s - loss: 1.1385e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1422e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.7244e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5337e-04 - mean\_absolute\_error: 0.0096 22/126 [====>.........................] - ETA: 0s - loss: 1.0294e-04 - mean\_absolute\_error: 0.0079 43/126 [=========>....................] - ETA: 0s - loss: 1.1680e-04 - mean\_absolute\_error: 0.0083 65/126 [==============>...............] - ETA: 0s - loss: 1.1446e-04 - mean\_absolute\_error: 0.0081 86/126 [===================>..........] - ETA: 0s - loss: 1.1039e-04 - mean\_absolute\_error: 0.0080106/126 [========================>.....] - ETA: 0s - loss: 1.0948e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0703e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0508e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3754e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 1.1235e-04 - mean\_absolute\_error: 0.0079 43/126 [=========>....................] - ETA: 0s - loss: 1.2766e-04 - mean\_absolute\_error: 0.0087 63/126 [==============>...............] - ETA: 0s - loss: 1.2072e-04 - mean\_absolute\_error: 0.0084 83/126 [==================>...........] - ETA: 0s - loss: 1.1444e-04 - mean\_absolute\_error: 0.0082104/126 [=======================>......] - ETA: 0s - loss: 1.1003e-04 - mean\_absolute\_error: 0.0080125/126 [============================>.] - ETA: 0s - loss: 1.0779e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0797e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0744e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5726e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 1.3994e-04 - mean\_absolute\_error: 0.0088 43/126 [=========>....................] - ETA: 0s - loss: 1.2026e-04 - mean\_absolute\_error: 0.0083 64/126 [==============>...............] - ETA: 0s - loss: 1.1284e-04 - mean\_absolute\_error: 0.0081 85/126 [===================>..........] - ETA: 0s - loss: 1.1703e-04 - mean\_absolute\_error: 0.0083106/126 [========================>.....] - ETA: 0s - loss: 1.1752e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1691e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0446e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7980e-05 - mean\_absolute\_error: 0.0047 22/126 [====>.........................] - ETA: 0s - loss: 1.2605e-04 - mean\_absolute\_error: 0.0084 43/126 [=========>....................] - ETA: 0s - loss: 1.1569e-04 - mean\_absolute\_error: 0.0080 64/126 [==============>...............] - ETA: 0s - loss: 1.1509e-04 - mean\_absolute\_error: 0.0080 85/126 [===================>..........] - ETA: 0s - loss: 1.1192e-04 - mean\_absolute\_error: 0.0080106/126 [========================>.....] - ETA: 0s - loss: 1.2136e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1731e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0578e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9099e-04 - mean\_absolute\_error: 0.0086 23/126 [====>.........................] - ETA: 0s - loss: 1.2315e-04 - mean\_absolute\_error: 0.0079 44/126 [=========>....................] - ETA: 0s - loss: 1.0625e-04 - mean\_absolute\_error: 0.0076 65/126 [==============>...............] - ETA: 0s - loss: 1.0594e-04 - mean\_absolute\_error: 0.0076 86/126 [===================>..........] - ETA: 0s - loss: 1.0484e-04 - mean\_absolute\_error: 0.0077107/126 [========================>.....] - ETA: 0s - loss: 1.0473e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.1886e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.9069e-04 - val\_mean\_absolute\_error: 0.0114  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6852e-05 - mean\_absolute\_error: 0.0069 22/126 [====>.........................] - ETA: 0s - loss: 1.1452e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.1142e-04 - mean\_absolute\_error: 0.0079 63/126 [==============>...............] - ETA: 0s - loss: 1.1350e-04 - mean\_absolute\_error: 0.0080 84/126 [===================>..........] - ETA: 0s - loss: 1.1815e-04 - mean\_absolute\_error: 0.0082105/126 [========================>.....] - ETA: 0s - loss: 1.1162e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - ETA: 0s - loss: 1.1030e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1030e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1034e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0950e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 9.1591e-05 - mean\_absolute\_error: 0.0073 44/126 [=========>....................] - ETA: 0s - loss: 1.0111e-04 - mean\_absolute\_error: 0.0075 64/126 [==============>...............] - ETA: 0s - loss: 9.8061e-05 - mean\_absolute\_error: 0.0075 86/126 [===================>..........] - ETA: 0s - loss: 1.0377e-04 - mean\_absolute\_error: 0.0077106/126 [========================>.....] - ETA: 0s - loss: 1.0431e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0489e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0381e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8163e-05 - mean\_absolute\_error: 0.0057 23/126 [====>.........................] - ETA: 0s - loss: 1.1447e-04 - mean\_absolute\_error: 0.0082 45/126 [=========>....................] - ETA: 0s - loss: 1.0783e-04 - mean\_absolute\_error: 0.0080 66/126 [==============>...............] - ETA: 0s - loss: 1.1559e-04 - mean\_absolute\_error: 0.0082 87/126 [===================>..........] - ETA: 0s - loss: 1.1483e-04 - mean\_absolute\_error: 0.0082108/126 [========================>.....] - ETA: 0s - loss: 1.1497e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.2754e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.5588e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2806e-04 - mean\_absolute\_error: 0.0094 23/126 [====>.........................] - ETA: 0s - loss: 1.1799e-04 - mean\_absolute\_error: 0.0084 44/126 [=========>....................] - ETA: 0s - loss: 1.0942e-04 - mean\_absolute\_error: 0.0081 65/126 [==============>...............] - ETA: 0s - loss: 1.2203e-04 - mean\_absolute\_error: 0.0085 86/126 [===================>..........] - ETA: 0s - loss: 1.2888e-04 - mean\_absolute\_error: 0.0089107/126 [========================>.....] - ETA: 0s - loss: 1.2545e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2213e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 2.2009e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6213e-04 - mean\_absolute\_error: 0.0143 23/126 [====>.........................] - ETA: 0s - loss: 1.3671e-04 - mean\_absolute\_error: 0.0090 44/126 [=========>....................] - ETA: 0s - loss: 1.4129e-04 - mean\_absolute\_error: 0.0092 65/126 [==============>...............] - ETA: 0s - loss: 1.3062e-04 - mean\_absolute\_error: 0.0089 87/126 [===================>..........] - ETA: 0s - loss: 1.2004e-04 - mean\_absolute\_error: 0.0085107/126 [========================>.....] - ETA: 0s - loss: 1.1297e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1093e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0750e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8650e-05 - mean\_absolute\_error: 0.0057 22/126 [====>.........................] - ETA: 0s - loss: 1.0980e-04 - mean\_absolute\_error: 0.0081 43/126 [=========>....................] - ETA: 0s - loss: 1.5326e-04 - mean\_absolute\_error: 0.0097 63/126 [==============>...............] - ETA: 0s - loss: 1.5170e-04 - mean\_absolute\_error: 0.0096 85/126 [===================>..........] - ETA: 0s - loss: 1.4599e-04 - mean\_absolute\_error: 0.0094106/126 [========================>.....] - ETA: 0s - loss: 1.3724e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.3478e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.4565e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5555e-04 - mean\_absolute\_error: 0.0109 22/126 [====>.........................] - ETA: 0s - loss: 1.1282e-04 - mean\_absolute\_error: 0.0077 43/126 [=========>....................] - ETA: 0s - loss: 9.8152e-05 - mean\_absolute\_error: 0.0074 65/126 [==============>...............] - ETA: 0s - loss: 9.9578e-05 - mean\_absolute\_error: 0.0075 87/126 [===================>..........] - ETA: 0s - loss: 1.0753e-04 - mean\_absolute\_error: 0.0078108/126 [========================>.....] - ETA: 0s - loss: 1.0741e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0507e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.3969e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1526e-04 - mean\_absolute\_error: 0.0089 21/126 [====>.........................] - ETA: 0s - loss: 9.3532e-05 - mean\_absolute\_error: 0.0073 43/126 [=========>....................] - ETA: 0s - loss: 9.9178e-05 - mean\_absolute\_error: 0.0077 64/126 [==============>...............] - ETA: 0s - loss: 1.0807e-04 - mean\_absolute\_error: 0.0081 85/126 [===================>..........] - ETA: 0s - loss: 1.0922e-04 - mean\_absolute\_error: 0.0080106/126 [========================>.....] - ETA: 0s - loss: 1.0825e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0658e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1242e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3851e-05 - mean\_absolute\_error: 0.0067 22/126 [====>.........................] - ETA: 0s - loss: 1.0088e-04 - mean\_absolute\_error: 0.0074 42/126 [=========>....................] - ETA: 0s - loss: 9.6305e-05 - mean\_absolute\_error: 0.0074 63/126 [==============>...............] - ETA: 0s - loss: 9.9518e-05 - mean\_absolute\_error: 0.0076 85/126 [===================>..........] - ETA: 0s - loss: 1.0379e-04 - mean\_absolute\_error: 0.0078106/126 [========================>.....] - ETA: 0s - loss: 1.0671e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0605e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.6372e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2157e-04 - mean\_absolute\_error: 0.0094 22/126 [====>.........................] - ETA: 0s - loss: 1.0971e-04 - mean\_absolute\_error: 0.0083 44/126 [=========>....................] - ETA: 0s - loss: 1.0885e-04 - mean\_absolute\_error: 0.0080 65/126 [==============>...............] - ETA: 0s - loss: 1.0751e-04 - mean\_absolute\_error: 0.0079 86/126 [===================>..........] - ETA: 0s - loss: 1.0841e-04 - mean\_absolute\_error: 0.0079107/126 [========================>.....] - ETA: 0s - loss: 1.0577e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0430e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.5487e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6802e-05 - mean\_absolute\_error: 0.0089 22/126 [====>.........................] - ETA: 0s - loss: 1.0504e-04 - mean\_absolute\_error: 0.0077 43/126 [=========>....................] - ETA: 0s - loss: 1.0076e-04 - mean\_absolute\_error: 0.0076 64/126 [==============>...............] - ETA: 0s - loss: 1.1288e-04 - mean\_absolute\_error: 0.0081 85/126 [===================>..........] - ETA: 0s - loss: 1.1648e-04 - mean\_absolute\_error: 0.0082107/126 [========================>.....] - ETA: 0s - loss: 1.2781e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2585e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.3233e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5284e-04 - mean\_absolute\_error: 0.0101 23/126 [====>.........................] - ETA: 0s - loss: 1.1390e-04 - mean\_absolute\_error: 0.0082 44/126 [=========>....................] - ETA: 0s - loss: 1.0575e-04 - mean\_absolute\_error: 0.0080 64/126 [==============>...............] - ETA: 0s - loss: 1.0324e-04 - mean\_absolute\_error: 0.0079 85/126 [===================>..........] - ETA: 0s - loss: 1.0984e-04 - mean\_absolute\_error: 0.0081107/126 [========================>.....] - ETA: 0s - loss: 1.0589e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0372e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.9118e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8737e-04 - mean\_absolute\_error: 0.0117 23/126 [====>.........................] - ETA: 0s - loss: 9.7485e-05 - mean\_absolute\_error: 0.0075 44/126 [=========>....................] - ETA: 0s - loss: 9.6542e-05 - mean\_absolute\_error: 0.0076 64/126 [==============>...............] - ETA: 0s - loss: 9.6869e-05 - mean\_absolute\_error: 0.0075 85/126 [===================>..........] - ETA: 0s - loss: 1.1992e-04 - mean\_absolute\_error: 0.0084106/126 [========================>.....] - ETA: 0s - loss: 1.3277e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - ETA: 0s - loss: 1.3640e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.3640e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 2.0540e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9189e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 1.6145e-04 - mean\_absolute\_error: 0.0100 44/126 [=========>....................] - ETA: 0s - loss: 1.4486e-04 - mean\_absolute\_error: 0.0094 65/126 [==============>...............] - ETA: 0s - loss: 1.2550e-04 - mean\_absolute\_error: 0.0087 85/126 [===================>..........] - ETA: 0s - loss: 1.2121e-04 - mean\_absolute\_error: 0.0085106/126 [========================>.....] - ETA: 0s - loss: 1.2029e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2557e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.2742e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0300e-04 - mean\_absolute\_error: 0.0076 21/126 [====>.........................] - ETA: 0s - loss: 1.1947e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.0548e-04 - mean\_absolute\_error: 0.0078 63/126 [==============>...............] - ETA: 0s - loss: 1.0126e-04 - mean\_absolute\_error: 0.0076 84/126 [===================>..........] - ETA: 0s - loss: 1.0581e-04 - mean\_absolute\_error: 0.0078105/126 [========================>.....] - ETA: 0s - loss: 1.0354e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - ETA: 0s - loss: 1.0559e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0559e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0153e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4871e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 1.0480e-04 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 1.0204e-04 - mean\_absolute\_error: 0.0075 64/126 [==============>...............] - ETA: 0s - loss: 9.8123e-05 - mean\_absolute\_error: 0.0074 86/126 [===================>..........] - ETA: 0s - loss: 1.0049e-04 - mean\_absolute\_error: 0.0076107/126 [========================>.....] - ETA: 0s - loss: 1.0263e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0694e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.2628e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5123e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 1.4668e-04 - mean\_absolute\_error: 0.0095 44/126 [=========>....................] - ETA: 0s - loss: 1.2305e-04 - mean\_absolute\_error: 0.0086 64/126 [==============>...............] - ETA: 0s - loss: 1.1815e-04 - mean\_absolute\_error: 0.0083 86/126 [===================>..........] - ETA: 0s - loss: 1.2066e-04 - mean\_absolute\_error: 0.0085107/126 [========================>.....] - ETA: 0s - loss: 1.2542e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2553e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 2.1228e-04 - val\_mean\_absolute\_error: 0.0119  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2488e-04 - mean\_absolute\_error: 0.0130 22/126 [====>.........................] - ETA: 0s - loss: 1.2613e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.2403e-04 - mean\_absolute\_error: 0.0086 66/126 [==============>...............] - ETA: 0s - loss: 1.1504e-04 - mean\_absolute\_error: 0.0082 87/126 [===================>..........] - ETA: 0s - loss: 1.1712e-04 - mean\_absolute\_error: 0.0084108/126 [========================>.....] - ETA: 0s - loss: 1.1450e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1717e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 2.4355e-04 - val\_mean\_absolute\_error: 0.0133  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8090e-04 - mean\_absolute\_error: 0.0114 23/126 [====>.........................] - ETA: 0s - loss: 1.0578e-04 - mean\_absolute\_error: 0.0079 44/126 [=========>....................] - ETA: 0s - loss: 1.1464e-04 - mean\_absolute\_error: 0.0083 65/126 [==============>...............] - ETA: 0s - loss: 1.0890e-04 - mean\_absolute\_error: 0.0080 85/126 [===================>..........] - ETA: 0s - loss: 1.0947e-04 - mean\_absolute\_error: 0.0080105/126 [========================>.....] - ETA: 0s - loss: 1.1395e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1242e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.4747e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2218e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 1.2449e-04 - mean\_absolute\_error: 0.0085 44/126 [=========>....................] - ETA: 0s - loss: 1.0933e-04 - mean\_absolute\_error: 0.0079 66/126 [==============>...............] - ETA: 0s - loss: 1.0457e-04 - mean\_absolute\_error: 0.0077 87/126 [===================>..........] - ETA: 0s - loss: 1.0094e-04 - mean\_absolute\_error: 0.0075108/126 [========================>.....] - ETA: 0s - loss: 1.0023e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0006e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.4488e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8058e-05 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 1.0649e-04 - mean\_absolute\_error: 0.0078 44/126 [=========>....................] - ETA: 0s - loss: 1.1479e-04 - mean\_absolute\_error: 0.0081 65/126 [==============>...............] - ETA: 0s - loss: 1.0768e-04 - mean\_absolute\_error: 0.0079 86/126 [===================>..........] - ETA: 0s - loss: 1.0165e-04 - mean\_absolute\_error: 0.0077107/126 [========================>.....] - ETA: 0s - loss: 1.0317e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0451e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0132e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1034e-05 - mean\_absolute\_error: 0.0075 22/126 [====>.........................] - ETA: 0s - loss: 1.2100e-04 - mean\_absolute\_error: 0.0084 43/126 [=========>....................] - ETA: 0s - loss: 1.0192e-04 - mean\_absolute\_error: 0.0077 65/126 [==============>...............] - ETA: 0s - loss: 1.0755e-04 - mean\_absolute\_error: 0.0080 86/126 [===================>..........] - ETA: 0s - loss: 1.0692e-04 - mean\_absolute\_error: 0.0079107/126 [========================>.....] - ETA: 0s - loss: 1.0534e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0755e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.9897e-04 - val\_mean\_absolute\_error: 0.0118  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4148e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 1.0264e-04 - mean\_absolute\_error: 0.0079 42/126 [=========>....................] - ETA: 0s - loss: 1.0347e-04 - mean\_absolute\_error: 0.0078 63/126 [==============>...............] - ETA: 0s - loss: 1.0605e-04 - mean\_absolute\_error: 0.0078 84/126 [===================>..........] - ETA: 0s - loss: 1.0287e-04 - mean\_absolute\_error: 0.0077106/126 [========================>.....] - ETA: 0s - loss: 1.0472e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - ETA: 0s - loss: 1.0115e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0115e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 9.9918e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3888e-05 - mean\_absolute\_error: 0.0064 22/126 [====>.........................] - ETA: 0s - loss: 7.7180e-05 - mean\_absolute\_error: 0.0068 43/126 [=========>....................] - ETA: 0s - loss: 8.5273e-05 - mean\_absolute\_error: 0.0072 64/126 [==============>...............] - ETA: 0s - loss: 8.8907e-05 - mean\_absolute\_error: 0.0073 86/126 [===================>..........] - ETA: 0s - loss: 9.5319e-05 - mean\_absolute\_error: 0.0075107/126 [========================>.....] - ETA: 0s - loss: 9.6080e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 1.0368e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.3413e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4233e-04 - mean\_absolute\_error: 0.0096 23/126 [====>.........................] - ETA: 0s - loss: 1.3652e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.2706e-04 - mean\_absolute\_error: 0.0085 65/126 [==============>...............] - ETA: 0s - loss: 1.1454e-04 - mean\_absolute\_error: 0.0081 86/126 [===================>..........] - ETA: 0s - loss: 1.0817e-04 - mean\_absolute\_error: 0.0079107/126 [========================>.....] - ETA: 0s - loss: 1.0286e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0240e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0151e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1911e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 1.0498e-04 - mean\_absolute\_error: 0.0080 44/126 [=========>....................] - ETA: 0s - loss: 1.0607e-04 - mean\_absolute\_error: 0.0080 65/126 [==============>...............] - ETA: 0s - loss: 1.0399e-04 - mean\_absolute\_error: 0.0078 86/126 [===================>..........] - ETA: 0s - loss: 1.0143e-04 - mean\_absolute\_error: 0.0077106/126 [========================>.....] - ETA: 0s - loss: 1.0295e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0062e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.5761e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1430e-04 - mean\_absolute\_error: 0.0078 22/126 [====>.........................] - ETA: 0s - loss: 1.1385e-04 - mean\_absolute\_error: 0.0082 43/126 [=========>....................] - ETA: 0s - loss: 1.2001e-04 - mean\_absolute\_error: 0.0085 65/126 [==============>...............] - ETA: 0s - loss: 1.1413e-04 - mean\_absolute\_error: 0.0082 85/126 [===================>..........] - ETA: 0s - loss: 1.0882e-04 - mean\_absolute\_error: 0.0080106/126 [========================>.....] - ETA: 0s - loss: 1.0695e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.1000e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0428e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 9.4921e-05 - mean\_absolute\_error: 0.0077 22/126 [====>.........................] - ETA: 0s - loss: 1.8020e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 1.5421e-04 - mean\_absolute\_error: 0.0099 65/126 [==============>...............] - ETA: 0s - loss: 1.3247e-04 - mean\_absolute\_error: 0.0090 87/126 [===================>..........] - ETA: 0s - loss: 1.2305e-04 - mean\_absolute\_error: 0.0086107/126 [========================>.....] - ETA: 0s - loss: 1.2630e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2509e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.7936e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6949e-05 - mean\_absolute\_error: 0.0062 22/126 [====>.........................] - ETA: 0s - loss: 9.9317e-05 - mean\_absolute\_error: 0.0077 42/126 [=========>....................] - ETA: 0s - loss: 9.4227e-05 - mean\_absolute\_error: 0.0074 62/126 [=============>................] - ETA: 0s - loss: 1.0545e-04 - mean\_absolute\_error: 0.0079 83/126 [==================>...........] - ETA: 0s - loss: 1.0920e-04 - mean\_absolute\_error: 0.0080103/126 [=======================>......] - ETA: 0s - loss: 1.1677e-04 - mean\_absolute\_error: 0.0083123/126 [============================>.] - ETA: 0s - loss: 1.1181e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1103e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 9.6894e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4228e-05 - mean\_absolute\_error: 0.0057 23/126 [====>.........................] - ETA: 0s - loss: 1.0005e-04 - mean\_absolute\_error: 0.0073 45/126 [=========>....................] - ETA: 0s - loss: 9.5727e-05 - mean\_absolute\_error: 0.0074 66/126 [==============>...............] - ETA: 0s - loss: 1.1783e-04 - mean\_absolute\_error: 0.0083 85/126 [===================>..........] - ETA: 0s - loss: 1.1435e-04 - mean\_absolute\_error: 0.0081106/126 [========================>.....] - ETA: 0s - loss: 1.1095e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0905e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.2111e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3509e-04 - mean\_absolute\_error: 0.0136 22/126 [====>.........................] - ETA: 0s - loss: 1.0228e-04 - mean\_absolute\_error: 0.0079 43/126 [=========>....................] - ETA: 0s - loss: 1.0683e-04 - mean\_absolute\_error: 0.0080 65/126 [==============>...............] - ETA: 0s - loss: 1.0217e-04 - mean\_absolute\_error: 0.0077 87/126 [===================>..........] - ETA: 0s - loss: 9.5354e-05 - mean\_absolute\_error: 0.0074107/126 [========================>.....] - ETA: 0s - loss: 9.6876e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9534e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1600e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1056e-04 - mean\_absolute\_error: 0.0079 21/126 [====>.........................] - ETA: 0s - loss: 1.1784e-04 - mean\_absolute\_error: 0.0086 32/126 [======>.......................] - ETA: 0s - loss: 1.0984e-04 - mean\_absolute\_error: 0.0083 49/126 [==========>...................] - ETA: 0s - loss: 1.1547e-04 - mean\_absolute\_error: 0.0084 70/126 [===============>..............] - ETA: 0s - loss: 1.2312e-04 - mean\_absolute\_error: 0.0087 91/126 [====================>.........] - ETA: 0s - loss: 1.1737e-04 - mean\_absolute\_error: 0.0085113/126 [=========================>....] - ETA: 0s - loss: 1.1795e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.1786e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.6297e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7671e-04 - mean\_absolute\_error: 0.0109 23/126 [====>.........................] - ETA: 0s - loss: 1.0880e-04 - mean\_absolute\_error: 0.0081 44/126 [=========>....................] - ETA: 0s - loss: 1.0883e-04 - mean\_absolute\_error: 0.0081 64/126 [==============>...............] - ETA: 0s - loss: 1.2369e-04 - mean\_absolute\_error: 0.0087 86/126 [===================>..........] - ETA: 0s - loss: 1.2220e-04 - mean\_absolute\_error: 0.0086106/126 [========================>.....] - ETA: 0s - loss: 1.1696e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1888e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 2.4274e-04 - val\_mean\_absolute\_error: 0.0130  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9470e-04 - mean\_absolute\_error: 0.0119 22/126 [====>.........................] - ETA: 0s - loss: 1.2486e-04 - mean\_absolute\_error: 0.0089 43/126 [=========>....................] - ETA: 0s - loss: 1.8454e-04 - mean\_absolute\_error: 0.0109 64/126 [==============>...............] - ETA: 0s - loss: 1.6302e-04 - mean\_absolute\_error: 0.0101 85/126 [===================>..........] - ETA: 0s - loss: 1.4926e-04 - mean\_absolute\_error: 0.0096106/126 [========================>.....] - ETA: 0s - loss: 1.3730e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.3263e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.4962e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5426e-04 - mean\_absolute\_error: 0.0102 23/126 [====>.........................] - ETA: 0s - loss: 1.2283e-04 - mean\_absolute\_error: 0.0086 43/126 [=========>....................] - ETA: 0s - loss: 1.1853e-04 - mean\_absolute\_error: 0.0084 63/126 [==============>...............] - ETA: 0s - loss: 1.1119e-04 - mean\_absolute\_error: 0.0082 85/126 [===================>..........] - ETA: 0s - loss: 1.0956e-04 - mean\_absolute\_error: 0.0081106/126 [========================>.....] - ETA: 0s - loss: 1.1564e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1472e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 9.9147e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1188e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 9.2428e-05 - mean\_absolute\_error: 0.0070 43/126 [=========>....................] - ETA: 0s - loss: 9.8163e-05 - mean\_absolute\_error: 0.0075 64/126 [==============>...............] - ETA: 0s - loss: 1.0560e-04 - mean\_absolute\_error: 0.0078 85/126 [===================>..........] - ETA: 0s - loss: 1.0545e-04 - mean\_absolute\_error: 0.0079105/126 [========================>.....] - ETA: 0s - loss: 1.1717e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - ETA: 0s - loss: 1.1511e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1511e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0176e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9912e-05 - mean\_absolute\_error: 0.0081 22/126 [====>.........................] - ETA: 0s - loss: 1.0235e-04 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 9.5590e-05 - mean\_absolute\_error: 0.0074 64/126 [==============>...............] - ETA: 0s - loss: 9.7192e-05 - mean\_absolute\_error: 0.0075 85/126 [===================>..........] - ETA: 0s - loss: 9.7944e-05 - mean\_absolute\_error: 0.0075106/126 [========================>.....] - ETA: 0s - loss: 9.8683e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 1.0037e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0112e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7883e-04 - mean\_absolute\_error: 0.0086 19/126 [===>..........................] - ETA: 0s - loss: 1.2334e-04 - mean\_absolute\_error: 0.0084 40/126 [========>.....................] - ETA: 0s - loss: 1.0395e-04 - mean\_absolute\_error: 0.0076 61/126 [=============>................] - ETA: 0s - loss: 1.1220e-04 - mean\_absolute\_error: 0.0080 83/126 [==================>...........] - ETA: 0s - loss: 1.1668e-04 - mean\_absolute\_error: 0.0082104/126 [=======================>......] - ETA: 0s - loss: 1.1022e-04 - mean\_absolute\_error: 0.0080125/126 [============================>.] - ETA: 0s - loss: 1.1019e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1011e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.0429e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4735e-04 - mean\_absolute\_error: 0.0101 22/126 [====>.........................] - ETA: 0s - loss: 1.0035e-04 - mean\_absolute\_error: 0.0077 44/126 [=========>....................] - ETA: 0s - loss: 9.7419e-05 - mean\_absolute\_error: 0.0076 66/126 [==============>...............] - ETA: 0s - loss: 9.2617e-05 - mean\_absolute\_error: 0.0074 87/126 [===================>..........] - ETA: 0s - loss: 9.7041e-05 - mean\_absolute\_error: 0.0076108/126 [========================>.....] - ETA: 0s - loss: 9.7585e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.5883e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 9.7054e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9805e-05 - mean\_absolute\_error: 0.0057 22/126 [====>.........................] - ETA: 0s - loss: 1.0031e-04 - mean\_absolute\_error: 0.0077 42/126 [=========>....................] - ETA: 0s - loss: 9.7140e-05 - mean\_absolute\_error: 0.0075 63/126 [==============>...............] - ETA: 0s - loss: 9.2938e-05 - mean\_absolute\_error: 0.0073 84/126 [===================>..........] - ETA: 0s - loss: 8.9800e-05 - mean\_absolute\_error: 0.0072105/126 [========================>.....] - ETA: 0s - loss: 8.9302e-05 - mean\_absolute\_error: 0.0072126/126 [==============================] - ETA: 0s - loss: 9.2962e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.2962e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 9.6926e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1329e-05 - mean\_absolute\_error: 0.0051 23/126 [====>.........................] - ETA: 0s - loss: 9.7998e-05 - mean\_absolute\_error: 0.0074 45/126 [=========>....................] - ETA: 0s - loss: 9.8686e-05 - mean\_absolute\_error: 0.0075 66/126 [==============>...............] - ETA: 0s - loss: 9.5845e-05 - mean\_absolute\_error: 0.0075 87/126 [===================>..........] - ETA: 0s - loss: 1.0363e-04 - mean\_absolute\_error: 0.0078108/126 [========================>.....] - ETA: 0s - loss: 9.9877e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9707e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.2586e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0403e-04 - mean\_absolute\_error: 0.0083 21/126 [====>.........................] - ETA: 0s - loss: 1.4653e-04 - mean\_absolute\_error: 0.0096 43/126 [=========>....................] - ETA: 0s - loss: 1.2883e-04 - mean\_absolute\_error: 0.0088 64/126 [==============>...............] - ETA: 0s - loss: 1.1894e-04 - mean\_absolute\_error: 0.0084 85/126 [===================>..........] - ETA: 0s - loss: 1.1901e-04 - mean\_absolute\_error: 0.0084107/126 [========================>.....] - ETA: 0s - loss: 1.1938e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2011e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.5342e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9934e-05 - mean\_absolute\_error: 0.0078 22/126 [====>.........................] - ETA: 0s - loss: 1.2039e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.0407e-04 - mean\_absolute\_error: 0.0078 64/126 [==============>...............] - ETA: 0s - loss: 9.8603e-05 - mean\_absolute\_error: 0.0076 86/126 [===================>..........] - ETA: 0s - loss: 9.5801e-05 - mean\_absolute\_error: 0.0075107/126 [========================>.....] - ETA: 0s - loss: 9.5232e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - ETA: 0s - loss: 9.3355e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.3355e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0770e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4648e-05 - mean\_absolute\_error: 0.0072 22/126 [====>.........................] - ETA: 0s - loss: 1.2386e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.1099e-04 - mean\_absolute\_error: 0.0082 63/126 [==============>...............] - ETA: 0s - loss: 1.0605e-04 - mean\_absolute\_error: 0.0079 84/126 [===================>..........] - ETA: 0s - loss: 1.0682e-04 - mean\_absolute\_error: 0.0080104/126 [=======================>......] - ETA: 0s - loss: 1.0745e-04 - mean\_absolute\_error: 0.0080124/126 [============================>.] - ETA: 0s - loss: 1.1299e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1292e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.2199e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6519e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 8.0902e-05 - mean\_absolute\_error: 0.0071 43/126 [=========>....................] - ETA: 0s - loss: 8.4649e-05 - mean\_absolute\_error: 0.0070 64/126 [==============>...............] - ETA: 0s - loss: 9.7488e-05 - mean\_absolute\_error: 0.0076 86/126 [===================>..........] - ETA: 0s - loss: 9.8691e-05 - mean\_absolute\_error: 0.0076108/126 [========================>.....] - ETA: 0s - loss: 9.9277e-05 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 9.9577e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.3513e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0797e-04 - mean\_absolute\_error: 0.0082 22/126 [====>.........................] - ETA: 0s - loss: 1.1409e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.2029e-04 - mean\_absolute\_error: 0.0086 64/126 [==============>...............] - ETA: 0s - loss: 1.0939e-04 - mean\_absolute\_error: 0.0081 85/126 [===================>..........] - ETA: 0s - loss: 1.0266e-04 - mean\_absolute\_error: 0.0078106/126 [========================>.....] - ETA: 0s - loss: 1.0857e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0657e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0609e-04 - val\_mean\_absolute\_error: 0.0082

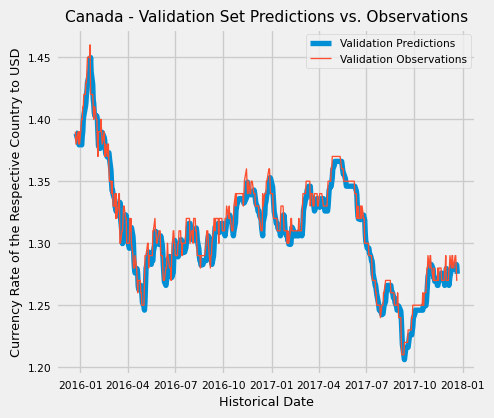
<keras.src.callbacks.History at 0x24c3c712c90>

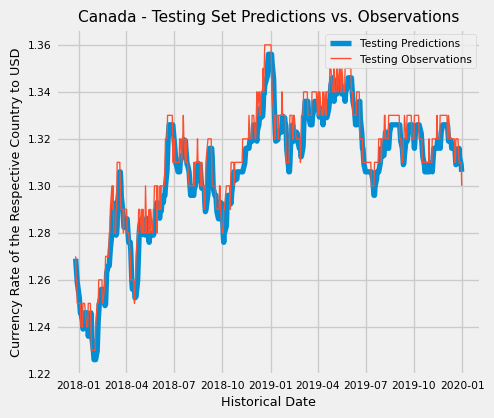
After the training and fitting of the Machine Learning model for Canada, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue lines represent the prediction model’s projections and the thinner red lines is the observed/gathered data.

```{python}  
# Testing the Machine Learning Model prediction for Austrailia with the train,   
# validation, and test sets  
# Most important is the test set prediction as this tests the effectiveness  
# of the Machine Learning model on data it has not seen before   
canada\_train\_pred = canada\_model.predict(X\_canada\_train).flatten()  
  
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4)  
plt.plot(dates\_canada\_train, y\_canada\_train, linewidth=1)  
plt.legend(["Training Predictions", "Training Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Canada - Training Set Predictions vs. Observations")  
plt.show()  
  
canada\_val\_pred = canada\_model.predict(X\_canada\_val).flatten()  
  
plt.plot(dates\_canada\_val, canada\_val\_pred, linewidth=4)  
plt.plot(dates\_canada\_val, y\_canada\_val, linewidth=1)  
plt.legend(["Validation Predictions", "Validation Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Canada - Validation Set Predictions vs. Observations")  
plt.show()  
  
canada\_test\_pred = canada\_model.predict(X\_canada\_test).flatten()  
  
plt.plot(dates\_canada\_test, canada\_test\_pred, linewidth=4)  
plt.plot(dates\_canada\_test, y\_canada\_test, linewidth=1)  
plt.legend(["Testing Predictions", "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Canada - Testing Set Predictions vs. Observations")  
plt.show()  
```

1/126 [..............................] - ETA: 44s 43/126 [=========>....................] - ETA: 0s 84/126 [===================>..........] - ETA: 0s126/126 [==============================] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

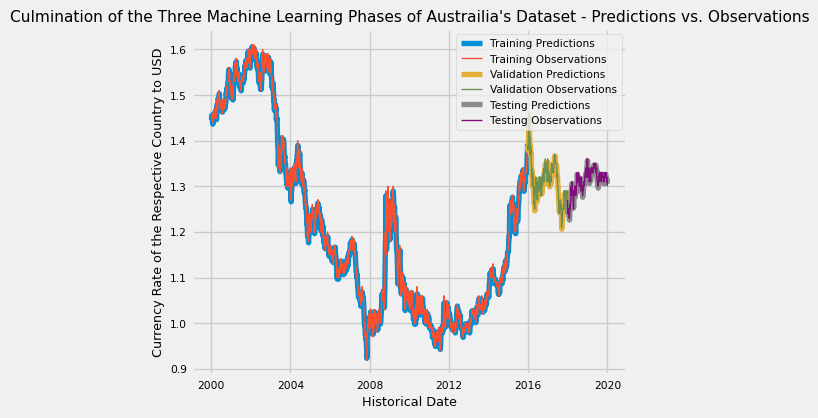






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and fitting towards predicting Canada’s international currency rate with the United States.

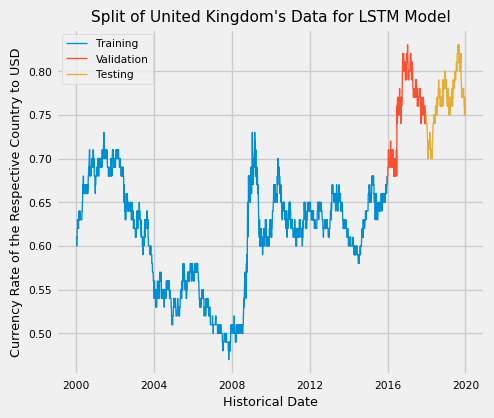
```{python}  
# Plotting Canada's observational (reference) data with the predictions of its   
# Machine Learning Model (as a way to visually inspect the effectiveness of the   
# model)   
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4)  
plt.plot(dates\_canada\_train, y\_canada\_train, linewidth=1)  
plt.plot(dates\_canada\_val, canada\_val\_pred, linewidth=4)  
plt.plot(dates\_canada\_val, y\_canada\_val, linewidth=1)  
plt.plot(dates\_canada\_test, canada\_test\_pred, linewidth=4)  
plt.plot(dates\_canada\_test, y\_canada\_test, linewidth=1)  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations"], loc="upper right")  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of Austrailia's Dataset - Predictions vs. Observations")  
plt.show()  
```



Then, I worked on the United Kingdom’s data (as shown below):

Since the data (date, X, and y) is split into three np.arrays and to be more efficient, I will manually split the United Kingdom’s data into train, test, and validation datasets for the Machine Learning model with 80% going to the training dataset, the next 10% going to the validation dataset, and the last 10% going to the test dataset for each np.array respectively.

```{python}  
# Splitting United Kingdom's data into train, test, and validation sets on 3   
# mediums: the X-axis, the y-axis, and the indices (represented by dates)  
dates\_united\_kingdom\_train, X\_united\_kingdom\_train, y\_united\_kingdom\_train = dates\_united\_kingdom[:percentile\_80], X\_united\_kingdom[:percentile\_80], y\_united\_kingdom[:percentile\_80]  
dates\_united\_kingdom\_val, X\_united\_kingdom\_val, y\_united\_kingdom\_val = dates\_united\_kingdom[percentile\_80:percentile\_90], X\_united\_kingdom[percentile\_80:percentile\_90], y\_united\_kingdom[percentile\_80:percentile\_90]  
dates\_united\_kingdom\_test, X\_united\_kingdom\_test, y\_united\_kingdom\_test = dates\_united\_kingdom[percentile\_90:], X\_united\_kingdom[percentile\_90:], y\_united\_kingdom[percentile\_90:]  
  
plt.plot(dates\_united\_kingdom\_train, y\_united\_kingdom\_train, linewidth=1)  
plt.plot(dates\_united\_kingdom\_val, y\_united\_kingdom\_val, linewidth=1)  
plt.plot(dates\_united\_kingdom\_test, y\_united\_kingdom\_test, linewidth=1)  
  
plt.legend(["Training", "Validation", "Testing"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Split of United Kingdom's Data for LSTM Model")  
plt.show()  
```



Now, I began to configure the Machine Learning model. We added Sequential layers: an Input layer 3 by 1 because we will have 3 np.arrays of Input and 1 np.array as output, utilize a LSTM (Long Short-Term Memory) layer of 64 neurons, apply 2 levels of dense layers with 32 neurons and folliowing recommendations online to use the RELU (Rectified Linear Unit) Activiation Function, and I followed up with one last dense layer of 1 neuron as our output layer since we are just trying to linearly-predict the next currency-rate on a near-future date. Once I configured the Sequential layers, we are ready to compile the model, utilzing the mean\_square\_error as our minimizing loss function, using the Adam optimizer, and comparing our trained model against our data with the mean\_absolute\_error metric. Lastly, I fitted our model, utilzing our X\_train and Y\_train datasets for fitting with validation from our X\_valid and Y\_valid datasets at 100 epochs.

```{python}  
# Configuring the Machine Learning Tensorflow Model for United Kingdom  
united\_kingdom\_model = Sequential([layers.Input((3, 1)),  
 layers.LSTM(64),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(1)])  
  
united\_kingdom\_model.compile(loss="mse",  
 optimizer=Adam(learning\_rate=0.001),  
 metrics=["mean\_absolute\_error"])  
  
united\_kingdom\_model.fit(X\_united\_kingdom\_train, y\_united\_kingdom\_train, validation\_data=(X\_united\_kingdom\_val, y\_united\_kingdom\_val), epochs=100)  
```

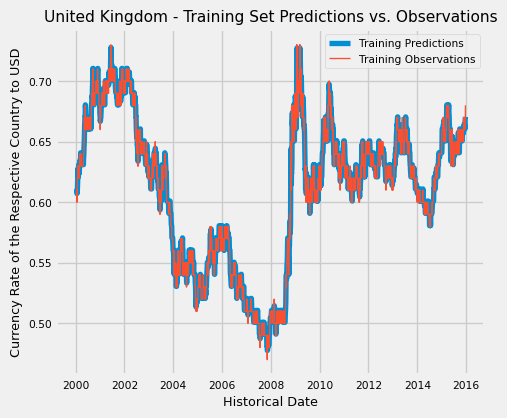
Epoch 1/100  
 1/126 [..............................] - ETA: 3:55 - loss: 0.4161 - mean\_absolute\_error: 0.6415 22/126 [====>.........................] - ETA: 0s - loss: 0.2797 - mean\_absolute\_error: 0.5219 43/126 [=========>....................] - ETA: 0s - loss: 0.1701 - mean\_absolute\_error: 0.3630 64/126 [==============>...............] - ETA: 0s - loss: 0.1160 - mean\_absolute\_error: 0.2640 83/126 [==================>...........] - ETA: 0s - loss: 0.0897 - mean\_absolute\_error: 0.2103103/126 [=======================>......] - ETA: 0s - loss: 0.0725 - mean\_absolute\_error: 0.1741124/126 [============================>.] - ETA: 0s - loss: 0.0603 - mean\_absolute\_error: 0.1483126/126 [==============================] - 3s 6ms/step - loss: 0.0597 - mean\_absolute\_error: 0.1469 - val\_loss: 0.0047 - val\_mean\_absolute\_error: 0.0662  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1305e-04 - mean\_absolute\_error: 0.0215 23/126 [====>.........................] - ETA: 0s - loss: 6.9162e-04 - mean\_absolute\_error: 0.0212 46/126 [=========>....................] - ETA: 0s - loss: 6.8772e-04 - mean\_absolute\_error: 0.0211 68/126 [===============>..............] - ETA: 0s - loss: 6.9722e-04 - mean\_absolute\_error: 0.0214 90/126 [====================>.........] - ETA: 0s - loss: 6.6714e-04 - mean\_absolute\_error: 0.0209112/126 [=========================>....] - ETA: 0s - loss: 6.5929e-04 - mean\_absolute\_error: 0.0208126/126 [==============================] - 0s 3ms/step - loss: 6.4777e-04 - mean\_absolute\_error: 0.0207 - val\_loss: 0.0035 - val\_mean\_absolute\_error: 0.0567  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4701e-04 - mean\_absolute\_error: 0.0206 22/126 [====>.........................] - ETA: 0s - loss: 5.0990e-04 - mean\_absolute\_error: 0.0182 44/126 [=========>....................] - ETA: 0s - loss: 5.3601e-04 - mean\_absolute\_error: 0.0187 65/126 [==============>...............] - ETA: 0s - loss: 5.1686e-04 - mean\_absolute\_error: 0.0183 87/126 [===================>..........] - ETA: 0s - loss: 5.0841e-04 - mean\_absolute\_error: 0.0182109/126 [========================>.....] - ETA: 0s - loss: 4.9408e-04 - mean\_absolute\_error: 0.0180126/126 [==============================] - 0s 3ms/step - loss: 4.8719e-04 - mean\_absolute\_error: 0.0179 - val\_loss: 0.0020 - val\_mean\_absolute\_error: 0.0421  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4777e-04 - mean\_absolute\_error: 0.0157 23/126 [====>.........................] - ETA: 0s - loss: 4.0682e-04 - mean\_absolute\_error: 0.0167 45/126 [=========>....................] - ETA: 0s - loss: 3.8398e-04 - mean\_absolute\_error: 0.0160 67/126 [==============>...............] - ETA: 0s - loss: 3.6988e-04 - mean\_absolute\_error: 0.0157 88/126 [===================>..........] - ETA: 0s - loss: 3.5406e-04 - mean\_absolute\_error: 0.0153109/126 [========================>.....] - ETA: 0s - loss: 3.3745e-04 - mean\_absolute\_error: 0.0148126/126 [==============================] - 0s 3ms/step - loss: 3.3047e-04 - mean\_absolute\_error: 0.0147 - val\_loss: 0.0011 - val\_mean\_absolute\_error: 0.0313  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9079e-04 - mean\_absolute\_error: 0.0130 22/126 [====>.........................] - ETA: 0s - loss: 2.3595e-04 - mean\_absolute\_error: 0.0123 43/126 [=========>....................] - ETA: 0s - loss: 2.3227e-04 - mean\_absolute\_error: 0.0123 64/126 [==============>...............] - ETA: 0s - loss: 2.2070e-04 - mean\_absolute\_error: 0.0119 86/126 [===================>..........] - ETA: 0s - loss: 2.1088e-04 - mean\_absolute\_error: 0.0117108/126 [========================>.....] - ETA: 0s - loss: 2.0094e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 1.9356e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 6.1710e-04 - val\_mean\_absolute\_error: 0.0231  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2841e-04 - mean\_absolute\_error: 0.0088 22/126 [====>.........................] - ETA: 0s - loss: 1.2456e-04 - mean\_absolute\_error: 0.0091 43/126 [=========>....................] - ETA: 0s - loss: 1.2269e-04 - mean\_absolute\_error: 0.0089 64/126 [==============>...............] - ETA: 0s - loss: 1.1232e-04 - mean\_absolute\_error: 0.0085 85/126 [===================>..........] - ETA: 0s - loss: 1.0872e-04 - mean\_absolute\_error: 0.0083107/126 [========================>.....] - ETA: 0s - loss: 1.0340e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.0007e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.8251e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4533e-05 - mean\_absolute\_error: 0.0063 22/126 [====>.........................] - ETA: 0s - loss: 6.1368e-05 - mean\_absolute\_error: 0.0062 45/126 [=========>....................] - ETA: 0s - loss: 5.7517e-05 - mean\_absolute\_error: 0.0060 67/126 [==============>...............] - ETA: 0s - loss: 5.5449e-05 - mean\_absolute\_error: 0.0059 88/126 [===================>..........] - ETA: 0s - loss: 5.4958e-05 - mean\_absolute\_error: 0.0058110/126 [=========================>....] - ETA: 0s - loss: 5.4670e-05 - mean\_absolute\_error: 0.0057126/126 [==============================] - 0s 3ms/step - loss: 5.4259e-05 - mean\_absolute\_error: 0.0057 - val\_loss: 6.7547e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8707e-05 - mean\_absolute\_error: 0.0059 23/126 [====>.........................] - ETA: 0s - loss: 4.2223e-05 - mean\_absolute\_error: 0.0051 45/126 [=========>....................] - ETA: 0s - loss: 4.1584e-05 - mean\_absolute\_error: 0.0050 67/126 [==============>...............] - ETA: 0s - loss: 4.2565e-05 - mean\_absolute\_error: 0.0049 88/126 [===================>..........] - ETA: 0s - loss: 4.1876e-05 - mean\_absolute\_error: 0.0049109/126 [========================>.....] - ETA: 0s - loss: 4.1224e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0208e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.1207e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 4.3026e-05 - mean\_absolute\_error: 0.0052 22/126 [====>.........................] - ETA: 0s - loss: 3.5548e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 3.6027e-05 - mean\_absolute\_error: 0.0045 65/126 [==============>...............] - ETA: 0s - loss: 3.6903e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.6923e-05 - mean\_absolute\_error: 0.0044109/126 [========================>.....] - ETA: 0s - loss: 3.7163e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6992e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.9055e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3943e-05 - mean\_absolute\_error: 0.0032 23/126 [====>.........................] - ETA: 0s - loss: 4.0193e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 4.0417e-05 - mean\_absolute\_error: 0.0048 67/126 [==============>...............] - ETA: 0s - loss: 4.0962e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 4.1172e-05 - mean\_absolute\_error: 0.0048109/126 [========================>.....] - ETA: 0s - loss: 4.1216e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0321e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.0311e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2753e-05 - mean\_absolute\_error: 0.0038 24/126 [====>.........................] - ETA: 0s - loss: 3.7187e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 3.8109e-05 - mean\_absolute\_error: 0.0045 69/126 [===============>..............] - ETA: 0s - loss: 3.8746e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.7781e-05 - mean\_absolute\_error: 0.0044110/126 [=========================>....] - ETA: 0s - loss: 3.6553e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6941e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.7084e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8318e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 3.6066e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 3.7541e-05 - mean\_absolute\_error: 0.0044 67/126 [==============>...............] - ETA: 0s - loss: 3.8353e-05 - mean\_absolute\_error: 0.0046 89/126 [====================>.........] - ETA: 0s - loss: 3.8794e-05 - mean\_absolute\_error: 0.0047111/126 [=========================>....] - ETA: 0s - loss: 3.8507e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.9402e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 8.2972e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2130e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 3.5509e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 3.7434e-05 - mean\_absolute\_error: 0.0044 67/126 [==============>...............] - ETA: 0s - loss: 3.7097e-05 - mean\_absolute\_error: 0.0044 88/126 [===================>..........] - ETA: 0s - loss: 3.7531e-05 - mean\_absolute\_error: 0.0044110/126 [=========================>....] - ETA: 0s - loss: 3.6588e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.7219e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.1677e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9919e-05 - mean\_absolute\_error: 0.0051 22/126 [====>.........................] - ETA: 0s - loss: 3.6559e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.7644e-05 - mean\_absolute\_error: 0.0045 65/126 [==============>...............] - ETA: 0s - loss: 3.9168e-05 - mean\_absolute\_error: 0.0046 86/126 [===================>..........] - ETA: 0s - loss: 3.9849e-05 - mean\_absolute\_error: 0.0047108/126 [========================>.....] - ETA: 0s - loss: 3.9676e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8366e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0779e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5306e-05 - mean\_absolute\_error: 0.0056 23/126 [====>.........................] - ETA: 0s - loss: 3.7151e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 3.9652e-05 - mean\_absolute\_error: 0.0046 65/126 [==============>...............] - ETA: 0s - loss: 3.9326e-05 - mean\_absolute\_error: 0.0046 87/126 [===================>..........] - ETA: 0s - loss: 3.7735e-05 - mean\_absolute\_error: 0.0044108/126 [========================>.....] - ETA: 0s - loss: 3.7043e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6831e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.4354e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8924e-05 - mean\_absolute\_error: 0.0056 23/126 [====>.........................] - ETA: 0s - loss: 3.8931e-05 - mean\_absolute\_error: 0.0045 44/126 [=========>....................] - ETA: 0s - loss: 4.2633e-05 - mean\_absolute\_error: 0.0048 65/126 [==============>...............] - ETA: 0s - loss: 4.1789e-05 - mean\_absolute\_error: 0.0047 87/126 [===================>..........] - ETA: 0s - loss: 3.8807e-05 - mean\_absolute\_error: 0.0046108/126 [========================>.....] - ETA: 0s - loss: 3.8441e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7328e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.0734e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2276e-05 - mean\_absolute\_error: 0.0042 23/126 [====>.........................] - ETA: 0s - loss: 3.4606e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 3.5785e-05 - mean\_absolute\_error: 0.0045 66/126 [==============>...............] - ETA: 0s - loss: 3.6119e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.5172e-05 - mean\_absolute\_error: 0.0044109/126 [========================>.....] - ETA: 0s - loss: 3.5219e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6392e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.7629e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7127e-05 - mean\_absolute\_error: 0.0036 23/126 [====>.........................] - ETA: 0s - loss: 3.6799e-05 - mean\_absolute\_error: 0.0046 44/126 [=========>....................] - ETA: 0s - loss: 3.7370e-05 - mean\_absolute\_error: 0.0045 65/126 [==============>...............] - ETA: 0s - loss: 3.6750e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.7099e-05 - mean\_absolute\_error: 0.0044108/126 [========================>.....] - ETA: 0s - loss: 3.7800e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8898e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 1.0927e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5506e-05 - mean\_absolute\_error: 0.0058 23/126 [====>.........................] - ETA: 0s - loss: 3.9881e-05 - mean\_absolute\_error: 0.0048 44/126 [=========>....................] - ETA: 0s - loss: 3.8770e-05 - mean\_absolute\_error: 0.0046 66/126 [==============>...............] - ETA: 0s - loss: 3.6412e-05 - mean\_absolute\_error: 0.0044 87/126 [===================>..........] - ETA: 0s - loss: 3.6899e-05 - mean\_absolute\_error: 0.0044108/126 [========================>.....] - ETA: 0s - loss: 3.7474e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7955e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.9558e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3442e-05 - mean\_absolute\_error: 0.0047 23/126 [====>.........................] - ETA: 0s - loss: 3.4634e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 3.5490e-05 - mean\_absolute\_error: 0.0043 65/126 [==============>...............] - ETA: 0s - loss: 3.6326e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.5295e-05 - mean\_absolute\_error: 0.0043107/126 [========================>.....] - ETA: 0s - loss: 3.7165e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6597e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.0824e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1032e-05 - mean\_absolute\_error: 0.0032 23/126 [====>.........................] - ETA: 0s - loss: 3.1606e-05 - mean\_absolute\_error: 0.0041 44/126 [=========>....................] - ETA: 0s - loss: 3.3820e-05 - mean\_absolute\_error: 0.0043 65/126 [==============>...............] - ETA: 0s - loss: 3.6211e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.6804e-05 - mean\_absolute\_error: 0.0044108/126 [========================>.....] - ETA: 0s - loss: 3.6183e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6975e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.9012e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9162e-05 - mean\_absolute\_error: 0.0038 23/126 [====>.........................] - ETA: 0s - loss: 4.3928e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 4.1328e-05 - mean\_absolute\_error: 0.0047 67/126 [==============>...............] - ETA: 0s - loss: 3.9674e-05 - mean\_absolute\_error: 0.0046 89/126 [====================>.........] - ETA: 0s - loss: 3.8628e-05 - mean\_absolute\_error: 0.0045110/126 [=========================>....] - ETA: 0s - loss: 3.8300e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7543e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 9.9876e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6698e-05 - mean\_absolute\_error: 0.0071 22/126 [====>.........................] - ETA: 0s - loss: 4.1507e-05 - mean\_absolute\_error: 0.0049 44/126 [=========>....................] - ETA: 0s - loss: 3.9116e-05 - mean\_absolute\_error: 0.0047 67/126 [==============>...............] - ETA: 0s - loss: 3.6944e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.7157e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.8461e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8781e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0252e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7033e-05 - mean\_absolute\_error: 0.0065 24/126 [====>.........................] - ETA: 0s - loss: 3.9247e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 3.8415e-05 - mean\_absolute\_error: 0.0045 69/126 [===============>..............] - ETA: 0s - loss: 3.9336e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.9006e-05 - mean\_absolute\_error: 0.0046110/126 [=========================>....] - ETA: 0s - loss: 3.8742e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8289e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0205e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3533e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 3.5605e-05 - mean\_absolute\_error: 0.0043 45/126 [=========>....................] - ETA: 0s - loss: 3.7991e-05 - mean\_absolute\_error: 0.0045 66/126 [==============>...............] - ETA: 0s - loss: 3.7468e-05 - mean\_absolute\_error: 0.0045 86/126 [===================>..........] - ETA: 0s - loss: 3.7686e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 3.6948e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8326e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.5188e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7723e-05 - mean\_absolute\_error: 0.0056 21/126 [====>.........................] - ETA: 0s - loss: 4.6569e-05 - mean\_absolute\_error: 0.0052 43/126 [=========>....................] - ETA: 0s - loss: 4.8090e-05 - mean\_absolute\_error: 0.0053 64/126 [==============>...............] - ETA: 0s - loss: 4.5686e-05 - mean\_absolute\_error: 0.0051 86/126 [===================>..........] - ETA: 0s - loss: 4.5072e-05 - mean\_absolute\_error: 0.0050107/126 [========================>.....] - ETA: 0s - loss: 4.3955e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2972e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.9368e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4800e-05 - mean\_absolute\_error: 0.0045 23/126 [====>.........................] - ETA: 0s - loss: 3.3731e-05 - mean\_absolute\_error: 0.0043 44/126 [=========>....................] - ETA: 0s - loss: 3.4616e-05 - mean\_absolute\_error: 0.0043 66/126 [==============>...............] - ETA: 0s - loss: 3.5912e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.9250e-05 - mean\_absolute\_error: 0.0048108/126 [========================>.....] - ETA: 0s - loss: 4.3575e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.3750e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 8.9255e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2446e-05 - mean\_absolute\_error: 0.0048 22/126 [====>.........................] - ETA: 0s - loss: 4.4984e-05 - mean\_absolute\_error: 0.0048 44/126 [=========>....................] - ETA: 0s - loss: 4.1551e-05 - mean\_absolute\_error: 0.0047 66/126 [==============>...............] - ETA: 0s - loss: 3.9476e-05 - mean\_absolute\_error: 0.0046 87/126 [===================>..........] - ETA: 0s - loss: 3.8024e-05 - mean\_absolute\_error: 0.0045108/126 [========================>.....] - ETA: 0s - loss: 3.8108e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7294e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 9.7703e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2535e-05 - mean\_absolute\_error: 0.0062 24/126 [====>.........................] - ETA: 0s - loss: 4.4336e-05 - mean\_absolute\_error: 0.0049 45/126 [=========>....................] - ETA: 0s - loss: 3.9450e-05 - mean\_absolute\_error: 0.0046 67/126 [==============>...............] - ETA: 0s - loss: 3.7866e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.8635e-05 - mean\_absolute\_error: 0.0046108/126 [========================>.....] - ETA: 0s - loss: 3.8518e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8903e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.2688e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9900e-05 - mean\_absolute\_error: 0.0052 22/126 [====>.........................] - ETA: 0s - loss: 3.2169e-05 - mean\_absolute\_error: 0.0042 43/126 [=========>....................] - ETA: 0s - loss: 3.7962e-05 - mean\_absolute\_error: 0.0045 65/126 [==============>...............] - ETA: 0s - loss: 3.8184e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.8710e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 3.8226e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7426e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.3409e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7837e-05 - mean\_absolute\_error: 0.0041 22/126 [====>.........................] - ETA: 0s - loss: 3.5802e-05 - mean\_absolute\_error: 0.0042 41/126 [========>.....................] - ETA: 0s - loss: 3.5790e-05 - mean\_absolute\_error: 0.0043 63/126 [==============>...............] - ETA: 0s - loss: 3.7285e-05 - mean\_absolute\_error: 0.0045 85/126 [===================>..........] - ETA: 0s - loss: 3.8551e-05 - mean\_absolute\_error: 0.0046106/126 [========================>.....] - ETA: 0s - loss: 3.9060e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.9444e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0213e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5766e-05 - mean\_absolute\_error: 0.0042 22/126 [====>.........................] - ETA: 0s - loss: 3.6050e-05 - mean\_absolute\_error: 0.0045 43/126 [=========>....................] - ETA: 0s - loss: 3.4790e-05 - mean\_absolute\_error: 0.0043 64/126 [==============>...............] - ETA: 0s - loss: 3.5843e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.4423e-05 - mean\_absolute\_error: 0.0043108/126 [========================>.....] - ETA: 0s - loss: 3.6859e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6994e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.0911e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5600e-05 - mean\_absolute\_error: 0.0038 23/126 [====>.........................] - ETA: 0s - loss: 4.1800e-05 - mean\_absolute\_error: 0.0050 45/126 [=========>....................] - ETA: 0s - loss: 4.6763e-05 - mean\_absolute\_error: 0.0053 67/126 [==============>...............] - ETA: 0s - loss: 4.9350e-05 - mean\_absolute\_error: 0.0054 89/126 [====================>.........] - ETA: 0s - loss: 4.5784e-05 - mean\_absolute\_error: 0.0052111/126 [=========================>....] - ETA: 0s - loss: 4.4085e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.4119e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 1.1030e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 6.0402e-05 - mean\_absolute\_error: 0.0067 22/126 [====>.........................] - ETA: 0s - loss: 4.2325e-05 - mean\_absolute\_error: 0.0049 44/126 [=========>....................] - ETA: 0s - loss: 3.8856e-05 - mean\_absolute\_error: 0.0046 65/126 [==============>...............] - ETA: 0s - loss: 3.8244e-05 - mean\_absolute\_error: 0.0046 87/126 [===================>..........] - ETA: 0s - loss: 3.6935e-05 - mean\_absolute\_error: 0.0045107/126 [========================>.....] - ETA: 0s - loss: 3.6600e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.9314e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0865e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1863e-05 - mean\_absolute\_error: 0.0040 23/126 [====>.........................] - ETA: 0s - loss: 3.7978e-05 - mean\_absolute\_error: 0.0046 42/126 [=========>....................] - ETA: 0s - loss: 4.0774e-05 - mean\_absolute\_error: 0.0048 63/126 [==============>...............] - ETA: 0s - loss: 3.9313e-05 - mean\_absolute\_error: 0.0047 84/126 [===================>..........] - ETA: 0s - loss: 3.8939e-05 - mean\_absolute\_error: 0.0047106/126 [========================>.....] - ETA: 0s - loss: 4.0374e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0488e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.7665e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9058e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 4.5418e-05 - mean\_absolute\_error: 0.0053 45/126 [=========>....................] - ETA: 0s - loss: 4.1883e-05 - mean\_absolute\_error: 0.0050 67/126 [==============>...............] - ETA: 0s - loss: 4.3377e-05 - mean\_absolute\_error: 0.0051 89/126 [====================>.........] - ETA: 0s - loss: 4.1449e-05 - mean\_absolute\_error: 0.0049110/126 [=========================>....] - ETA: 0s - loss: 4.1364e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1047e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.5238e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9814e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 3.4285e-05 - mean\_absolute\_error: 0.0043 45/126 [=========>....................] - ETA: 0s - loss: 3.7516e-05 - mean\_absolute\_error: 0.0045 66/126 [==============>...............] - ETA: 0s - loss: 3.6685e-05 - mean\_absolute\_error: 0.0045 88/126 [===================>..........] - ETA: 0s - loss: 3.7947e-05 - mean\_absolute\_error: 0.0046108/126 [========================>.....] - ETA: 0s - loss: 4.0920e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.3317e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 7.7669e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6270e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 5.6923e-05 - mean\_absolute\_error: 0.0061 45/126 [=========>....................] - ETA: 0s - loss: 5.7023e-05 - mean\_absolute\_error: 0.0060 66/126 [==============>...............] - ETA: 0s - loss: 5.4367e-05 - mean\_absolute\_error: 0.0058 88/126 [===================>..........] - ETA: 0s - loss: 4.9557e-05 - mean\_absolute\_error: 0.0054110/126 [=========================>....] - ETA: 0s - loss: 4.9255e-05 - mean\_absolute\_error: 0.0054126/126 [==============================] - 0s 3ms/step - loss: 4.8962e-05 - mean\_absolute\_error: 0.0054 - val\_loss: 7.3102e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9091e-05 - mean\_absolute\_error: 0.0052 23/126 [====>.........................] - ETA: 0s - loss: 3.9566e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.9407e-05 - mean\_absolute\_error: 0.0046 66/126 [==============>...............] - ETA: 0s - loss: 4.0013e-05 - mean\_absolute\_error: 0.0048 87/126 [===================>..........] - ETA: 0s - loss: 4.1187e-05 - mean\_absolute\_error: 0.0049109/126 [========================>.....] - ETA: 0s - loss: 4.0531e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1443e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 9.8714e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3483e-05 - mean\_absolute\_error: 0.0069 22/126 [====>.........................] - ETA: 0s - loss: 5.5743e-05 - mean\_absolute\_error: 0.0058 44/126 [=========>....................] - ETA: 0s - loss: 5.3094e-05 - mean\_absolute\_error: 0.0056 66/126 [==============>...............] - ETA: 0s - loss: 5.0255e-05 - mean\_absolute\_error: 0.0055 88/126 [===================>..........] - ETA: 0s - loss: 4.8304e-05 - mean\_absolute\_error: 0.0054108/126 [========================>.....] - ETA: 0s - loss: 4.5821e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.4399e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 9.2444e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9438e-05 - mean\_absolute\_error: 0.0062 23/126 [====>.........................] - ETA: 0s - loss: 3.7001e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 4.2162e-05 - mean\_absolute\_error: 0.0049 64/126 [==============>...............] - ETA: 0s - loss: 4.2752e-05 - mean\_absolute\_error: 0.0050 87/126 [===================>..........] - ETA: 0s - loss: 4.0720e-05 - mean\_absolute\_error: 0.0048110/126 [=========================>....] - ETA: 0s - loss: 4.0931e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1515e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.8895e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2336e-05 - mean\_absolute\_error: 0.0047 24/126 [====>.........................] - ETA: 0s - loss: 4.0891e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 3.9053e-05 - mean\_absolute\_error: 0.0047 69/126 [===============>..............] - ETA: 0s - loss: 4.4018e-05 - mean\_absolute\_error: 0.0051 90/126 [====================>.........] - ETA: 0s - loss: 4.4625e-05 - mean\_absolute\_error: 0.0051110/126 [=========================>....] - ETA: 0s - loss: 4.3220e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2357e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.9030e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3030e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 4.8584e-05 - mean\_absolute\_error: 0.0054 41/126 [========>.....................] - ETA: 0s - loss: 5.6664e-05 - mean\_absolute\_error: 0.0059 61/126 [=============>................] - ETA: 0s - loss: 5.2969e-05 - mean\_absolute\_error: 0.0056 81/126 [==================>...........] - ETA: 0s - loss: 5.2300e-05 - mean\_absolute\_error: 0.0056102/126 [=======================>......] - ETA: 0s - loss: 4.8310e-05 - mean\_absolute\_error: 0.0053124/126 [============================>.] - ETA: 0s - loss: 4.6196e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.6161e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 7.3249e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7209e-05 - mean\_absolute\_error: 0.0041 23/126 [====>.........................] - ETA: 0s - loss: 3.9273e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 3.7640e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.8782e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.8566e-05 - mean\_absolute\_error: 0.0046112/126 [=========================>....] - ETA: 0s - loss: 3.9060e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8596e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.3347e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7601e-05 - mean\_absolute\_error: 0.0053 24/126 [====>.........................] - ETA: 0s - loss: 4.9380e-05 - mean\_absolute\_error: 0.0054 46/126 [=========>....................] - ETA: 0s - loss: 5.9553e-05 - mean\_absolute\_error: 0.0060 67/126 [==============>...............] - ETA: 0s - loss: 5.3367e-05 - mean\_absolute\_error: 0.0057 89/126 [====================>.........] - ETA: 0s - loss: 5.1438e-05 - mean\_absolute\_error: 0.0055111/126 [=========================>....] - ETA: 0s - loss: 5.2099e-05 - mean\_absolute\_error: 0.0056126/126 [==============================] - 0s 3ms/step - loss: 5.1798e-05 - mean\_absolute\_error: 0.0056 - val\_loss: 8.2099e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1881e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.9131e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 3.7585e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.5902e-05 - mean\_absolute\_error: 0.0044 90/126 [====================>.........] - ETA: 0s - loss: 3.6163e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.7141e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7412e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.8565e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2150e-05 - mean\_absolute\_error: 0.0039 22/126 [====>.........................] - ETA: 0s - loss: 4.5270e-05 - mean\_absolute\_error: 0.0050 44/126 [=========>....................] - ETA: 0s - loss: 4.5828e-05 - mean\_absolute\_error: 0.0052 65/126 [==============>...............] - ETA: 0s - loss: 4.2993e-05 - mean\_absolute\_error: 0.0050 87/126 [===================>..........] - ETA: 0s - loss: 4.3088e-05 - mean\_absolute\_error: 0.0050109/126 [========================>.....] - ETA: 0s - loss: 4.1506e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1453e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.9955e-05 - val\_mean\_absolute\_error: 0.0080  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0688e-05 - mean\_absolute\_error: 0.0059 23/126 [====>.........................] - ETA: 0s - loss: 4.7833e-05 - mean\_absolute\_error: 0.0053 45/126 [=========>....................] - ETA: 0s - loss: 4.1457e-05 - mean\_absolute\_error: 0.0050 67/126 [==============>...............] - ETA: 0s - loss: 4.1029e-05 - mean\_absolute\_error: 0.0049 89/126 [====================>.........] - ETA: 0s - loss: 4.1155e-05 - mean\_absolute\_error: 0.0049110/126 [=========================>....] - ETA: 0s - loss: 3.9489e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0285e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.9334e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9746e-05 - mean\_absolute\_error: 0.0036 23/126 [====>.........................] - ETA: 0s - loss: 5.5283e-05 - mean\_absolute\_error: 0.0059 44/126 [=========>....................] - ETA: 0s - loss: 5.1787e-05 - mean\_absolute\_error: 0.0056 65/126 [==============>...............] - ETA: 0s - loss: 4.6494e-05 - mean\_absolute\_error: 0.0052 86/126 [===================>..........] - ETA: 0s - loss: 4.4754e-05 - mean\_absolute\_error: 0.0050108/126 [========================>.....] - ETA: 0s - loss: 4.2824e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.2632e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.0777e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5636e-05 - mean\_absolute\_error: 0.0052 23/126 [====>.........................] - ETA: 0s - loss: 4.5244e-05 - mean\_absolute\_error: 0.0052 45/126 [=========>....................] - ETA: 0s - loss: 4.2641e-05 - mean\_absolute\_error: 0.0050 67/126 [==============>...............] - ETA: 0s - loss: 4.1424e-05 - mean\_absolute\_error: 0.0048 87/126 [===================>..........] - ETA: 0s - loss: 4.0159e-05 - mean\_absolute\_error: 0.0047110/126 [=========================>....] - ETA: 0s - loss: 3.9410e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9014e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2350e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3616e-05 - mean\_absolute\_error: 0.0069 21/126 [====>.........................] - ETA: 0s - loss: 4.0254e-05 - mean\_absolute\_error: 0.0046 44/126 [=========>....................] - ETA: 0s - loss: 4.6453e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 4.5915e-05 - mean\_absolute\_error: 0.0051 90/126 [====================>.........] - ETA: 0s - loss: 4.3548e-05 - mean\_absolute\_error: 0.0049112/126 [=========================>....] - ETA: 0s - loss: 4.1046e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0971e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.3061e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1839e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 4.3540e-05 - mean\_absolute\_error: 0.0051 46/126 [=========>....................] - ETA: 0s - loss: 3.9204e-05 - mean\_absolute\_error: 0.0048 67/126 [==============>...............] - ETA: 0s - loss: 3.8382e-05 - mean\_absolute\_error: 0.0047 89/126 [====================>.........] - ETA: 0s - loss: 3.8346e-05 - mean\_absolute\_error: 0.0046110/126 [=========================>....] - ETA: 0s - loss: 3.9205e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8545e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.5077e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2950e-05 - mean\_absolute\_error: 0.0032 22/126 [====>.........................] - ETA: 0s - loss: 3.7505e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 4.5341e-05 - mean\_absolute\_error: 0.0052 66/126 [==============>...............] - ETA: 0s - loss: 4.6408e-05 - mean\_absolute\_error: 0.0052 88/126 [===================>..........] - ETA: 0s - loss: 4.9168e-05 - mean\_absolute\_error: 0.0054110/126 [=========================>....] - ETA: 0s - loss: 4.7581e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 4.6091e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 6.5096e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2934e-05 - mean\_absolute\_error: 0.0032 24/126 [====>.........................] - ETA: 0s - loss: 4.4586e-05 - mean\_absolute\_error: 0.0050 45/126 [=========>....................] - ETA: 0s - loss: 4.7613e-05 - mean\_absolute\_error: 0.0053 65/126 [==============>...............] - ETA: 0s - loss: 4.2773e-05 - mean\_absolute\_error: 0.0050 87/126 [===================>..........] - ETA: 0s - loss: 4.2230e-05 - mean\_absolute\_error: 0.0049108/126 [========================>.....] - ETA: 0s - loss: 4.0488e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0055e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.0743e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5588e-05 - mean\_absolute\_error: 0.0040 22/126 [====>.........................] - ETA: 0s - loss: 4.4807e-05 - mean\_absolute\_error: 0.0052 44/126 [=========>....................] - ETA: 0s - loss: 4.7284e-05 - mean\_absolute\_error: 0.0055 65/126 [==============>...............] - ETA: 0s - loss: 4.5379e-05 - mean\_absolute\_error: 0.0053 87/126 [===================>..........] - ETA: 0s - loss: 4.3389e-05 - mean\_absolute\_error: 0.0051109/126 [========================>.....] - ETA: 0s - loss: 4.6516e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 5.3019e-05 - mean\_absolute\_error: 0.0056 - val\_loss: 1.0030e-04 - val\_mean\_absolute\_error: 0.0077  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3775e-05 - mean\_absolute\_error: 0.0064 23/126 [====>.........................] - ETA: 0s - loss: 4.1905e-05 - mean\_absolute\_error: 0.0051 45/126 [=========>....................] - ETA: 0s - loss: 4.6836e-05 - mean\_absolute\_error: 0.0054 68/126 [===============>..............] - ETA: 0s - loss: 4.5563e-05 - mean\_absolute\_error: 0.0052 90/126 [====================>.........] - ETA: 0s - loss: 4.3814e-05 - mean\_absolute\_error: 0.0051112/126 [=========================>....] - ETA: 0s - loss: 4.2566e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.1498e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.8901e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1243e-05 - mean\_absolute\_error: 0.0035 22/126 [====>.........................] - ETA: 0s - loss: 3.8262e-05 - mean\_absolute\_error: 0.0046 42/126 [=========>....................] - ETA: 0s - loss: 3.5434e-05 - mean\_absolute\_error: 0.0044 65/126 [==============>...............] - ETA: 0s - loss: 3.8232e-05 - mean\_absolute\_error: 0.0047 87/126 [===================>..........] - ETA: 0s - loss: 3.8060e-05 - mean\_absolute\_error: 0.0046110/126 [=========================>....] - ETA: 0s - loss: 3.7305e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6659e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.8648e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1283e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 3.2560e-05 - mean\_absolute\_error: 0.0042 45/126 [=========>....................] - ETA: 0s - loss: 3.9220e-05 - mean\_absolute\_error: 0.0047 68/126 [===============>..............] - ETA: 0s - loss: 4.4115e-05 - mean\_absolute\_error: 0.0051 89/126 [====================>.........] - ETA: 0s - loss: 4.3242e-05 - mean\_absolute\_error: 0.0049112/126 [=========================>....] - ETA: 0s - loss: 4.4370e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.5214e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.6449e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5495e-05 - mean\_absolute\_error: 0.0048 23/126 [====>.........................] - ETA: 0s - loss: 4.0916e-05 - mean\_absolute\_error: 0.0047 44/126 [=========>....................] - ETA: 0s - loss: 3.9104e-05 - mean\_absolute\_error: 0.0046 65/126 [==============>...............] - ETA: 0s - loss: 3.8588e-05 - mean\_absolute\_error: 0.0046 87/126 [===================>..........] - ETA: 0s - loss: 3.8211e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 3.7918e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7331e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.4649e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4061e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.5417e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 3.5496e-05 - mean\_absolute\_error: 0.0045 67/126 [==============>...............] - ETA: 0s - loss: 3.6834e-05 - mean\_absolute\_error: 0.0046 89/126 [====================>.........] - ETA: 0s - loss: 3.6820e-05 - mean\_absolute\_error: 0.0045110/126 [=========================>....] - ETA: 0s - loss: 3.7969e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.9179e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.6435e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5793e-05 - mean\_absolute\_error: 0.0050 22/126 [====>.........................] - ETA: 0s - loss: 4.3442e-05 - mean\_absolute\_error: 0.0051 44/126 [=========>....................] - ETA: 0s - loss: 4.2998e-05 - mean\_absolute\_error: 0.0049 66/126 [==============>...............] - ETA: 0s - loss: 4.4929e-05 - mean\_absolute\_error: 0.0051 87/126 [===================>..........] - ETA: 0s - loss: 4.4415e-05 - mean\_absolute\_error: 0.0051108/126 [========================>.....] - ETA: 0s - loss: 4.5116e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.4023e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 9.4558e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4359e-05 - mean\_absolute\_error: 0.0049 23/126 [====>.........................] - ETA: 0s - loss: 3.8534e-05 - mean\_absolute\_error: 0.0049 44/126 [=========>....................] - ETA: 0s - loss: 3.6686e-05 - mean\_absolute\_error: 0.0046 65/126 [==============>...............] - ETA: 0s - loss: 3.5935e-05 - mean\_absolute\_error: 0.0046 88/126 [===================>..........] - ETA: 0s - loss: 3.7576e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 3.7358e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8335e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2581e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3744e-05 - mean\_absolute\_error: 0.0040 22/126 [====>.........................] - ETA: 0s - loss: 3.9610e-05 - mean\_absolute\_error: 0.0048 44/126 [=========>....................] - ETA: 0s - loss: 3.6322e-05 - mean\_absolute\_error: 0.0045 66/126 [==============>...............] - ETA: 0s - loss: 3.8913e-05 - mean\_absolute\_error: 0.0046 88/126 [===================>..........] - ETA: 0s - loss: 4.1543e-05 - mean\_absolute\_error: 0.0049110/126 [=========================>....] - ETA: 0s - loss: 4.2110e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1141e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.3421e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8834e-05 - mean\_absolute\_error: 0.0039 24/126 [====>.........................] - ETA: 0s - loss: 3.8706e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 3.9429e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.9870e-05 - mean\_absolute\_error: 0.0049 90/126 [====================>.........] - ETA: 0s - loss: 4.0409e-05 - mean\_absolute\_error: 0.0049111/126 [=========================>....] - ETA: 0s - loss: 4.1508e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0079e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.3832e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3852e-05 - mean\_absolute\_error: 0.0044 24/126 [====>.........................] - ETA: 0s - loss: 4.4540e-05 - mean\_absolute\_error: 0.0051 46/126 [=========>....................] - ETA: 0s - loss: 4.3921e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 4.2521e-05 - mean\_absolute\_error: 0.0050 89/126 [====================>.........] - ETA: 0s - loss: 4.2176e-05 - mean\_absolute\_error: 0.0050111/126 [=========================>....] - ETA: 0s - loss: 4.3888e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.4137e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.7275e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4733e-05 - mean\_absolute\_error: 0.0046 23/126 [====>.........................] - ETA: 0s - loss: 3.3022e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 3.4880e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.6603e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.6717e-05 - mean\_absolute\_error: 0.0045109/126 [========================>.....] - ETA: 0s - loss: 3.7976e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7277e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.3987e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3716e-05 - mean\_absolute\_error: 0.0045 23/126 [====>.........................] - ETA: 0s - loss: 3.8106e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 4.1007e-05 - mean\_absolute\_error: 0.0047 66/126 [==============>...............] - ETA: 0s - loss: 4.2569e-05 - mean\_absolute\_error: 0.0049 88/126 [===================>..........] - ETA: 0s - loss: 4.1524e-05 - mean\_absolute\_error: 0.0049108/126 [========================>.....] - ETA: 0s - loss: 4.0995e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0009e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.6141e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8260e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.7004e-05 - mean\_absolute\_error: 0.0047 41/126 [========>.....................] - ETA: 0s - loss: 3.4475e-05 - mean\_absolute\_error: 0.0044 51/126 [===========>..................] - ETA: 0s - loss: 3.5639e-05 - mean\_absolute\_error: 0.0045 62/126 [=============>................] - ETA: 0s - loss: 3.8393e-05 - mean\_absolute\_error: 0.0047 77/126 [=================>............] - ETA: 0s - loss: 3.8099e-05 - mean\_absolute\_error: 0.0047 93/126 [=====================>........] - ETA: 0s - loss: 3.7912e-05 - mean\_absolute\_error: 0.0046111/126 [=========================>....] - ETA: 0s - loss: 3.8016e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 4ms/step - loss: 3.8978e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 8.4093e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4462e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 4.3286e-05 - mean\_absolute\_error: 0.0049 45/126 [=========>....................] - ETA: 0s - loss: 4.3530e-05 - mean\_absolute\_error: 0.0049 67/126 [==============>...............] - ETA: 0s - loss: 3.9983e-05 - mean\_absolute\_error: 0.0047 88/126 [===================>..........] - ETA: 0s - loss: 3.7964e-05 - mean\_absolute\_error: 0.0045109/126 [========================>.....] - ETA: 0s - loss: 3.8757e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8751e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.4383e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0842e-05 - mean\_absolute\_error: 0.0046 22/126 [====>.........................] - ETA: 0s - loss: 3.7408e-05 - mean\_absolute\_error: 0.0044 41/126 [========>.....................] - ETA: 0s - loss: 3.9888e-05 - mean\_absolute\_error: 0.0045 62/126 [=============>................] - ETA: 0s - loss: 3.6784e-05 - mean\_absolute\_error: 0.0044 85/126 [===================>..........] - ETA: 0s - loss: 3.8958e-05 - mean\_absolute\_error: 0.0046106/126 [========================>.....] - ETA: 0s - loss: 3.8060e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8540e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.7282e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4418e-05 - mean\_absolute\_error: 0.0047 23/126 [====>.........................] - ETA: 0s - loss: 3.3456e-05 - mean\_absolute\_error: 0.0043 45/126 [=========>....................] - ETA: 0s - loss: 3.4069e-05 - mean\_absolute\_error: 0.0043 67/126 [==============>...............] - ETA: 0s - loss: 3.5176e-05 - mean\_absolute\_error: 0.0043 89/126 [====================>.........] - ETA: 0s - loss: 3.8074e-05 - mean\_absolute\_error: 0.0046111/126 [=========================>....] - ETA: 0s - loss: 3.9285e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0751e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.5469e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1817e-05 - mean\_absolute\_error: 0.0044 24/126 [====>.........................] - ETA: 0s - loss: 3.6723e-05 - mean\_absolute\_error: 0.0045 46/126 [=========>....................] - ETA: 0s - loss: 3.6399e-05 - mean\_absolute\_error: 0.0044 65/126 [==============>...............] - ETA: 0s - loss: 3.5117e-05 - mean\_absolute\_error: 0.0043 86/126 [===================>..........] - ETA: 0s - loss: 3.8370e-05 - mean\_absolute\_error: 0.0045107/126 [========================>.....] - ETA: 0s - loss: 3.8221e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7285e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.2750e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6607e-05 - mean\_absolute\_error: 0.0072 24/126 [====>.........................] - ETA: 0s - loss: 5.4748e-05 - mean\_absolute\_error: 0.0059 44/126 [=========>....................] - ETA: 0s - loss: 4.7128e-05 - mean\_absolute\_error: 0.0052 67/126 [==============>...............] - ETA: 0s - loss: 4.3588e-05 - mean\_absolute\_error: 0.0050 88/126 [===================>..........] - ETA: 0s - loss: 4.5220e-05 - mean\_absolute\_error: 0.0052108/126 [========================>.....] - ETA: 0s - loss: 4.6538e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.5708e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 6.8291e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5042e-05 - mean\_absolute\_error: 0.0050 23/126 [====>.........................] - ETA: 0s - loss: 3.6581e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.3914e-05 - mean\_absolute\_error: 0.0044 67/126 [==============>...............] - ETA: 0s - loss: 4.0264e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 4.2967e-05 - mean\_absolute\_error: 0.0050111/126 [=========================>....] - ETA: 0s - loss: 4.1783e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1621e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.4906e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6948e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 4.1790e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.9471e-05 - mean\_absolute\_error: 0.0046 67/126 [==============>...............] - ETA: 0s - loss: 3.7540e-05 - mean\_absolute\_error: 0.0045 89/126 [====================>.........] - ETA: 0s - loss: 3.7398e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.6979e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6953e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.3399e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8699e-05 - mean\_absolute\_error: 0.0036 20/126 [===>..........................] - ETA: 0s - loss: 3.3156e-05 - mean\_absolute\_error: 0.0041 42/126 [=========>....................] - ETA: 0s - loss: 3.5497e-05 - mean\_absolute\_error: 0.0044 64/126 [==============>...............] - ETA: 0s - loss: 3.5918e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.4580e-05 - mean\_absolute\_error: 0.0043107/126 [========================>.....] - ETA: 0s - loss: 3.4676e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.7350e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.8827e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9256e-05 - mean\_absolute\_error: 0.0052 21/126 [====>.........................] - ETA: 0s - loss: 4.8238e-05 - mean\_absolute\_error: 0.0054 43/126 [=========>....................] - ETA: 0s - loss: 3.8379e-05 - mean\_absolute\_error: 0.0046 64/126 [==============>...............] - ETA: 0s - loss: 3.8297e-05 - mean\_absolute\_error: 0.0046 86/126 [===================>..........] - ETA: 0s - loss: 4.0055e-05 - mean\_absolute\_error: 0.0047108/126 [========================>.....] - ETA: 0s - loss: 4.0010e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1061e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.3097e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9292e-05 - mean\_absolute\_error: 0.0042 22/126 [====>.........................] - ETA: 0s - loss: 4.4504e-05 - mean\_absolute\_error: 0.0051 42/126 [=========>....................] - ETA: 0s - loss: 4.5462e-05 - mean\_absolute\_error: 0.0052 64/126 [==============>...............] - ETA: 0s - loss: 4.4314e-05 - mean\_absolute\_error: 0.0051 85/126 [===================>..........] - ETA: 0s - loss: 4.2439e-05 - mean\_absolute\_error: 0.0050108/126 [========================>.....] - ETA: 0s - loss: 4.0929e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.9986e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.2541e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7060e-05 - mean\_absolute\_error: 0.0041 23/126 [====>.........................] - ETA: 0s - loss: 3.7150e-05 - mean\_absolute\_error: 0.0047 46/126 [=========>....................] - ETA: 0s - loss: 3.9460e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.8308e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.8068e-05 - mean\_absolute\_error: 0.0046112/126 [=========================>....] - ETA: 0s - loss: 3.7529e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7072e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2768e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1507e-05 - mean\_absolute\_error: 0.0046 23/126 [====>.........................] - ETA: 0s - loss: 4.1739e-05 - mean\_absolute\_error: 0.0049 44/126 [=========>....................] - ETA: 0s - loss: 4.5947e-05 - mean\_absolute\_error: 0.0053 65/126 [==============>...............] - ETA: 0s - loss: 4.4347e-05 - mean\_absolute\_error: 0.0051 86/126 [===================>..........] - ETA: 0s - loss: 4.1953e-05 - mean\_absolute\_error: 0.0049108/126 [========================>.....] - ETA: 0s - loss: 4.0557e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0069e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.1579e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4763e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 4.1132e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 4.1691e-05 - mean\_absolute\_error: 0.0049 67/126 [==============>...............] - ETA: 0s - loss: 4.0877e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 3.9775e-05 - mean\_absolute\_error: 0.0048110/126 [=========================>....] - ETA: 0s - loss: 3.9988e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.8803e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.5462e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9413e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 4.0990e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.7085e-05 - mean\_absolute\_error: 0.0044 67/126 [==============>...............] - ETA: 0s - loss: 3.5703e-05 - mean\_absolute\_error: 0.0044 88/126 [===================>..........] - ETA: 0s - loss: 3.8581e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 4.0409e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1049e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 8.8900e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 7.2123e-05 - mean\_absolute\_error: 0.0073 22/126 [====>.........................] - ETA: 0s - loss: 5.1055e-05 - mean\_absolute\_error: 0.0057 43/126 [=========>....................] - ETA: 0s - loss: 5.0420e-05 - mean\_absolute\_error: 0.0057 64/126 [==============>...............] - ETA: 0s - loss: 4.9520e-05 - mean\_absolute\_error: 0.0056 86/126 [===================>..........] - ETA: 0s - loss: 4.9919e-05 - mean\_absolute\_error: 0.0056108/126 [========================>.....] - ETA: 0s - loss: 4.6668e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 4.6559e-05 - mean\_absolute\_error: 0.0053 - val\_loss: 9.8031e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4650e-05 - mean\_absolute\_error: 0.0050 23/126 [====>.........................] - ETA: 0s - loss: 4.2632e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.9030e-05 - mean\_absolute\_error: 0.0046 66/126 [==============>...............] - ETA: 0s - loss: 3.8479e-05 - mean\_absolute\_error: 0.0047 88/126 [===================>..........] - ETA: 0s - loss: 3.7150e-05 - mean\_absolute\_error: 0.0046109/126 [========================>.....] - ETA: 0s - loss: 3.9152e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9780e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.2322e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7908e-05 - mean\_absolute\_error: 0.0048 15/126 [==>...........................] - ETA: 0s - loss: 3.4510e-05 - mean\_absolute\_error: 0.0043 33/126 [======>.......................] - ETA: 0s - loss: 3.4979e-05 - mean\_absolute\_error: 0.0045 50/126 [==========>...................] - ETA: 0s - loss: 3.7052e-05 - mean\_absolute\_error: 0.0046 69/126 [===============>..............] - ETA: 0s - loss: 4.0422e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 4.0540e-05 - mean\_absolute\_error: 0.0048113/126 [=========================>....] - ETA: 0s - loss: 3.9476e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.9028e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.0882e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8847e-05 - mean\_absolute\_error: 0.0034 22/126 [====>.........................] - ETA: 0s - loss: 3.5348e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 4.0246e-05 - mean\_absolute\_error: 0.0049 64/126 [==============>...............] - ETA: 0s - loss: 3.7019e-05 - mean\_absolute\_error: 0.0046 82/126 [==================>...........] - ETA: 0s - loss: 3.7722e-05 - mean\_absolute\_error: 0.0046101/126 [=======================>......] - ETA: 0s - loss: 3.8108e-05 - mean\_absolute\_error: 0.0046118/126 [===========================>..] - ETA: 0s - loss: 3.7944e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7555e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.4567e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9264e-05 - mean\_absolute\_error: 0.0035 18/126 [===>..........................] - ETA: 0s - loss: 3.9280e-05 - mean\_absolute\_error: 0.0044 35/126 [=======>......................] - ETA: 0s - loss: 3.8063e-05 - mean\_absolute\_error: 0.0045 52/126 [===========>..................] - ETA: 0s - loss: 3.9721e-05 - mean\_absolute\_error: 0.0047 71/126 [===============>..............] - ETA: 0s - loss: 4.0718e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 3.8794e-05 - mean\_absolute\_error: 0.0046107/126 [========================>.....] - ETA: 0s - loss: 3.8215e-05 - mean\_absolute\_error: 0.0046125/126 [============================>.] - ETA: 0s - loss: 3.6941e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7052e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.3206e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5419e-05 - mean\_absolute\_error: 0.0038 14/126 [==>...........................] - ETA: 0s - loss: 4.6136e-05 - mean\_absolute\_error: 0.0053 33/126 [======>.......................] - ETA: 0s - loss: 4.5177e-05 - mean\_absolute\_error: 0.0051 51/126 [===========>..................] - ETA: 0s - loss: 4.1801e-05 - mean\_absolute\_error: 0.0049 67/126 [==============>...............] - ETA: 0s - loss: 3.9820e-05 - mean\_absolute\_error: 0.0048 86/126 [===================>..........] - ETA: 0s - loss: 4.0898e-05 - mean\_absolute\_error: 0.0050105/126 [========================>.....] - ETA: 0s - loss: 4.0086e-05 - mean\_absolute\_error: 0.0049123/126 [============================>.] - ETA: 0s - loss: 3.9495e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0104e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.7024e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0730e-05 - mean\_absolute\_error: 0.0031 18/126 [===>..........................] - ETA: 0s - loss: 2.9359e-05 - mean\_absolute\_error: 0.0038 36/126 [=======>......................] - ETA: 0s - loss: 2.9772e-05 - mean\_absolute\_error: 0.0039 52/126 [===========>..................] - ETA: 0s - loss: 3.1024e-05 - mean\_absolute\_error: 0.0040 70/126 [===============>..............] - ETA: 0s - loss: 3.1699e-05 - mean\_absolute\_error: 0.0041 85/126 [===================>..........] - ETA: 0s - loss: 3.4226e-05 - mean\_absolute\_error: 0.0043103/126 [=======================>......] - ETA: 0s - loss: 3.6310e-05 - mean\_absolute\_error: 0.0044118/126 [===========================>..] - ETA: 0s - loss: 3.7163e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 4ms/step - loss: 3.7851e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0608e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 4.2112e-05 - mean\_absolute\_error: 0.0053 18/126 [===>..........................] - ETA: 0s - loss: 3.5616e-05 - mean\_absolute\_error: 0.0045 35/126 [=======>......................] - ETA: 0s - loss: 3.3739e-05 - mean\_absolute\_error: 0.0043 53/126 [===========>..................] - ETA: 0s - loss: 3.4342e-05 - mean\_absolute\_error: 0.0044 74/126 [================>.............] - ETA: 0s - loss: 3.4296e-05 - mean\_absolute\_error: 0.0044 94/126 [=====================>........] - ETA: 0s - loss: 3.5753e-05 - mean\_absolute\_error: 0.0044117/126 [==========================>...] - ETA: 0s - loss: 3.6302e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6450e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.4422e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7621e-05 - mean\_absolute\_error: 0.0028 23/126 [====>.........................] - ETA: 0s - loss: 4.0233e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 4.6807e-05 - mean\_absolute\_error: 0.0053 67/126 [==============>...............] - ETA: 0s - loss: 4.4234e-05 - mean\_absolute\_error: 0.0051 90/126 [====================>.........] - ETA: 0s - loss: 4.1588e-05 - mean\_absolute\_error: 0.0049112/126 [=========================>....] - ETA: 0s - loss: 4.0659e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0581e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.0794e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2602e-05 - mean\_absolute\_error: 0.0042 23/126 [====>.........................] - ETA: 0s - loss: 3.4977e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 3.8370e-05 - mean\_absolute\_error: 0.0046 66/126 [==============>...............] - ETA: 0s - loss: 3.6242e-05 - mean\_absolute\_error: 0.0044 87/126 [===================>..........] - ETA: 0s - loss: 3.4786e-05 - mean\_absolute\_error: 0.0043110/126 [=========================>....] - ETA: 0s - loss: 3.3609e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.5029e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.1335e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6749e-05 - mean\_absolute\_error: 0.0042 20/126 [===>..........................] - ETA: 0s - loss: 3.6844e-05 - mean\_absolute\_error: 0.0043 40/126 [========>.....................] - ETA: 0s - loss: 3.4132e-05 - mean\_absolute\_error: 0.0041 61/126 [=============>................] - ETA: 0s - loss: 3.4022e-05 - mean\_absolute\_error: 0.0042 82/126 [==================>...........] - ETA: 0s - loss: 3.7580e-05 - mean\_absolute\_error: 0.0045103/126 [=======================>......] - ETA: 0s - loss: 3.7569e-05 - mean\_absolute\_error: 0.0045125/126 [============================>.] - ETA: 0s - loss: 3.6711e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6682e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.3995e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0553e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 5.0504e-05 - mean\_absolute\_error: 0.0056 44/126 [=========>....................] - ETA: 0s - loss: 5.3471e-05 - mean\_absolute\_error: 0.0058 66/126 [==============>...............] - ETA: 0s - loss: 5.2918e-05 - mean\_absolute\_error: 0.0057 88/126 [===================>..........] - ETA: 0s - loss: 5.0407e-05 - mean\_absolute\_error: 0.0055110/126 [=========================>....] - ETA: 0s - loss: 4.6970e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 4.5492e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 8.6195e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2428e-05 - mean\_absolute\_error: 0.0063 23/126 [====>.........................] - ETA: 0s - loss: 3.7694e-05 - mean\_absolute\_error: 0.0048 44/126 [=========>....................] - ETA: 0s - loss: 3.3536e-05 - mean\_absolute\_error: 0.0043 65/126 [==============>...............] - ETA: 0s - loss: 3.5826e-05 - mean\_absolute\_error: 0.0044 87/126 [===================>..........] - ETA: 0s - loss: 3.5677e-05 - mean\_absolute\_error: 0.0043108/126 [========================>.....] - ETA: 0s - loss: 3.4477e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.4356e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 7.0857e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1406e-05 - mean\_absolute\_error: 0.0046 23/126 [====>.........................] - ETA: 0s - loss: 3.9788e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.8169e-05 - mean\_absolute\_error: 0.0048 67/126 [==============>...............] - ETA: 0s - loss: 3.9074e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 3.7836e-05 - mean\_absolute\_error: 0.0047109/126 [========================>.....] - ETA: 0s - loss: 3.7794e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8279e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.6739e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0111e-04 - mean\_absolute\_error: 0.0087 22/126 [====>.........................] - ETA: 0s - loss: 5.0983e-05 - mean\_absolute\_error: 0.0055 43/126 [=========>....................] - ETA: 0s - loss: 4.7133e-05 - mean\_absolute\_error: 0.0053 64/126 [==============>...............] - ETA: 0s - loss: 4.1818e-05 - mean\_absolute\_error: 0.0049 85/126 [===================>..........] - ETA: 0s - loss: 4.0455e-05 - mean\_absolute\_error: 0.0048106/126 [========================>.....] - ETA: 0s - loss: 3.9215e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9319e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.0562e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0113e-05 - mean\_absolute\_error: 0.0041 23/126 [====>.........................] - ETA: 0s - loss: 3.2648e-05 - mean\_absolute\_error: 0.0043 43/126 [=========>....................] - ETA: 0s - loss: 3.3970e-05 - mean\_absolute\_error: 0.0044 64/126 [==============>...............] - ETA: 0s - loss: 3.6749e-05 - mean\_absolute\_error: 0.0045 86/126 [===================>..........] - ETA: 0s - loss: 3.9208e-05 - mean\_absolute\_error: 0.0047107/126 [========================>.....] - ETA: 0s - loss: 3.9081e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8820e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.1684e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4281e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 5.6070e-05 - mean\_absolute\_error: 0.0060 45/126 [=========>....................] - ETA: 0s - loss: 4.4369e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 4.2796e-05 - mean\_absolute\_error: 0.0050 88/126 [===================>..........] - ETA: 0s - loss: 4.1525e-05 - mean\_absolute\_error: 0.0049110/126 [=========================>....] - ETA: 0s - loss: 4.1163e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1641e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 1.1771e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 4.2762e-05 - mean\_absolute\_error: 0.0051 22/126 [====>.........................] - ETA: 0s - loss: 4.1921e-05 - mean\_absolute\_error: 0.0050 43/126 [=========>....................] - ETA: 0s - loss: 3.7131e-05 - mean\_absolute\_error: 0.0047 66/126 [==============>...............] - ETA: 0s - loss: 3.5904e-05 - mean\_absolute\_error: 0.0046 88/126 [===================>..........] - ETA: 0s - loss: 3.5407e-05 - mean\_absolute\_error: 0.0045109/126 [========================>.....] - ETA: 0s - loss: 3.5889e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.5871e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.2483e-05 - val\_mean\_absolute\_error: 0.0057

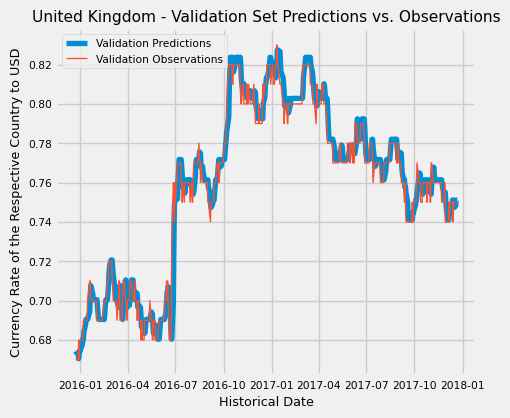
<keras.src.callbacks.History at 0x24c4587fb10>

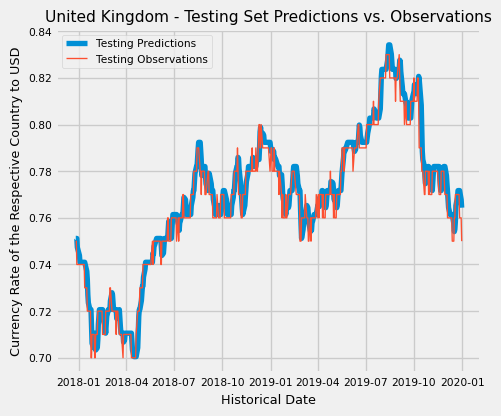
After the training and fitting of the Machine Learning model for the United Kingdom, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue lines represent the prediction model’s projections and the thinner red lines is the observed/gathered data.

```{python}  
# Testing the Machine Learning Model prediction for United Kingdom with the train,   
# validation, and test sets  
# Most important is the test set prediction as this tests the effectiveness  
# of the Machine Learning model on data it has not seen before   
united\_kingdom\_train\_pred = united\_kingdom\_model.predict(X\_united\_kingdom\_train).flatten()  
  
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_train, y\_united\_kingdom\_train, linewidth=1)  
plt.legend(["Training Predictions", "Training Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("United Kingdom - Training Set Predictions vs. Observations")  
plt.show()  
  
united\_kingdom\_val\_pred = united\_kingdom\_model.predict(X\_united\_kingdom\_val).flatten()  
  
plt.plot(dates\_united\_kingdom\_val, united\_kingdom\_val\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_val, y\_united\_kingdom\_val, linewidth=1)  
plt.legend(["Validation Predictions", "Validation Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("United Kingdom - Validation Set Predictions vs. Observations")  
plt.show()  
  
united\_kingdom\_test\_pred = united\_kingdom\_model.predict(X\_united\_kingdom\_test).flatten()  
  
plt.plot(dates\_united\_kingdom\_test, united\_kingdom\_test\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_test, y\_united\_kingdom\_test, linewidth=1)  
plt.legend(["Testing Predictions", "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("United Kingdom - Testing Set Predictions vs. Observations")  
plt.show()  
```

1/126 [..............................] - ETA: 44s 41/126 [========>.....................] - ETA: 0s 84/126 [===================>..........] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

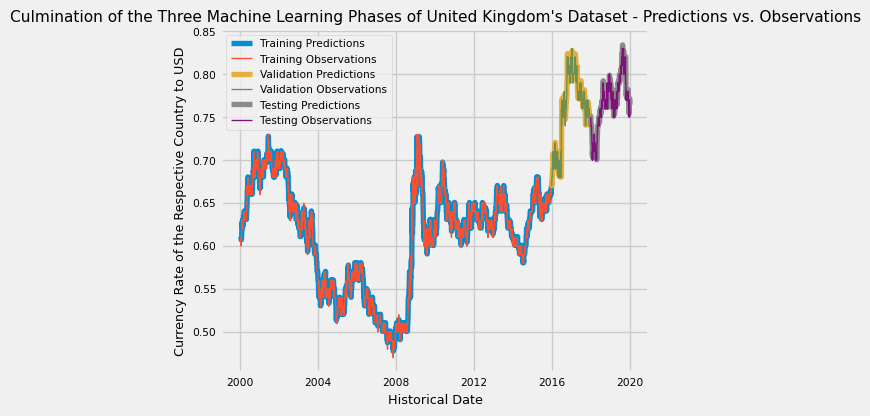






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and fitting towards predicting the United Kingdom’s international currency rate with the United States.

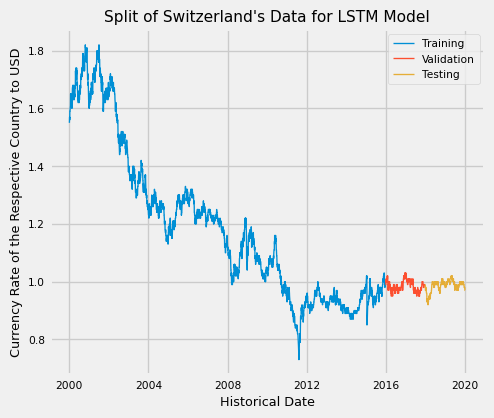
```{python}  
# Plotting United Kingdom's observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model)   
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_train, y\_united\_kingdom\_train, linewidth=1)  
plt.plot(dates\_united\_kingdom\_val, united\_kingdom\_val\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_val, y\_united\_kingdom\_val, linewidth=1)  
plt.plot(dates\_united\_kingdom\_test, united\_kingdom\_test\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_test, y\_united\_kingdom\_test, linewidth=1)  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of United Kingdom's Dataset - Predictions vs. Observations")  
plt.show()  
```



Lastly, I worked on Switzerland’s data (as shown below):

Since the data (date, X, and y) is split into three np.arrays and to be more efficient, I will manually split Switzerland’s data into train, test, and validation datasets for the Machine Learning model with 80% going to the training dataset, the next 10% going to the validation dataset, and the last 10% going to the test dataset for each np.array respectively.

```{python}  
# Splitting Switzerland's data into train, test, and validation sets on 3   
# mediums: the X-axis, the y-axis, and the indices (represented by dates)  
dates\_switzerland\_train, X\_switzerland\_train, y\_switzerland\_train = dates\_switzerland[:percentile\_80], X\_switzerland[:percentile\_80], y\_switzerland[:percentile\_80]  
dates\_switzerland\_val, X\_switzerland\_val, y\_switzerland\_val = dates\_switzerland[percentile\_80:percentile\_90], X\_switzerland[percentile\_80:percentile\_90], y\_switzerland[percentile\_80:percentile\_90]  
dates\_switzerland\_test, X\_switzerland\_test, y\_switzerland\_test = dates\_switzerland[percentile\_90:], X\_switzerland[percentile\_90:], y\_switzerland[percentile\_90:]  
  
plt.plot(dates\_switzerland\_train, y\_switzerland\_train, linewidth=1)  
plt.plot(dates\_switzerland\_val, y\_switzerland\_val, linewidth=1)  
plt.plot(dates\_switzerland\_test, y\_switzerland\_test, linewidth=1)  
  
plt.legend(["Training", "Validation", "Testing"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Split of Switzerland's Data for LSTM Model")  
plt.show()  
```



Now, I began to configure the Machine Learning model. We added Sequential layers: an Input layer 3 by 1 because we will have 3 np.arrays of Input and 1 np.array as output, utilize a LSTM (Long Short-Term Memory) layer of 64 neurons, apply 2 levels of dense layers with 32 neurons and folliowing recommendations online to use the RELU (Rectified Linear Unit) Activiation Function, and I followed up with one last dense layer of 1 neuron as our output layer since we are just trying to linearly-predict the next currency-rate on a near-future date. Once I configured the Sequential layers, we are ready to compile the model, utilzing the mean\_square\_error as our minimizing loss function, using the Adam optimizer, and comparing our trained model against our data with the mean\_absolute\_error metric. Lastly, I fitted our model, utilzing our X\_train and Y\_train datasets for fitting with validation from our X\_valid and Y\_valid datasets at 100 epochs.

```{python}  
# Configuring the Machine Learning Tensorflow Model for Switzerland  
switzerland\_model = Sequential([layers.Input((3, 1)),  
 layers.LSTM(64),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(32, activation="relu"),  
 layers.Dense(1)])  
  
switzerland\_model.compile(loss="mse",  
 optimizer=Adam(learning\_rate=0.001),  
 metrics=["mean\_absolute\_error"])  
  
switzerland\_model.fit(X\_switzerland\_train, y\_switzerland\_train, validation\_data=(X\_switzerland\_val, y\_switzerland\_val), epochs=100)  
```

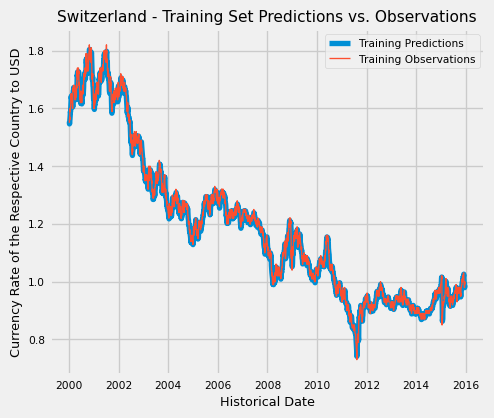
Epoch 1/100  
 1/126 [..............................] - ETA: 4:00 - loss: 1.8665 - mean\_absolute\_error: 1.3305 20/126 [===>..........................] - ETA: 0s - loss: 1.2681 - mean\_absolute\_error: 1.0949 39/126 [========>.....................] - ETA: 0s - loss: 0.8920 - mean\_absolute\_error: 0.8822 59/126 [=============>................] - ETA: 0s - loss: 0.6003 - mean\_absolute\_error: 0.6371 79/126 [=================>............] - ETA: 0s - loss: 0.4502 - mean\_absolute\_error: 0.4925101/126 [=======================>......] - ETA: 0s - loss: 0.3531 - mean\_absolute\_error: 0.3975123/126 [============================>.] - ETA: 0s - loss: 0.2905 - mean\_absolute\_error: 0.3350126/126 [==============================] - 3s 6ms/step - loss: 0.2851 - mean\_absolute\_error: 0.3296 - val\_loss: 0.0029 - val\_mean\_absolute\_error: 0.0535  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0031 - mean\_absolute\_error: 0.0497 24/126 [====>.........................] - ETA: 0s - loss: 0.0027 - mean\_absolute\_error: 0.0434 46/126 [=========>....................] - ETA: 0s - loss: 0.0025 - mean\_absolute\_error: 0.0421 68/126 [===============>..............] - ETA: 0s - loss: 0.0023 - mean\_absolute\_error: 0.0403 89/126 [====================>.........] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0380110/126 [=========================>....] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0359126/126 [==============================] - 0s 3ms/step - loss: 0.0018 - mean\_absolute\_error: 0.0345 - val\_loss: 6.2259e-04 - val\_mean\_absolute\_error: 0.0239  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7572e-04 - mean\_absolute\_error: 0.0230 22/126 [====>.........................] - ETA: 0s - loss: 7.5048e-04 - mean\_absolute\_error: 0.0226 44/126 [=========>....................] - ETA: 0s - loss: 6.8389e-04 - mean\_absolute\_error: 0.0215 66/126 [==============>...............] - ETA: 0s - loss: 6.0595e-04 - mean\_absolute\_error: 0.0201 88/126 [===================>..........] - ETA: 0s - loss: 5.4141e-04 - mean\_absolute\_error: 0.0189110/126 [=========================>....] - ETA: 0s - loss: 4.9530e-04 - mean\_absolute\_error: 0.0178126/126 [==============================] - 0s 3ms/step - loss: 4.6604e-04 - mean\_absolute\_error: 0.0172 - val\_loss: 1.5102e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9322e-04 - mean\_absolute\_error: 0.0123 22/126 [====>.........................] - ETA: 0s - loss: 2.3344e-04 - mean\_absolute\_error: 0.0120 43/126 [=========>....................] - ETA: 0s - loss: 2.1171e-04 - mean\_absolute\_error: 0.0115 64/126 [==============>...............] - ETA: 0s - loss: 2.0030e-04 - mean\_absolute\_error: 0.0112 86/126 [===================>..........] - ETA: 0s - loss: 2.0004e-04 - mean\_absolute\_error: 0.0110107/126 [========================>.....] - ETA: 0s - loss: 1.9976e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 1.9262e-04 - mean\_absolute\_error: 0.0107 - val\_loss: 5.9366e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6519e-04 - mean\_absolute\_error: 0.0108 22/126 [====>.........................] - ETA: 0s - loss: 1.6239e-04 - mean\_absolute\_error: 0.0100 43/126 [=========>....................] - ETA: 0s - loss: 1.5885e-04 - mean\_absolute\_error: 0.0098 65/126 [==============>...............] - ETA: 0s - loss: 1.6346e-04 - mean\_absolute\_error: 0.0097 87/126 [===================>..........] - ETA: 0s - loss: 1.6437e-04 - mean\_absolute\_error: 0.0098108/126 [========================>.....] - ETA: 0s - loss: 1.6167e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6678e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 5.0712e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0993e-04 - mean\_absolute\_error: 0.0087 23/126 [====>.........................] - ETA: 0s - loss: 1.4379e-04 - mean\_absolute\_error: 0.0095 44/126 [=========>....................] - ETA: 0s - loss: 1.6400e-04 - mean\_absolute\_error: 0.0096 65/126 [==============>...............] - ETA: 0s - loss: 1.6135e-04 - mean\_absolute\_error: 0.0096 87/126 [===================>..........] - ETA: 0s - loss: 1.6725e-04 - mean\_absolute\_error: 0.0097109/126 [========================>.....] - ETA: 0s - loss: 1.6430e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6569e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.2499e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5769e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 1.5862e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 1.6453e-04 - mean\_absolute\_error: 0.0096 67/126 [==============>...............] - ETA: 0s - loss: 1.6114e-04 - mean\_absolute\_error: 0.0096 88/126 [===================>..........] - ETA: 0s - loss: 1.6202e-04 - mean\_absolute\_error: 0.0096110/126 [=========================>....] - ETA: 0s - loss: 1.6168e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6431e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.1756e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8496e-04 - mean\_absolute\_error: 0.0112 22/126 [====>.........................] - ETA: 0s - loss: 1.5126e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 1.6146e-04 - mean\_absolute\_error: 0.0097 65/126 [==============>...............] - ETA: 0s - loss: 1.5920e-04 - mean\_absolute\_error: 0.0096 86/126 [===================>..........] - ETA: 0s - loss: 1.6191e-04 - mean\_absolute\_error: 0.0097106/126 [========================>.....] - ETA: 0s - loss: 1.6346e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6470e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.2249e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9098e-04 - mean\_absolute\_error: 0.0117 24/126 [====>.........................] - ETA: 0s - loss: 1.8955e-04 - mean\_absolute\_error: 0.0105 45/126 [=========>....................] - ETA: 0s - loss: 1.6997e-04 - mean\_absolute\_error: 0.0100 67/126 [==============>...............] - ETA: 0s - loss: 1.6975e-04 - mean\_absolute\_error: 0.0098 89/126 [====================>.........] - ETA: 0s - loss: 1.6339e-04 - mean\_absolute\_error: 0.0097112/126 [=========================>....] - ETA: 0s - loss: 1.6702e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6564e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.1991e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0900e-04 - mean\_absolute\_error: 0.0086 23/126 [====>.........................] - ETA: 0s - loss: 1.5643e-04 - mean\_absolute\_error: 0.0096 45/126 [=========>....................] - ETA: 0s - loss: 1.6493e-04 - mean\_absolute\_error: 0.0097 68/126 [===============>..............] - ETA: 0s - loss: 1.6223e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.6814e-04 - mean\_absolute\_error: 0.0097111/126 [=========================>....] - ETA: 0s - loss: 1.6469e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6383e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 6.6415e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1548e-04 - mean\_absolute\_error: 0.0088 24/126 [====>.........................] - ETA: 0s - loss: 1.4976e-04 - mean\_absolute\_error: 0.0096 46/126 [=========>....................] - ETA: 0s - loss: 1.5905e-04 - mean\_absolute\_error: 0.0095 66/126 [==============>...............] - ETA: 0s - loss: 1.5447e-04 - mean\_absolute\_error: 0.0094 88/126 [===================>..........] - ETA: 0s - loss: 1.5411e-04 - mean\_absolute\_error: 0.0095110/126 [=========================>....] - ETA: 0s - loss: 1.6129e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6154e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.3400e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2995e-04 - mean\_absolute\_error: 0.0093 23/126 [====>.........................] - ETA: 0s - loss: 1.5340e-04 - mean\_absolute\_error: 0.0096 46/126 [=========>....................] - ETA: 0s - loss: 1.7233e-04 - mean\_absolute\_error: 0.0098 67/126 [==============>...............] - ETA: 0s - loss: 1.7279e-04 - mean\_absolute\_error: 0.0097 90/126 [====================>.........] - ETA: 0s - loss: 1.6777e-04 - mean\_absolute\_error: 0.0096111/126 [=========================>....] - ETA: 0s - loss: 1.6449e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6337e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.2866e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7784e-04 - mean\_absolute\_error: 0.0095 15/126 [==>...........................] - ETA: 0s - loss: 1.7960e-04 - mean\_absolute\_error: 0.0100 30/126 [======>.......................] - ETA: 0s - loss: 1.6804e-04 - mean\_absolute\_error: 0.0098 45/126 [=========>....................] - ETA: 0s - loss: 1.6029e-04 - mean\_absolute\_error: 0.0097 63/126 [==============>...............] - ETA: 0s - loss: 1.5705e-04 - mean\_absolute\_error: 0.0096 83/126 [==================>...........] - ETA: 0s - loss: 1.6123e-04 - mean\_absolute\_error: 0.0096106/126 [========================>.....] - ETA: 0s - loss: 1.5971e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6011e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.4072e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3897e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 1.5175e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.6290e-04 - mean\_absolute\_error: 0.0094 67/126 [==============>...............] - ETA: 0s - loss: 1.6691e-04 - mean\_absolute\_error: 0.0095 89/126 [====================>.........] - ETA: 0s - loss: 1.6757e-04 - mean\_absolute\_error: 0.0097112/126 [=========================>....] - ETA: 0s - loss: 1.6640e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6518e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.2523e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2343e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.7147e-04 - mean\_absolute\_error: 0.0100 45/126 [=========>....................] - ETA: 0s - loss: 1.6139e-04 - mean\_absolute\_error: 0.0097 67/126 [==============>...............] - ETA: 0s - loss: 1.6368e-04 - mean\_absolute\_error: 0.0095 89/126 [====================>.........] - ETA: 0s - loss: 1.5727e-04 - mean\_absolute\_error: 0.0095110/126 [=========================>....] - ETA: 0s - loss: 1.5942e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.6398e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 6.9680e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4209e-04 - mean\_absolute\_error: 0.0089 24/126 [====>.........................] - ETA: 0s - loss: 1.6244e-04 - mean\_absolute\_error: 0.0097 45/126 [=========>....................] - ETA: 0s - loss: 1.5111e-04 - mean\_absolute\_error: 0.0094 66/126 [==============>...............] - ETA: 0s - loss: 1.4809e-04 - mean\_absolute\_error: 0.0094 89/126 [====================>.........] - ETA: 0s - loss: 1.5669e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.6240e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.6559e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.0521e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4970e-04 - mean\_absolute\_error: 0.0101 23/126 [====>.........................] - ETA: 0s - loss: 1.8023e-04 - mean\_absolute\_error: 0.0098 44/126 [=========>....................] - ETA: 0s - loss: 1.6771e-04 - mean\_absolute\_error: 0.0097 68/126 [===============>..............] - ETA: 0s - loss: 1.7339e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.6432e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.6302e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5941e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0859e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1249e-04 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.4540e-04 - mean\_absolute\_error: 0.0094 46/126 [=========>....................] - ETA: 0s - loss: 1.4587e-04 - mean\_absolute\_error: 0.0093 67/126 [==============>...............] - ETA: 0s - loss: 1.4246e-04 - mean\_absolute\_error: 0.0091 90/126 [====================>.........] - ETA: 0s - loss: 1.4593e-04 - mean\_absolute\_error: 0.0092110/126 [=========================>....] - ETA: 0s - loss: 1.5666e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5505e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.1639e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1204e-04 - mean\_absolute\_error: 0.0082 23/126 [====>.........................] - ETA: 0s - loss: 1.5505e-04 - mean\_absolute\_error: 0.0097 45/126 [=========>....................] - ETA: 0s - loss: 1.5995e-04 - mean\_absolute\_error: 0.0094 67/126 [==============>...............] - ETA: 0s - loss: 1.5731e-04 - mean\_absolute\_error: 0.0094 90/126 [====================>.........] - ETA: 0s - loss: 1.5390e-04 - mean\_absolute\_error: 0.0094111/126 [=========================>....] - ETA: 0s - loss: 1.5045e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5525e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.3259e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1298e-05 - mean\_absolute\_error: 0.0079 23/126 [====>.........................] - ETA: 0s - loss: 1.5524e-04 - mean\_absolute\_error: 0.0092 40/126 [========>.....................] - ETA: 0s - loss: 1.4865e-04 - mean\_absolute\_error: 0.0091 56/126 [============>.................] - ETA: 0s - loss: 1.4624e-04 - mean\_absolute\_error: 0.0091 72/126 [================>.............] - ETA: 0s - loss: 1.4765e-04 - mean\_absolute\_error: 0.0092 91/126 [====================>.........] - ETA: 0s - loss: 1.5869e-04 - mean\_absolute\_error: 0.0095110/126 [=========================>....] - ETA: 0s - loss: 1.5775e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5922e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.1324e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0566e-04 - mean\_absolute\_error: 0.0078 22/126 [====>.........................] - ETA: 0s - loss: 1.4505e-04 - mean\_absolute\_error: 0.0093 44/126 [=========>....................] - ETA: 0s - loss: 1.4570e-04 - mean\_absolute\_error: 0.0092 65/126 [==============>...............] - ETA: 0s - loss: 1.4627e-04 - mean\_absolute\_error: 0.0092 85/126 [===================>..........] - ETA: 0s - loss: 1.4897e-04 - mean\_absolute\_error: 0.0093106/126 [========================>.....] - ETA: 0s - loss: 1.4569e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - ETA: 0s - loss: 1.5590e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5590e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.9108e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3528e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 1.3626e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.4704e-04 - mean\_absolute\_error: 0.0091 68/126 [===============>..............] - ETA: 0s - loss: 1.5380e-04 - mean\_absolute\_error: 0.0094 90/126 [====================>.........] - ETA: 0s - loss: 1.5407e-04 - mean\_absolute\_error: 0.0094113/126 [=========================>....] - ETA: 0s - loss: 1.5732e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5887e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 7.3924e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3513e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 1.6187e-04 - mean\_absolute\_error: 0.0092 44/126 [=========>....................] - ETA: 0s - loss: 1.4746e-04 - mean\_absolute\_error: 0.0090 64/126 [==============>...............] - ETA: 0s - loss: 1.4724e-04 - mean\_absolute\_error: 0.0091 85/126 [===================>..........] - ETA: 0s - loss: 1.5624e-04 - mean\_absolute\_error: 0.0094107/126 [========================>.....] - ETA: 0s - loss: 1.6068e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5992e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0502e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7007e-04 - mean\_absolute\_error: 0.0090 21/126 [====>.........................] - ETA: 0s - loss: 1.5665e-04 - mean\_absolute\_error: 0.0094 41/126 [========>.....................] - ETA: 0s - loss: 1.5042e-04 - mean\_absolute\_error: 0.0094 63/126 [==============>...............] - ETA: 0s - loss: 1.5543e-04 - mean\_absolute\_error: 0.0093 85/126 [===================>..........] - ETA: 0s - loss: 1.4887e-04 - mean\_absolute\_error: 0.0091107/126 [========================>.....] - ETA: 0s - loss: 1.5830e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5894e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.0770e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5178e-05 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 1.6891e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 1.6496e-04 - mean\_absolute\_error: 0.0097 65/126 [==============>...............] - ETA: 0s - loss: 1.6459e-04 - mean\_absolute\_error: 0.0098 87/126 [===================>..........] - ETA: 0s - loss: 1.5761e-04 - mean\_absolute\_error: 0.0095108/126 [========================>.....] - ETA: 0s - loss: 1.5408e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5853e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.3349e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1510e-04 - mean\_absolute\_error: 0.0107 23/126 [====>.........................] - ETA: 0s - loss: 1.4220e-04 - mean\_absolute\_error: 0.0090 44/126 [=========>....................] - ETA: 0s - loss: 1.3421e-04 - mean\_absolute\_error: 0.0088 66/126 [==============>...............] - ETA: 0s - loss: 1.3569e-04 - mean\_absolute\_error: 0.0089 88/126 [===================>..........] - ETA: 0s - loss: 1.5093e-04 - mean\_absolute\_error: 0.0091109/126 [========================>.....] - ETA: 0s - loss: 1.5838e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5649e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.6080e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2073e-04 - mean\_absolute\_error: 0.0087 23/126 [====>.........................] - ETA: 0s - loss: 1.7663e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 1.5999e-04 - mean\_absolute\_error: 0.0095 68/126 [===============>..............] - ETA: 0s - loss: 1.6675e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.6116e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.6083e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5828e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 8.8117e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5469e-04 - mean\_absolute\_error: 0.0124 23/126 [====>.........................] - ETA: 0s - loss: 1.8620e-04 - mean\_absolute\_error: 0.0098 45/126 [=========>....................] - ETA: 0s - loss: 1.8515e-04 - mean\_absolute\_error: 0.0101 68/126 [===============>..............] - ETA: 0s - loss: 1.8461e-04 - mean\_absolute\_error: 0.0102 90/126 [====================>.........] - ETA: 0s - loss: 1.8194e-04 - mean\_absolute\_error: 0.0100112/126 [=========================>....] - ETA: 0s - loss: 1.7598e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.7056e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.2651e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4952e-04 - mean\_absolute\_error: 0.0098 24/126 [====>.........................] - ETA: 0s - loss: 1.3872e-04 - mean\_absolute\_error: 0.0091 45/126 [=========>....................] - ETA: 0s - loss: 1.6942e-04 - mean\_absolute\_error: 0.0093 66/126 [==============>...............] - ETA: 0s - loss: 1.6036e-04 - mean\_absolute\_error: 0.0093 87/126 [===================>..........] - ETA: 0s - loss: 1.5947e-04 - mean\_absolute\_error: 0.0093108/126 [========================>.....] - ETA: 0s - loss: 1.5208e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5025e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 6.1019e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1102e-04 - mean\_absolute\_error: 0.0080 22/126 [====>.........................] - ETA: 0s - loss: 1.5666e-04 - mean\_absolute\_error: 0.0093 42/126 [=========>....................] - ETA: 0s - loss: 1.3547e-04 - mean\_absolute\_error: 0.0088 64/126 [==============>...............] - ETA: 0s - loss: 1.4749e-04 - mean\_absolute\_error: 0.0093 86/126 [===================>..........] - ETA: 0s - loss: 1.4836e-04 - mean\_absolute\_error: 0.0093108/126 [========================>.....] - ETA: 0s - loss: 1.5708e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5483e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 8.3924e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0430e-04 - mean\_absolute\_error: 0.0113 21/126 [====>.........................] - ETA: 0s - loss: 1.4785e-04 - mean\_absolute\_error: 0.0092 42/126 [=========>....................] - ETA: 0s - loss: 1.4149e-04 - mean\_absolute\_error: 0.0090 62/126 [=============>................] - ETA: 0s - loss: 1.4636e-04 - mean\_absolute\_error: 0.0092 84/126 [===================>..........] - ETA: 0s - loss: 1.5279e-04 - mean\_absolute\_error: 0.0094103/126 [=======================>......] - ETA: 0s - loss: 1.4891e-04 - mean\_absolute\_error: 0.0093125/126 [============================>.] - ETA: 0s - loss: 1.5765e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5750e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 6.5563e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0511e-04 - mean\_absolute\_error: 0.0086 24/126 [====>.........................] - ETA: 0s - loss: 1.3918e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.4083e-04 - mean\_absolute\_error: 0.0091 67/126 [==============>...............] - ETA: 0s - loss: 1.4443e-04 - mean\_absolute\_error: 0.0090 87/126 [===================>..........] - ETA: 0s - loss: 1.4295e-04 - mean\_absolute\_error: 0.0090109/126 [========================>.....] - ETA: 0s - loss: 1.5013e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5301e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 9.2072e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3791e-04 - mean\_absolute\_error: 0.0126 23/126 [====>.........................] - ETA: 0s - loss: 1.8484e-04 - mean\_absolute\_error: 0.0100 46/126 [=========>....................] - ETA: 0s - loss: 1.8572e-04 - mean\_absolute\_error: 0.0103 68/126 [===============>..............] - ETA: 0s - loss: 2.0162e-04 - mean\_absolute\_error: 0.0109 90/126 [====================>.........] - ETA: 0s - loss: 1.9571e-04 - mean\_absolute\_error: 0.0107111/126 [=========================>....] - ETA: 0s - loss: 1.9337e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 1.8740e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 6.1078e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9408e-04 - mean\_absolute\_error: 0.0093 22/126 [====>.........................] - ETA: 0s - loss: 2.1941e-04 - mean\_absolute\_error: 0.0108 44/126 [=========>....................] - ETA: 0s - loss: 1.8545e-04 - mean\_absolute\_error: 0.0100 66/126 [==============>...............] - ETA: 0s - loss: 1.8118e-04 - mean\_absolute\_error: 0.0099 87/126 [===================>..........] - ETA: 0s - loss: 1.6797e-04 - mean\_absolute\_error: 0.0096107/126 [========================>.....] - ETA: 0s - loss: 1.5922e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - ETA: 0s - loss: 1.5851e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5851e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 7.2916e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5718e-04 - mean\_absolute\_error: 0.0095 22/126 [====>.........................] - ETA: 0s - loss: 1.6966e-04 - mean\_absolute\_error: 0.0099 43/126 [=========>....................] - ETA: 0s - loss: 1.6475e-04 - mean\_absolute\_error: 0.0098 64/126 [==============>...............] - ETA: 0s - loss: 1.6485e-04 - mean\_absolute\_error: 0.0096 86/126 [===================>..........] - ETA: 0s - loss: 1.6285e-04 - mean\_absolute\_error: 0.0095108/126 [========================>.....] - ETA: 0s - loss: 1.6312e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5707e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.7839e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3759e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 1.5437e-04 - mean\_absolute\_error: 0.0093 44/126 [=========>....................] - ETA: 0s - loss: 1.4474e-04 - mean\_absolute\_error: 0.0090 66/126 [==============>...............] - ETA: 0s - loss: 1.4970e-04 - mean\_absolute\_error: 0.0090 86/126 [===================>..........] - ETA: 0s - loss: 1.4352e-04 - mean\_absolute\_error: 0.0089108/126 [========================>.....] - ETA: 0s - loss: 1.5290e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5818e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.7572e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0503e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 1.6438e-04 - mean\_absolute\_error: 0.0096 44/126 [=========>....................] - ETA: 0s - loss: 1.4933e-04 - mean\_absolute\_error: 0.0092 66/126 [==============>...............] - ETA: 0s - loss: 1.4696e-04 - mean\_absolute\_error: 0.0092 88/126 [===================>..........] - ETA: 0s - loss: 1.5664e-04 - mean\_absolute\_error: 0.0094109/126 [========================>.....] - ETA: 0s - loss: 1.5846e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5827e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 7.3284e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9634e-04 - mean\_absolute\_error: 0.0137 23/126 [====>.........................] - ETA: 0s - loss: 1.6794e-04 - mean\_absolute\_error: 0.0103 46/126 [=========>....................] - ETA: 0s - loss: 1.6111e-04 - mean\_absolute\_error: 0.0098 68/126 [===============>..............] - ETA: 0s - loss: 1.5410e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.5461e-04 - mean\_absolute\_error: 0.0097112/126 [=========================>....] - ETA: 0s - loss: 1.6338e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.7101e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 5.1943e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7729e-04 - mean\_absolute\_error: 0.0101 13/126 [==>...........................] - ETA: 0s - loss: 1.7188e-04 - mean\_absolute\_error: 0.0093 34/126 [=======>......................] - ETA: 0s - loss: 1.4371e-04 - mean\_absolute\_error: 0.0089 56/126 [============>.................] - ETA: 0s - loss: 1.5249e-04 - mean\_absolute\_error: 0.0091 78/126 [=================>............] - ETA: 0s - loss: 1.6260e-04 - mean\_absolute\_error: 0.0094100/126 [======================>.......] - ETA: 0s - loss: 1.6856e-04 - mean\_absolute\_error: 0.0097120/126 [===========================>..] - ETA: 0s - loss: 1.8024e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.8074e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 6.4740e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3533e-04 - mean\_absolute\_error: 0.0116 23/126 [====>.........................] - ETA: 0s - loss: 1.5805e-04 - mean\_absolute\_error: 0.0094 45/126 [=========>....................] - ETA: 0s - loss: 1.4997e-04 - mean\_absolute\_error: 0.0091 67/126 [==============>...............] - ETA: 0s - loss: 1.5853e-04 - mean\_absolute\_error: 0.0095 89/126 [====================>.........] - ETA: 0s - loss: 1.6446e-04 - mean\_absolute\_error: 0.0095111/126 [=========================>....] - ETA: 0s - loss: 1.7152e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6547e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.7353e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4828e-04 - mean\_absolute\_error: 0.0125 22/126 [====>.........................] - ETA: 0s - loss: 1.7651e-04 - mean\_absolute\_error: 0.0095 43/126 [=========>....................] - ETA: 0s - loss: 1.6991e-04 - mean\_absolute\_error: 0.0095 65/126 [==============>...............] - ETA: 0s - loss: 1.6289e-04 - mean\_absolute\_error: 0.0094 87/126 [===================>..........] - ETA: 0s - loss: 1.6307e-04 - mean\_absolute\_error: 0.0095109/126 [========================>.....] - ETA: 0s - loss: 1.6832e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6517e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 7.2368e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0658e-04 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.5293e-04 - mean\_absolute\_error: 0.0094 45/126 [=========>....................] - ETA: 0s - loss: 1.4750e-04 - mean\_absolute\_error: 0.0092 67/126 [==============>...............] - ETA: 0s - loss: 1.3865e-04 - mean\_absolute\_error: 0.0089 90/126 [====================>.........] - ETA: 0s - loss: 1.4824e-04 - mean\_absolute\_error: 0.0091111/126 [=========================>....] - ETA: 0s - loss: 1.5393e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4933e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.0049e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7542e-05 - mean\_absolute\_error: 0.0067 17/126 [===>..........................] - ETA: 0s - loss: 1.6439e-04 - mean\_absolute\_error: 0.0097 32/126 [======>.......................] - ETA: 0s - loss: 1.4468e-04 - mean\_absolute\_error: 0.0092 49/126 [==========>...................] - ETA: 0s - loss: 1.5771e-04 - mean\_absolute\_error: 0.0097 66/126 [==============>...............] - ETA: 0s - loss: 1.6805e-04 - mean\_absolute\_error: 0.0098 83/126 [==================>...........] - ETA: 0s - loss: 1.7201e-04 - mean\_absolute\_error: 0.0100101/126 [=======================>......] - ETA: 0s - loss: 1.7788e-04 - mean\_absolute\_error: 0.0101119/126 [===========================>..] - ETA: 0s - loss: 1.7166e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.7048e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 6.9882e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2717e-04 - mean\_absolute\_error: 0.0089 19/126 [===>..........................] - ETA: 0s - loss: 2.0625e-04 - mean\_absolute\_error: 0.0110 38/126 [========>.....................] - ETA: 0s - loss: 2.0753e-04 - mean\_absolute\_error: 0.0113 57/126 [============>.................] - ETA: 0s - loss: 1.9542e-04 - mean\_absolute\_error: 0.0109 76/126 [=================>............] - ETA: 0s - loss: 1.9309e-04 - mean\_absolute\_error: 0.0108 96/126 [=====================>........] - ETA: 0s - loss: 1.8837e-04 - mean\_absolute\_error: 0.0105117/126 [==========================>...] - ETA: 0s - loss: 1.8519e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 3ms/step - loss: 1.8137e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 8.0569e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4038e-04 - mean\_absolute\_error: 0.0119 22/126 [====>.........................] - ETA: 0s - loss: 1.6877e-04 - mean\_absolute\_error: 0.0094 43/126 [=========>....................] - ETA: 0s - loss: 1.5302e-04 - mean\_absolute\_error: 0.0092 62/126 [=============>................] - ETA: 0s - loss: 1.4254e-04 - mean\_absolute\_error: 0.0090 80/126 [==================>...........] - ETA: 0s - loss: 1.4612e-04 - mean\_absolute\_error: 0.0089 95/126 [=====================>........] - ETA: 0s - loss: 1.4927e-04 - mean\_absolute\_error: 0.0090106/126 [========================>.....] - ETA: 0s - loss: 1.4787e-04 - mean\_absolute\_error: 0.0090113/126 [=========================>....] - ETA: 0s - loss: 1.4730e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 4ms/step - loss: 1.4898e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 6.2496e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3195e-04 - mean\_absolute\_error: 0.0094 12/126 [=>............................] - ETA: 0s - loss: 1.5871e-04 - mean\_absolute\_error: 0.0096 24/126 [====>.........................] - ETA: 0s - loss: 1.4845e-04 - mean\_absolute\_error: 0.0094 36/126 [=======>......................] - ETA: 0s - loss: 1.5784e-04 - mean\_absolute\_error: 0.0096 46/126 [=========>....................] - ETA: 0s - loss: 1.7203e-04 - mean\_absolute\_error: 0.0100 55/126 [============>.................] - ETA: 0s - loss: 1.6796e-04 - mean\_absolute\_error: 0.0099 68/126 [===============>..............] - ETA: 0s - loss: 1.7036e-04 - mean\_absolute\_error: 0.0100 83/126 [==================>...........] - ETA: 0s - loss: 1.6212e-04 - mean\_absolute\_error: 0.0097 95/126 [=====================>........] - ETA: 0s - loss: 1.5695e-04 - mean\_absolute\_error: 0.0096107/126 [========================>.....] - ETA: 0s - loss: 1.5245e-04 - mean\_absolute\_error: 0.0094121/126 [===========================>..] - ETA: 0s - loss: 1.6354e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 1s 5ms/step - loss: 1.6675e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 2.1055e-04 - val\_mean\_absolute\_error: 0.0128  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5407e-04 - mean\_absolute\_error: 0.0193 14/126 [==>...........................] - ETA: 0s - loss: 1.8433e-04 - mean\_absolute\_error: 0.0108 26/126 [=====>........................] - ETA: 0s - loss: 1.6106e-04 - mean\_absolute\_error: 0.0099 37/126 [=======>......................] - ETA: 0s - loss: 1.5830e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 1.5127e-04 - mean\_absolute\_error: 0.0095 57/126 [============>.................] - ETA: 0s - loss: 1.4955e-04 - mean\_absolute\_error: 0.0094 72/126 [================>.............] - ETA: 0s - loss: 1.5657e-04 - mean\_absolute\_error: 0.0095 86/126 [===================>..........] - ETA: 0s - loss: 1.6510e-04 - mean\_absolute\_error: 0.0095100/126 [======================>.......] - ETA: 0s - loss: 1.6529e-04 - mean\_absolute\_error: 0.0095114/126 [==========================>...] - ETA: 0s - loss: 1.6132e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 1s 5ms/step - loss: 1.5986e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.9769e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0520e-05 - mean\_absolute\_error: 0.0072 13/126 [==>...........................] - ETA: 0s - loss: 1.3290e-04 - mean\_absolute\_error: 0.0089 26/126 [=====>........................] - ETA: 0s - loss: 1.3806e-04 - mean\_absolute\_error: 0.0090 37/126 [=======>......................] - ETA: 0s - loss: 1.5569e-04 - mean\_absolute\_error: 0.0094 47/126 [==========>...................] - ETA: 0s - loss: 1.5334e-04 - mean\_absolute\_error: 0.0094 57/126 [============>.................] - ETA: 0s - loss: 1.5477e-04 - mean\_absolute\_error: 0.0095 68/126 [===============>..............] - ETA: 0s - loss: 1.5957e-04 - mean\_absolute\_error: 0.0095 80/126 [==================>...........] - ETA: 0s - loss: 1.5489e-04 - mean\_absolute\_error: 0.0093 89/126 [====================>.........] - ETA: 0s - loss: 1.5379e-04 - mean\_absolute\_error: 0.0093101/126 [=======================>......] - ETA: 0s - loss: 1.5546e-04 - mean\_absolute\_error: 0.0094112/126 [=========================>....] - ETA: 0s - loss: 1.6068e-04 - mean\_absolute\_error: 0.0095122/126 [============================>.] - ETA: 0s - loss: 1.6406e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 1s 5ms/step - loss: 1.6461e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 1.1349e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0854e-04 - mean\_absolute\_error: 0.0123 9/126 [=>............................] - ETA: 0s - loss: 1.5672e-04 - mean\_absolute\_error: 0.0099 19/126 [===>..........................] - ETA: 0s - loss: 1.6063e-04 - mean\_absolute\_error: 0.0096 31/126 [======>.......................] - ETA: 0s - loss: 1.8561e-04 - mean\_absolute\_error: 0.0102 43/126 [=========>....................] - ETA: 0s - loss: 1.7236e-04 - mean\_absolute\_error: 0.0098 54/126 [===========>..................] - ETA: 0s - loss: 1.6736e-04 - mean\_absolute\_error: 0.0097 65/126 [==============>...............] - ETA: 0s - loss: 1.6494e-04 - mean\_absolute\_error: 0.0097 75/126 [================>.............] - ETA: 0s - loss: 1.7601e-04 - mean\_absolute\_error: 0.0099 85/126 [===================>..........] - ETA: 0s - loss: 1.7241e-04 - mean\_absolute\_error: 0.0098 96/126 [=====================>........] - ETA: 0s - loss: 1.6846e-04 - mean\_absolute\_error: 0.0097108/126 [========================>.....] - ETA: 0s - loss: 1.6290e-04 - mean\_absolute\_error: 0.0096114/126 [==========================>...] - ETA: 0s - loss: 1.6229e-04 - mean\_absolute\_error: 0.0096124/126 [============================>.] - ETA: 0s - loss: 1.6071e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 1s 6ms/step - loss: 1.6027e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 8.9680e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5321e-04 - mean\_absolute\_error: 0.0091 14/126 [==>...........................] - ETA: 0s - loss: 1.4232e-04 - mean\_absolute\_error: 0.0092 25/126 [====>.........................] - ETA: 0s - loss: 1.5160e-04 - mean\_absolute\_error: 0.0096 35/126 [=======>......................] - ETA: 0s - loss: 1.5081e-04 - mean\_absolute\_error: 0.0094 45/126 [=========>....................] - ETA: 0s - loss: 1.6450e-04 - mean\_absolute\_error: 0.0095 55/126 [============>.................] - ETA: 0s - loss: 1.6621e-04 - mean\_absolute\_error: 0.0096 66/126 [==============>...............] - ETA: 0s - loss: 1.6412e-04 - mean\_absolute\_error: 0.0096 77/126 [=================>............] - ETA: 0s - loss: 1.7284e-04 - mean\_absolute\_error: 0.0099 87/126 [===================>..........] - ETA: 0s - loss: 1.7736e-04 - mean\_absolute\_error: 0.0099 99/126 [======================>.......] - ETA: 0s - loss: 1.7285e-04 - mean\_absolute\_error: 0.0099114/126 [==========================>...] - ETA: 0s - loss: 1.6866e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 1s 5ms/step - loss: 1.6580e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 4.9444e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9756e-05 - mean\_absolute\_error: 0.0078 16/126 [==>...........................] - ETA: 0s - loss: 1.6541e-04 - mean\_absolute\_error: 0.0102 30/126 [======>.......................] - ETA: 0s - loss: 1.8931e-04 - mean\_absolute\_error: 0.0104 46/126 [=========>....................] - ETA: 0s - loss: 1.8217e-04 - mean\_absolute\_error: 0.0099 61/126 [=============>................] - ETA: 0s - loss: 1.7378e-04 - mean\_absolute\_error: 0.0098 75/126 [================>.............] - ETA: 0s - loss: 1.7671e-04 - mean\_absolute\_error: 0.0100 91/126 [====================>.........] - ETA: 0s - loss: 1.8738e-04 - mean\_absolute\_error: 0.0104108/126 [========================>.....] - ETA: 0s - loss: 1.8099e-04 - mean\_absolute\_error: 0.0102125/126 [============================>.] - ETA: 0s - loss: 1.7721e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 4ms/step - loss: 1.7683e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 7.4211e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2308e-04 - mean\_absolute\_error: 0.0123 23/126 [====>.........................] - ETA: 0s - loss: 1.3165e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.7326e-04 - mean\_absolute\_error: 0.0096 67/126 [==============>...............] - ETA: 0s - loss: 1.6587e-04 - mean\_absolute\_error: 0.0096 89/126 [====================>.........] - ETA: 0s - loss: 1.5823e-04 - mean\_absolute\_error: 0.0095111/126 [=========================>....] - ETA: 0s - loss: 1.5358e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5689e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 6.5921e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0769e-04 - mean\_absolute\_error: 0.0079 24/126 [====>.........................] - ETA: 0s - loss: 1.9709e-04 - mean\_absolute\_error: 0.0102 46/126 [=========>....................] - ETA: 0s - loss: 1.9446e-04 - mean\_absolute\_error: 0.0105 67/126 [==============>...............] - ETA: 0s - loss: 1.7469e-04 - mean\_absolute\_error: 0.0099 89/126 [====================>.........] - ETA: 0s - loss: 1.6162e-04 - mean\_absolute\_error: 0.0096112/126 [=========================>....] - ETA: 0s - loss: 1.5620e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5735e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.0610e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1233e-04 - mean\_absolute\_error: 0.0121 23/126 [====>.........................] - ETA: 0s - loss: 1.5513e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.5286e-04 - mean\_absolute\_error: 0.0090 68/126 [===============>..............] - ETA: 0s - loss: 1.4798e-04 - mean\_absolute\_error: 0.0090 90/126 [====================>.........] - ETA: 0s - loss: 1.4997e-04 - mean\_absolute\_error: 0.0092112/126 [=========================>....] - ETA: 0s - loss: 1.4898e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5177e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.2017e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1318e-04 - mean\_absolute\_error: 0.0082 23/126 [====>.........................] - ETA: 0s - loss: 1.2937e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.5220e-04 - mean\_absolute\_error: 0.0093 65/126 [==============>...............] - ETA: 0s - loss: 1.6315e-04 - mean\_absolute\_error: 0.0098 84/126 [===================>..........] - ETA: 0s - loss: 1.5570e-04 - mean\_absolute\_error: 0.0095101/126 [=======================>......] - ETA: 0s - loss: 1.5770e-04 - mean\_absolute\_error: 0.0095119/126 [===========================>..] - ETA: 0s - loss: 1.5607e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5951e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.9210e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1766e-04 - mean\_absolute\_error: 0.0087 21/126 [====>.........................] - ETA: 0s - loss: 1.6144e-04 - mean\_absolute\_error: 0.0096 41/126 [========>.....................] - ETA: 0s - loss: 1.6251e-04 - mean\_absolute\_error: 0.0093 62/126 [=============>................] - ETA: 0s - loss: 1.6308e-04 - mean\_absolute\_error: 0.0095 84/126 [===================>..........] - ETA: 0s - loss: 1.5743e-04 - mean\_absolute\_error: 0.0095106/126 [========================>.....] - ETA: 0s - loss: 1.6270e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.7837e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 5.7593e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0814e-04 - mean\_absolute\_error: 0.0085 20/126 [===>..........................] - ETA: 0s - loss: 2.1766e-04 - mean\_absolute\_error: 0.0112 36/126 [=======>......................] - ETA: 0s - loss: 2.0479e-04 - mean\_absolute\_error: 0.0110 52/126 [===========>..................] - ETA: 0s - loss: 1.8935e-04 - mean\_absolute\_error: 0.0106 66/126 [==============>...............] - ETA: 0s - loss: 1.8514e-04 - mean\_absolute\_error: 0.0105 80/126 [==================>...........] - ETA: 0s - loss: 1.8891e-04 - mean\_absolute\_error: 0.0105 91/126 [====================>.........] - ETA: 0s - loss: 1.8440e-04 - mean\_absolute\_error: 0.0104103/126 [=======================>......] - ETA: 0s - loss: 1.7812e-04 - mean\_absolute\_error: 0.0102118/126 [===========================>..] - ETA: 0s - loss: 1.7789e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 1s 4ms/step - loss: 1.7971e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 5.9083e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5529e-04 - mean\_absolute\_error: 0.0094 13/126 [==>...........................] - ETA: 0s - loss: 1.2136e-04 - mean\_absolute\_error: 0.0083 29/126 [=====>........................] - ETA: 0s - loss: 1.6235e-04 - mean\_absolute\_error: 0.0088 47/126 [==========>...................] - ETA: 0s - loss: 1.4583e-04 - mean\_absolute\_error: 0.0086 65/126 [==============>...............] - ETA: 0s - loss: 1.4097e-04 - mean\_absolute\_error: 0.0086 84/126 [===================>..........] - ETA: 0s - loss: 1.4528e-04 - mean\_absolute\_error: 0.0088102/126 [=======================>......] - ETA: 0s - loss: 1.4232e-04 - mean\_absolute\_error: 0.0088118/126 [===========================>..] - ETA: 0s - loss: 1.4225e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 4ms/step - loss: 1.4557e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 2.2456e-04 - val\_mean\_absolute\_error: 0.0134  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5536e-04 - mean\_absolute\_error: 0.0161 17/126 [===>..........................] - ETA: 0s - loss: 1.9285e-04 - mean\_absolute\_error: 0.0108 33/126 [======>.......................] - ETA: 0s - loss: 1.7864e-04 - mean\_absolute\_error: 0.0099 49/126 [==========>...................] - ETA: 0s - loss: 1.7767e-04 - mean\_absolute\_error: 0.0098 65/126 [==============>...............] - ETA: 0s - loss: 1.9867e-04 - mean\_absolute\_error: 0.0106 81/126 [==================>...........] - ETA: 0s - loss: 1.9765e-04 - mean\_absolute\_error: 0.0106 97/126 [======================>.......] - ETA: 0s - loss: 1.8495e-04 - mean\_absolute\_error: 0.0102112/126 [=========================>....] - ETA: 0s - loss: 1.7893e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 4ms/step - loss: 1.7553e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 5.7759e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2936e-04 - mean\_absolute\_error: 0.0094 21/126 [====>.........................] - ETA: 0s - loss: 1.4291e-04 - mean\_absolute\_error: 0.0091 40/126 [========>.....................] - ETA: 0s - loss: 1.7129e-04 - mean\_absolute\_error: 0.0102 61/126 [=============>................] - ETA: 0s - loss: 1.8215e-04 - mean\_absolute\_error: 0.0105 82/126 [==================>...........] - ETA: 0s - loss: 1.8241e-04 - mean\_absolute\_error: 0.0103103/126 [=======================>......] - ETA: 0s - loss: 1.7247e-04 - mean\_absolute\_error: 0.0100125/126 [============================>.] - ETA: 0s - loss: 1.6967e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6937e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 5.4586e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2412e-04 - mean\_absolute\_error: 0.0085 19/126 [===>..........................] - ETA: 0s - loss: 1.8718e-04 - mean\_absolute\_error: 0.0104 38/126 [========>.....................] - ETA: 0s - loss: 1.6695e-04 - mean\_absolute\_error: 0.0099 57/126 [============>.................] - ETA: 0s - loss: 1.5230e-04 - mean\_absolute\_error: 0.0094 78/126 [=================>............] - ETA: 0s - loss: 1.5546e-04 - mean\_absolute\_error: 0.0095 98/126 [======================>.......] - ETA: 0s - loss: 1.6403e-04 - mean\_absolute\_error: 0.0096116/126 [==========================>...] - ETA: 0s - loss: 1.5676e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.6055e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 6.6047e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8045e-04 - mean\_absolute\_error: 0.0110 20/126 [===>..........................] - ETA: 0s - loss: 1.5490e-04 - mean\_absolute\_error: 0.0088 40/126 [========>.....................] - ETA: 0s - loss: 1.7134e-04 - mean\_absolute\_error: 0.0096 60/126 [=============>................] - ETA: 0s - loss: 1.5402e-04 - mean\_absolute\_error: 0.0092 80/126 [==================>...........] - ETA: 0s - loss: 1.5031e-04 - mean\_absolute\_error: 0.0092100/126 [======================>.......] - ETA: 0s - loss: 1.7028e-04 - mean\_absolute\_error: 0.0098119/126 [===========================>..] - ETA: 0s - loss: 1.6368e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6054e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.9575e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4574e-05 - mean\_absolute\_error: 0.0074 20/126 [===>..........................] - ETA: 0s - loss: 1.3041e-04 - mean\_absolute\_error: 0.0089 40/126 [========>.....................] - ETA: 0s - loss: 1.5399e-04 - mean\_absolute\_error: 0.0096 60/126 [=============>................] - ETA: 0s - loss: 1.6550e-04 - mean\_absolute\_error: 0.0099 80/126 [==================>...........] - ETA: 0s - loss: 1.6360e-04 - mean\_absolute\_error: 0.0096101/126 [=======================>......] - ETA: 0s - loss: 1.6750e-04 - mean\_absolute\_error: 0.0096123/126 [============================>.] - ETA: 0s - loss: 1.6461e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6277e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 4.8475e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6757e-04 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.8220e-04 - mean\_absolute\_error: 0.0093 45/126 [=========>....................] - ETA: 0s - loss: 1.5444e-04 - mean\_absolute\_error: 0.0090 66/126 [==============>...............] - ETA: 0s - loss: 1.5450e-04 - mean\_absolute\_error: 0.0091 85/126 [===================>..........] - ETA: 0s - loss: 1.5304e-04 - mean\_absolute\_error: 0.0091103/126 [=======================>......] - ETA: 0s - loss: 1.5087e-04 - mean\_absolute\_error: 0.0091121/126 [===========================>..] - ETA: 0s - loss: 1.4948e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4871e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.2980e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0384e-04 - mean\_absolute\_error: 0.0081 21/126 [====>.........................] - ETA: 0s - loss: 1.5844e-04 - mean\_absolute\_error: 0.0097 42/126 [=========>....................] - ETA: 0s - loss: 1.5935e-04 - mean\_absolute\_error: 0.0094 64/126 [==============>...............] - ETA: 0s - loss: 1.5250e-04 - mean\_absolute\_error: 0.0091 86/126 [===================>..........] - ETA: 0s - loss: 1.4734e-04 - mean\_absolute\_error: 0.0090109/126 [========================>.....] - ETA: 0s - loss: 1.4578e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4387e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 6.3370e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4494e-04 - mean\_absolute\_error: 0.0095 21/126 [====>.........................] - ETA: 0s - loss: 1.3934e-04 - mean\_absolute\_error: 0.0090 40/126 [========>.....................] - ETA: 0s - loss: 1.3511e-04 - mean\_absolute\_error: 0.0090 57/126 [============>.................] - ETA: 0s - loss: 1.3521e-04 - mean\_absolute\_error: 0.0090 76/126 [=================>............] - ETA: 0s - loss: 1.3154e-04 - mean\_absolute\_error: 0.0089 97/126 [======================>.......] - ETA: 0s - loss: 1.3924e-04 - mean\_absolute\_error: 0.0090110/126 [=========================>....] - ETA: 0s - loss: 1.4400e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4520e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.9808e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8616e-04 - mean\_absolute\_error: 0.0111 23/126 [====>.........................] - ETA: 0s - loss: 1.7392e-04 - mean\_absolute\_error: 0.0104 43/126 [=========>....................] - ETA: 0s - loss: 1.5858e-04 - mean\_absolute\_error: 0.0098 65/126 [==============>...............] - ETA: 0s - loss: 1.5442e-04 - mean\_absolute\_error: 0.0096 86/126 [===================>..........] - ETA: 0s - loss: 1.5889e-04 - mean\_absolute\_error: 0.0094107/126 [========================>.....] - ETA: 0s - loss: 1.5489e-04 - mean\_absolute\_error: 0.0093125/126 [============================>.] - ETA: 0s - loss: 1.5622e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5611e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.2405e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1654e-05 - mean\_absolute\_error: 0.0064 21/126 [====>.........................] - ETA: 0s - loss: 1.2610e-04 - mean\_absolute\_error: 0.0084 41/126 [========>.....................] - ETA: 0s - loss: 1.2747e-04 - mean\_absolute\_error: 0.0086 62/126 [=============>................] - ETA: 0s - loss: 1.4469e-04 - mean\_absolute\_error: 0.0090 78/126 [=================>............] - ETA: 0s - loss: 1.4663e-04 - mean\_absolute\_error: 0.0091 94/126 [=====================>........] - ETA: 0s - loss: 1.5201e-04 - mean\_absolute\_error: 0.0093114/126 [==========================>...] - ETA: 0s - loss: 1.5401e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5763e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 8.0635e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1020e-04 - mean\_absolute\_error: 0.0081 21/126 [====>.........................] - ETA: 0s - loss: 1.3254e-04 - mean\_absolute\_error: 0.0091 41/126 [========>.....................] - ETA: 0s - loss: 1.4331e-04 - mean\_absolute\_error: 0.0090 61/126 [=============>................] - ETA: 0s - loss: 1.4411e-04 - mean\_absolute\_error: 0.0089 76/126 [=================>............] - ETA: 0s - loss: 1.4209e-04 - mean\_absolute\_error: 0.0089 94/126 [=====================>........] - ETA: 0s - loss: 1.5490e-04 - mean\_absolute\_error: 0.0094110/126 [=========================>....] - ETA: 0s - loss: 1.6462e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - ETA: 0s - loss: 1.5952e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5952e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 9.7861e-05 - val\_mean\_absolute\_error: 0.0082  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8271e-04 - mean\_absolute\_error: 0.0107 17/126 [===>..........................] - ETA: 0s - loss: 1.2309e-04 - mean\_absolute\_error: 0.0087 33/126 [======>.......................] - ETA: 0s - loss: 1.2613e-04 - mean\_absolute\_error: 0.0087 50/126 [==========>...................] - ETA: 0s - loss: 1.6140e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.6576e-04 - mean\_absolute\_error: 0.0096 85/126 [===================>..........] - ETA: 0s - loss: 1.6998e-04 - mean\_absolute\_error: 0.0098100/126 [======================>.......] - ETA: 0s - loss: 1.6736e-04 - mean\_absolute\_error: 0.0098114/126 [==========================>...] - ETA: 0s - loss: 1.6286e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6114e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 4.7262e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7980e-05 - mean\_absolute\_error: 0.0079 19/126 [===>..........................] - ETA: 0s - loss: 1.2243e-04 - mean\_absolute\_error: 0.0083 38/126 [========>.....................] - ETA: 0s - loss: 1.3738e-04 - mean\_absolute\_error: 0.0087 54/126 [===========>..................] - ETA: 0s - loss: 1.5105e-04 - mean\_absolute\_error: 0.0090 73/126 [================>.............] - ETA: 0s - loss: 1.5294e-04 - mean\_absolute\_error: 0.0092 93/126 [=====================>........] - ETA: 0s - loss: 1.5002e-04 - mean\_absolute\_error: 0.0091113/126 [=========================>....] - ETA: 0s - loss: 1.4674e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4519e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.7108e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6715e-05 - mean\_absolute\_error: 0.0076 21/126 [====>.........................] - ETA: 0s - loss: 1.4767e-04 - mean\_absolute\_error: 0.0093 39/126 [========>.....................] - ETA: 0s - loss: 1.8076e-04 - mean\_absolute\_error: 0.0099 59/126 [=============>................] - ETA: 0s - loss: 1.7445e-04 - mean\_absolute\_error: 0.0099 79/126 [=================>............] - ETA: 0s - loss: 1.7341e-04 - mean\_absolute\_error: 0.0100100/126 [======================>.......] - ETA: 0s - loss: 1.6357e-04 - mean\_absolute\_error: 0.0097121/126 [===========================>..] - ETA: 0s - loss: 1.5979e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6180e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 4.7691e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8987e-05 - mean\_absolute\_error: 0.0066 21/126 [====>.........................] - ETA: 0s - loss: 1.4891e-04 - mean\_absolute\_error: 0.0083 42/126 [=========>....................] - ETA: 0s - loss: 1.5998e-04 - mean\_absolute\_error: 0.0092 64/126 [==============>...............] - ETA: 0s - loss: 1.6586e-04 - mean\_absolute\_error: 0.0095 85/126 [===================>..........] - ETA: 0s - loss: 1.6120e-04 - mean\_absolute\_error: 0.0095105/126 [========================>.....] - ETA: 0s - loss: 1.5481e-04 - mean\_absolute\_error: 0.0093118/126 [===========================>..] - ETA: 0s - loss: 1.5349e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5416e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 8.8731e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4907e-04 - mean\_absolute\_error: 0.0093 19/126 [===>..........................] - ETA: 0s - loss: 2.1137e-04 - mean\_absolute\_error: 0.0109 39/126 [========>.....................] - ETA: 0s - loss: 1.7387e-04 - mean\_absolute\_error: 0.0099 58/126 [============>.................] - ETA: 0s - loss: 1.6576e-04 - mean\_absolute\_error: 0.0098 76/126 [=================>............] - ETA: 0s - loss: 1.5892e-04 - mean\_absolute\_error: 0.0095 94/126 [=====================>........] - ETA: 0s - loss: 1.6090e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.5582e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5385e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.8254e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4656e-04 - mean\_absolute\_error: 0.0088 21/126 [====>.........................] - ETA: 0s - loss: 1.4207e-04 - mean\_absolute\_error: 0.0091 42/126 [=========>....................] - ETA: 0s - loss: 1.4476e-04 - mean\_absolute\_error: 0.0088 62/126 [=============>................] - ETA: 0s - loss: 1.5312e-04 - mean\_absolute\_error: 0.0091 83/126 [==================>...........] - ETA: 0s - loss: 1.7756e-04 - mean\_absolute\_error: 0.0099105/126 [========================>.....] - ETA: 0s - loss: 1.7829e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7099e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 9.8507e-05 - val\_mean\_absolute\_error: 0.0083  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1927e-04 - mean\_absolute\_error: 0.0120 21/126 [====>.........................] - ETA: 0s - loss: 1.9705e-04 - mean\_absolute\_error: 0.0098 43/126 [=========>....................] - ETA: 0s - loss: 1.8972e-04 - mean\_absolute\_error: 0.0101 63/126 [==============>...............] - ETA: 0s - loss: 1.7516e-04 - mean\_absolute\_error: 0.0097 84/126 [===================>..........] - ETA: 0s - loss: 1.6245e-04 - mean\_absolute\_error: 0.0094103/126 [=======================>......] - ETA: 0s - loss: 1.6573e-04 - mean\_absolute\_error: 0.0096123/126 [============================>.] - ETA: 0s - loss: 1.6222e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6141e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 4.8487e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5162e-05 - mean\_absolute\_error: 0.0054 23/126 [====>.........................] - ETA: 0s - loss: 1.6413e-04 - mean\_absolute\_error: 0.0098 45/126 [=========>....................] - ETA: 0s - loss: 1.4709e-04 - mean\_absolute\_error: 0.0092 67/126 [==============>...............] - ETA: 0s - loss: 1.5382e-04 - mean\_absolute\_error: 0.0094 87/126 [===================>..........] - ETA: 0s - loss: 1.5857e-04 - mean\_absolute\_error: 0.0093109/126 [========================>.....] - ETA: 0s - loss: 1.5571e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5238e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.3519e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0706e-04 - mean\_absolute\_error: 0.0083 23/126 [====>.........................] - ETA: 0s - loss: 1.2092e-04 - mean\_absolute\_error: 0.0084 43/126 [=========>....................] - ETA: 0s - loss: 1.2560e-04 - mean\_absolute\_error: 0.0086 65/126 [==============>...............] - ETA: 0s - loss: 1.3355e-04 - mean\_absolute\_error: 0.0088 87/126 [===================>..........] - ETA: 0s - loss: 1.3545e-04 - mean\_absolute\_error: 0.0089109/126 [========================>.....] - ETA: 0s - loss: 1.3814e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4060e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 8.4701e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3076e-04 - mean\_absolute\_error: 0.0109 22/126 [====>.........................] - ETA: 0s - loss: 1.5993e-04 - mean\_absolute\_error: 0.0092 42/126 [=========>....................] - ETA: 0s - loss: 1.4241e-04 - mean\_absolute\_error: 0.0089 64/126 [==============>...............] - ETA: 0s - loss: 1.5700e-04 - mean\_absolute\_error: 0.0092 85/126 [===================>..........] - ETA: 0s - loss: 1.5249e-04 - mean\_absolute\_error: 0.0092105/126 [========================>.....] - ETA: 0s - loss: 1.5124e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - ETA: 0s - loss: 1.4791e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4791e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.8601e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3351e-04 - mean\_absolute\_error: 0.0088 24/126 [====>.........................] - ETA: 0s - loss: 1.2051e-04 - mean\_absolute\_error: 0.0086 46/126 [=========>....................] - ETA: 0s - loss: 1.4262e-04 - mean\_absolute\_error: 0.0093 67/126 [==============>...............] - ETA: 0s - loss: 1.3906e-04 - mean\_absolute\_error: 0.0090 88/126 [===================>..........] - ETA: 0s - loss: 1.5339e-04 - mean\_absolute\_error: 0.0093109/126 [========================>.....] - ETA: 0s - loss: 1.7343e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7172e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 4.8014e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2345e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 1.3226e-04 - mean\_absolute\_error: 0.0088 43/126 [=========>....................] - ETA: 0s - loss: 1.2991e-04 - mean\_absolute\_error: 0.0088 65/126 [==============>...............] - ETA: 0s - loss: 1.3009e-04 - mean\_absolute\_error: 0.0087 87/126 [===================>..........] - ETA: 0s - loss: 1.3528e-04 - mean\_absolute\_error: 0.0087108/126 [========================>.....] - ETA: 0s - loss: 1.3172e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3740e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 5.4263e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9345e-05 - mean\_absolute\_error: 0.0083 22/126 [====>.........................] - ETA: 0s - loss: 1.3338e-04 - mean\_absolute\_error: 0.0089 43/126 [=========>....................] - ETA: 0s - loss: 1.4433e-04 - mean\_absolute\_error: 0.0094 63/126 [==============>...............] - ETA: 0s - loss: 1.5711e-04 - mean\_absolute\_error: 0.0096 84/126 [===================>..........] - ETA: 0s - loss: 1.5066e-04 - mean\_absolute\_error: 0.0094105/126 [========================>.....] - ETA: 0s - loss: 1.4904e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.5306e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5431e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.1762e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6447e-04 - mean\_absolute\_error: 0.0105 19/126 [===>..........................] - ETA: 0s - loss: 2.0942e-04 - mean\_absolute\_error: 0.0114 40/126 [========>.....................] - ETA: 0s - loss: 1.6579e-04 - mean\_absolute\_error: 0.0100 62/126 [=============>................] - ETA: 0s - loss: 1.4984e-04 - mean\_absolute\_error: 0.0095 83/126 [==================>...........] - ETA: 0s - loss: 1.5339e-04 - mean\_absolute\_error: 0.0094104/126 [=======================>......] - ETA: 0s - loss: 1.4567e-04 - mean\_absolute\_error: 0.0092125/126 [============================>.] - ETA: 0s - loss: 1.5006e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5012e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 1.5318e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0285e-04 - mean\_absolute\_error: 0.0119 22/126 [====>.........................] - ETA: 0s - loss: 1.5392e-04 - mean\_absolute\_error: 0.0096 43/126 [=========>....................] - ETA: 0s - loss: 1.4355e-04 - mean\_absolute\_error: 0.0092 65/126 [==============>...............] - ETA: 0s - loss: 1.3424e-04 - mean\_absolute\_error: 0.0089 87/126 [===================>..........] - ETA: 0s - loss: 1.4285e-04 - mean\_absolute\_error: 0.0091108/126 [========================>.....] - ETA: 0s - loss: 1.3728e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.3930e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.4303e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3793e-04 - mean\_absolute\_error: 0.0127 23/126 [====>.........................] - ETA: 0s - loss: 1.4134e-04 - mean\_absolute\_error: 0.0086 45/126 [=========>....................] - ETA: 0s - loss: 1.4203e-04 - mean\_absolute\_error: 0.0089 66/126 [==============>...............] - ETA: 0s - loss: 1.3612e-04 - mean\_absolute\_error: 0.0088 88/126 [===================>..........] - ETA: 0s - loss: 1.3162e-04 - mean\_absolute\_error: 0.0087109/126 [========================>.....] - ETA: 0s - loss: 1.3967e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4477e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.8552e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7593e-05 - mean\_absolute\_error: 0.0065 22/126 [====>.........................] - ETA: 0s - loss: 1.2351e-04 - mean\_absolute\_error: 0.0085 43/126 [=========>....................] - ETA: 0s - loss: 1.3340e-04 - mean\_absolute\_error: 0.0089 65/126 [==============>...............] - ETA: 0s - loss: 1.3991e-04 - mean\_absolute\_error: 0.0088 86/126 [===================>..........] - ETA: 0s - loss: 1.3964e-04 - mean\_absolute\_error: 0.0089107/126 [========================>.....] - ETA: 0s - loss: 1.4493e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4292e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.4983e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0017e-04 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 1.5093e-04 - mean\_absolute\_error: 0.0091 45/126 [=========>....................] - ETA: 0s - loss: 1.8967e-04 - mean\_absolute\_error: 0.0102 66/126 [==============>...............] - ETA: 0s - loss: 1.7041e-04 - mean\_absolute\_error: 0.0098 87/126 [===================>..........] - ETA: 0s - loss: 1.5980e-04 - mean\_absolute\_error: 0.0095109/126 [========================>.....] - ETA: 0s - loss: 1.5935e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5927e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 8.2548e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8608e-04 - mean\_absolute\_error: 0.0111 23/126 [====>.........................] - ETA: 0s - loss: 1.5571e-04 - mean\_absolute\_error: 0.0098 44/126 [=========>....................] - ETA: 0s - loss: 1.4461e-04 - mean\_absolute\_error: 0.0094 66/126 [==============>...............] - ETA: 0s - loss: 1.4441e-04 - mean\_absolute\_error: 0.0093 88/126 [===================>..........] - ETA: 0s - loss: 1.4352e-04 - mean\_absolute\_error: 0.0091109/126 [========================>.....] - ETA: 0s - loss: 1.4562e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4571e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.5665e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6494e-05 - mean\_absolute\_error: 0.0073 22/126 [====>.........................] - ETA: 0s - loss: 1.6575e-04 - mean\_absolute\_error: 0.0097 43/126 [=========>....................] - ETA: 0s - loss: 1.4260e-04 - mean\_absolute\_error: 0.0090 64/126 [==============>...............] - ETA: 0s - loss: 1.3650e-04 - mean\_absolute\_error: 0.0089 86/126 [===================>..........] - ETA: 0s - loss: 1.3742e-04 - mean\_absolute\_error: 0.0088107/126 [========================>.....] - ETA: 0s - loss: 1.4589e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.5516e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 1.2206e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4714e-04 - mean\_absolute\_error: 0.0128 22/126 [====>.........................] - ETA: 0s - loss: 1.4762e-04 - mean\_absolute\_error: 0.0096 43/126 [=========>....................] - ETA: 0s - loss: 1.4621e-04 - mean\_absolute\_error: 0.0090 64/126 [==============>...............] - ETA: 0s - loss: 1.6823e-04 - mean\_absolute\_error: 0.0097 86/126 [===================>..........] - ETA: 0s - loss: 1.6566e-04 - mean\_absolute\_error: 0.0098107/126 [========================>.....] - ETA: 0s - loss: 1.5757e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5489e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 7.6246e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4122e-04 - mean\_absolute\_error: 0.0093 20/126 [===>..........................] - ETA: 0s - loss: 1.2304e-04 - mean\_absolute\_error: 0.0082 41/126 [========>.....................] - ETA: 0s - loss: 1.5412e-04 - mean\_absolute\_error: 0.0094 62/126 [=============>................] - ETA: 0s - loss: 1.8270e-04 - mean\_absolute\_error: 0.0103 83/126 [==================>...........] - ETA: 0s - loss: 1.6788e-04 - mean\_absolute\_error: 0.0099104/126 [=======================>......] - ETA: 0s - loss: 1.6812e-04 - mean\_absolute\_error: 0.0097124/126 [============================>.] - ETA: 0s - loss: 1.6183e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.6191e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 8.6914e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1954e-04 - mean\_absolute\_error: 0.0093 23/126 [====>.........................] - ETA: 0s - loss: 1.1963e-04 - mean\_absolute\_error: 0.0085 44/126 [=========>....................] - ETA: 0s - loss: 1.2419e-04 - mean\_absolute\_error: 0.0085 64/126 [==============>...............] - ETA: 0s - loss: 1.2598e-04 - mean\_absolute\_error: 0.0087 86/126 [===================>..........] - ETA: 0s - loss: 1.2927e-04 - mean\_absolute\_error: 0.0087108/126 [========================>.....] - ETA: 0s - loss: 1.3471e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4652e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 7.3150e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6361e-04 - mean\_absolute\_error: 0.0095 22/126 [====>.........................] - ETA: 0s - loss: 1.4541e-04 - mean\_absolute\_error: 0.0087 43/126 [=========>....................] - ETA: 0s - loss: 1.6662e-04 - mean\_absolute\_error: 0.0094 66/126 [==============>...............] - ETA: 0s - loss: 1.5027e-04 - mean\_absolute\_error: 0.0091 88/126 [===================>..........] - ETA: 0s - loss: 1.4674e-04 - mean\_absolute\_error: 0.0091108/126 [========================>.....] - ETA: 0s - loss: 1.4950e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5041e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.9452e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1090e-04 - mean\_absolute\_error: 0.0087 21/126 [====>.........................] - ETA: 0s - loss: 1.0634e-04 - mean\_absolute\_error: 0.0081 43/126 [=========>....................] - ETA: 0s - loss: 1.4720e-04 - mean\_absolute\_error: 0.0093 65/126 [==============>...............] - ETA: 0s - loss: 1.5588e-04 - mean\_absolute\_error: 0.0097 87/126 [===================>..........] - ETA: 0s - loss: 1.5274e-04 - mean\_absolute\_error: 0.0094108/126 [========================>.....] - ETA: 0s - loss: 1.5437e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5498e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 2.9200e-04 - val\_mean\_absolute\_error: 0.0158  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7313e-04 - mean\_absolute\_error: 0.0170 22/126 [====>.........................] - ETA: 0s - loss: 2.7988e-04 - mean\_absolute\_error: 0.0137 44/126 [=========>....................] - ETA: 0s - loss: 2.1493e-04 - mean\_absolute\_error: 0.0117 65/126 [==============>...............] - ETA: 0s - loss: 1.9766e-04 - mean\_absolute\_error: 0.0109 87/126 [===================>..........] - ETA: 0s - loss: 1.8678e-04 - mean\_absolute\_error: 0.0106109/126 [========================>.....] - ETA: 0s - loss: 1.8429e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 1.7569e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 4.4844e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5330e-04 - mean\_absolute\_error: 0.0099 22/126 [====>.........................] - ETA: 0s - loss: 1.1737e-04 - mean\_absolute\_error: 0.0083 43/126 [=========>....................] - ETA: 0s - loss: 1.1544e-04 - mean\_absolute\_error: 0.0082 64/126 [==============>...............] - ETA: 0s - loss: 1.1893e-04 - mean\_absolute\_error: 0.0083 84/126 [===================>..........] - ETA: 0s - loss: 1.1695e-04 - mean\_absolute\_error: 0.0083104/126 [=======================>......] - ETA: 0s - loss: 1.2860e-04 - mean\_absolute\_error: 0.0085125/126 [============================>.] - ETA: 0s - loss: 1.3220e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.3220e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 6.1842e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1751e-05 - mean\_absolute\_error: 0.0060 23/126 [====>.........................] - ETA: 0s - loss: 1.9202e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 1.8586e-04 - mean\_absolute\_error: 0.0106 65/126 [==============>...............] - ETA: 0s - loss: 1.6790e-04 - mean\_absolute\_error: 0.0101 86/126 [===================>..........] - ETA: 0s - loss: 1.6351e-04 - mean\_absolute\_error: 0.0098106/126 [========================>.....] - ETA: 0s - loss: 1.7131e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7178e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 4.6570e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0800e-04 - mean\_absolute\_error: 0.0076 21/126 [====>.........................] - ETA: 0s - loss: 1.6435e-04 - mean\_absolute\_error: 0.0092 42/126 [=========>....................] - ETA: 0s - loss: 1.6760e-04 - mean\_absolute\_error: 0.0097 64/126 [==============>...............] - ETA: 0s - loss: 1.5932e-04 - mean\_absolute\_error: 0.0095 86/126 [===================>..........] - ETA: 0s - loss: 1.5052e-04 - mean\_absolute\_error: 0.0093107/126 [========================>.....] - ETA: 0s - loss: 1.4536e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4802e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.5543e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5619e-04 - mean\_absolute\_error: 0.0100 22/126 [====>.........................] - ETA: 0s - loss: 1.3745e-04 - mean\_absolute\_error: 0.0084 44/126 [=========>....................] - ETA: 0s - loss: 1.2341e-04 - mean\_absolute\_error: 0.0081 64/126 [==============>...............] - ETA: 0s - loss: 1.2907e-04 - mean\_absolute\_error: 0.0083 86/126 [===================>..........] - ETA: 0s - loss: 1.2967e-04 - mean\_absolute\_error: 0.0084107/126 [========================>.....] - ETA: 0s - loss: 1.2949e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2830e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.4580e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9994e-05 - mean\_absolute\_error: 0.0067 22/126 [====>.........................] - ETA: 0s - loss: 1.4909e-04 - mean\_absolute\_error: 0.0090 44/126 [=========>....................] - ETA: 0s - loss: 1.3077e-04 - mean\_absolute\_error: 0.0086 66/126 [==============>...............] - ETA: 0s - loss: 1.3716e-04 - mean\_absolute\_error: 0.0087 87/126 [===================>..........] - ETA: 0s - loss: 1.3465e-04 - mean\_absolute\_error: 0.0087107/126 [========================>.....] - ETA: 0s - loss: 1.3572e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3208e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 5.5343e-05 - val\_mean\_absolute\_error: 0.0060

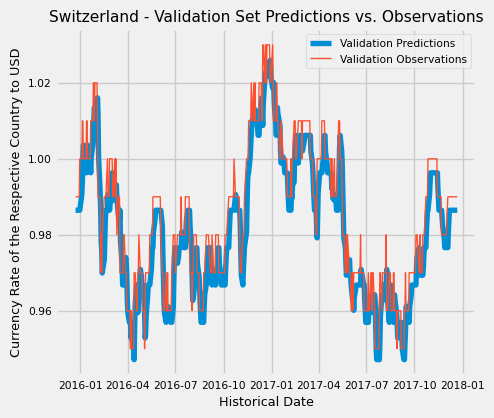
<keras.src.callbacks.History at 0x24c4e1b2e50>

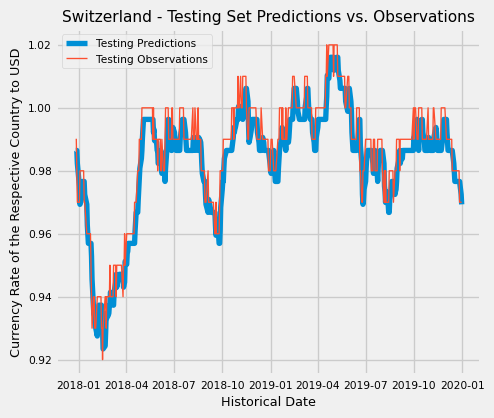
After the training and fitting of the Machine Learning model for Switzerland, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue lines represent the prediction model’s projections and the thinner red lines is the observed/gathered data.

```{python}  
# Testing the Machine Learning Model prediction for Switzerland with the train,   
# validation, and test sets  
# Most important is the test set prediction as this tests the effectiveness  
# of the Machine Learning model on data it has not seen before   
switzerland\_train\_pred = switzerland\_model.predict(X\_switzerland\_train).flatten()  
  
plt.plot(dates\_switzerland\_train, switzerland\_train\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_train, y\_switzerland\_train, linewidth=1)  
plt.legend(["Training Predictions", "Training Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Switzerland - Training Set Predictions vs. Observations")  
plt.show()  
  
switzerland\_val\_pred = switzerland\_model.predict(X\_switzerland\_val).flatten()  
  
plt.plot(dates\_switzerland\_val, switzerland\_val\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_val, y\_switzerland\_val, linewidth=1)  
plt.legend(["Validation Predictions", "Validation Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Switzerland - Validation Set Predictions vs. Observations")  
plt.show()  
  
switzerland\_test\_pred = switzerland\_model.predict(X\_switzerland\_test).flatten()  
  
plt.plot(dates\_switzerland\_test, switzerland\_test\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_test, y\_switzerland\_test, linewidth=1)  
plt.legend(["Testing Predictions", "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Switzerland - Testing Set Predictions vs. Observations")  
plt.show()  
```

1/126 [..............................] - ETA: 44s 42/126 [=========>....................] - ETA: 0s 84/126 [===================>..........] - ETA: 0s126/126 [==============================] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
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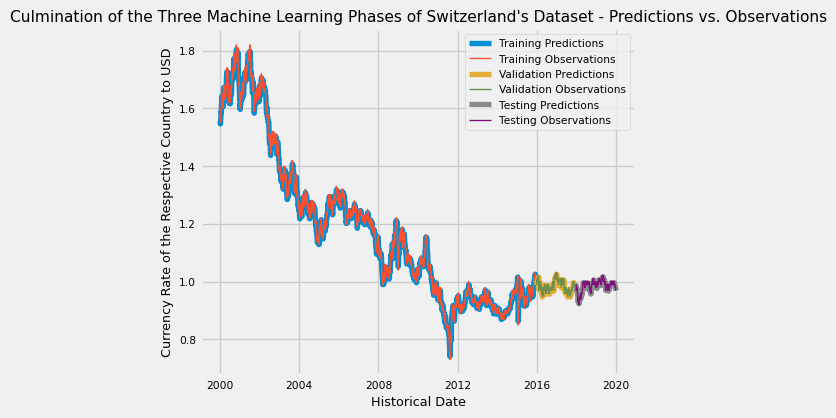






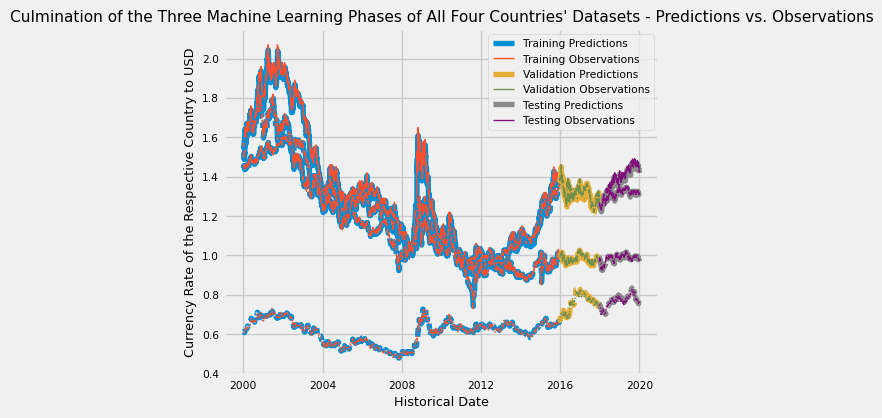
Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and fitting towards predicting Switzerland’s international currency rate with the United States.

```{python}  
# Plotting Switzerland's observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model)   
plt.plot(dates\_switzerland\_train, switzerland\_train\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_train, y\_switzerland\_train, linewidth=1)  
plt.plot(dates\_switzerland\_val, switzerland\_val\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_val, y\_switzerland\_val, linewidth=1)  
plt.plot(dates\_switzerland\_test, switzerland\_test\_pred, linewidth=4)  
plt.plot(dates\_switzerland\_test, y\_switzerland\_test, linewidth=1)  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of Switzerland's Dataset - Predictions vs. Observations")  
plt.show()  
```



To put it all together, I made one large visualization to encompass all 4 countries’ Machine Learning model prediction-based vs. observation-based visualizations - Austrailia, Canada, the United Kingdom, and Switzerland as shown below.

```{python}  
# Plotting all countries' observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model in an overall sense)   
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_train, y\_austrailia\_train, linewidth=1, linestyle="solid")  
plt.plot(dates\_austrailia\_val, austrailia\_val\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_val, y\_austrailia\_val, linewidth=1, linestyle="solid")  
plt.plot(dates\_austrailia\_test, austrailia\_test\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_test, y\_austrailia\_test, linewidth=1, linestyle="solid")  
  
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4, linestyle="dashed")  
plt.plot(dates\_canada\_train, y\_canada\_train, linewidth=1, linestyle="dashed")  
plt.plot(dates\_canada\_val, canada\_val\_pred, linewidth=4, linestyle="dashed")  
plt.plot(dates\_canada\_val, y\_canada\_val, linewidth=1, linestyle="dashed")  
plt.plot(dates\_canada\_test, canada\_test\_pred, linewidth=4, linestyle="dashed")  
plt.plot(dates\_canada\_test, y\_canada\_test, linewidth=1, linestyle="dashed")  
  
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4, linestyle="dotted")  
plt.plot(dates\_united\_kingdom\_train, y\_united\_kingdom\_train, linewidth=1, linestyle="dotted")  
plt.plot(dates\_united\_kingdom\_val, united\_kingdom\_val\_pred, linewidth=4, linestyle="dotted")  
plt.plot(dates\_united\_kingdom\_val, y\_united\_kingdom\_val, linewidth=1, linestyle="dotted")  
plt.plot(dates\_united\_kingdom\_test, united\_kingdom\_test\_pred, linewidth=4, linestyle="dotted")  
plt.plot(dates\_united\_kingdom\_test, y\_united\_kingdom\_test, linewidth=1, linestyle="dotted")  
  
plt.plot(dates\_switzerland\_train, switzerland\_train\_pred, linewidth=4, linestyle="dashdot")  
plt.plot(dates\_switzerland\_train, y\_switzerland\_train, linewidth=1, linestyle="dashdot")  
plt.plot(dates\_switzerland\_val, switzerland\_val\_pred, linewidth=4, linestyle="dashdot")  
plt.plot(dates\_switzerland\_val, y\_switzerland\_val, linewidth=1, linestyle="dashdot")  
plt.plot(dates\_switzerland\_test, switzerland\_test\_pred, linewidth=4, linestyle="dashdot")  
plt.plot(dates\_switzerland\_test, y\_switzerland\_test, linewidth=1, linestyle="dashdot")  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations"])  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of All Four Countries' Datasets - Predictions vs. Observations")  
plt.show()  
```



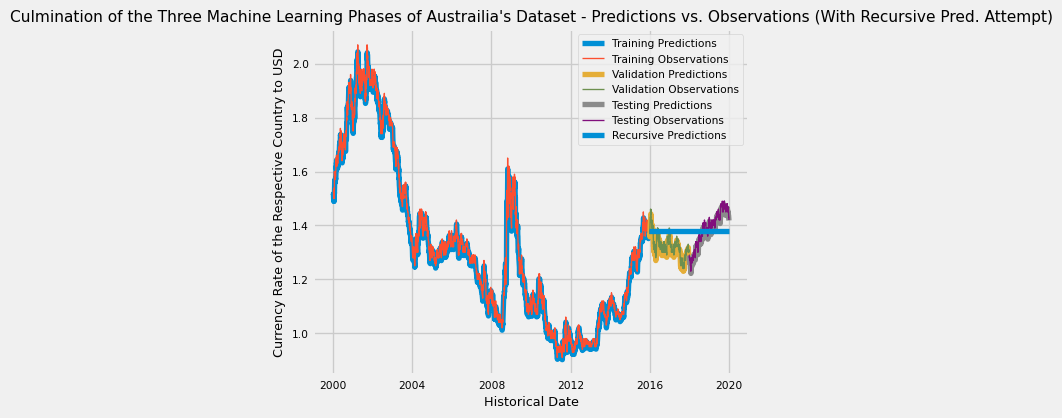
Ultimately, here is the moment of truth: I tried to recursively predict Austrailia’s future expected projection on its international currency rate between the United States through using my LSTM prediction model as shown below. By using the data from the training dataset for Austrailia, I tried to contrast the effectiveness of the model by constrasting its projection to the actual validation and testing data results. However, unfortunately, it did not predict as well as I hoped, but this was a good experiment, nonetheless.

```{python}  
# Attempt at using the model to predict into the future for Austrailia's currency   
# rate  
recursive\_pred: list = []  
recursive\_dates = np.concatenate([dates\_austrailia\_val, dates\_austrailia\_test])  
  
for target\_date in recursive\_dates:  
 last\_window = deepcopy(X\_austrailia\_train[-1])  
 next\_pred = austrailia\_model.predict(np.array([last\_window])).flatten()  
 recursive\_pred.append(next\_pred)  
 last\_window[-1] = next\_pred  
```

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To visualize the results of my recursive prediction that I completed, I added these results to the previous large visualization that encompassed all 4 countries’ Machine Learning model prediction-based vs. observation-based visualizations - Austrailia, Canada, the United Kingdom, and Switzerland as shown below.

```{python}  
# Plotting all countries' observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model in an overall sense) along with the new recursive prediction  
# results  
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_train, y\_austrailia\_train, linewidth=1, linestyle="solid")  
plt.plot(dates\_austrailia\_val, austrailia\_val\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_val, y\_austrailia\_val, linewidth=1, linestyle="solid")  
plt.plot(dates\_austrailia\_test, austrailia\_test\_pred, linewidth=4, linestyle="solid")  
plt.plot(dates\_austrailia\_test, y\_austrailia\_test, linewidth=1, linestyle="solid")  
plt.plot(recursive\_dates, recursive\_pred, linewidth=4, linestyle="solid")  
  
plt.legend(["Training Predictions",  
 "Training Observations",  
 "Validation Predictions",  
 "Validation Observations",  
 "Testing Predictions",  
 "Testing Observations",  
 "Recursive Predictions"], loc="upper right")  
plt.rcParams["font.size"] = 8  
plt.tight\_layout()  
plt.xlabel("Historical Date")  
plt.ylabel("Currency Rate of the Respective Country to USD")  
plt.title("Culmination of the Three Machine Learning Phases of Austrailia's Dataset - Predictions vs. Observations (With Recursive Pred. Attempt)")  
plt.show()  
```



## Conclusions

* Returning to my attempt to test the ability for my Machine Learning model to predict the International Currency rates for Austrailia from just the range of my training dataset as shown above, I felt that its prediction was acceptable in my opinion giving the averaging across the currency rate values in my validation and testing datasets would have proven to be considerably close in its precision.
* Thus, I reached the conclusion that my International Currency Predictor would not be a viable Machine Learning model for any real-life applications. This Machine Learning model raised a valuable point - financial market prediction is a difficult endeavor to accurately predict. From a more general point of view, this International Currency Maching Learning prediction model is not totally inaccurate or untrustworthy but rather it is only on the micro-scale. These financial predictions do not always account for current events in that respective country such as changing domestic or international relations or constantly changing socioeconomic trends which could significantly sway market confidence and impact currency rate fluctuation. Consequently, economists often have to look at larger economic trends across several decades in order to make more educated predictions.
* Ultimately, I learned a great deal about the complexities of financial prediction and usage of Machine Learning models as an attempt to solve this issue. Even though my model was not as successful at predicting as I would have hoped, I am interested to see the future of Machine Learning as it soon dominates these economic sub-field and continues to rise in its relevance by being a pivotal talking point for the future and applied soon enough to other sectors of our society.

## Reference Sources and Citations (IEEE Format)

To complete this blog post, I used the following online sources as references for developing this:

[1] US International Exchange Rates Dataset:

B. Ferreira, “Foreign Exchange Rates 2000-2019”, 2019. [Online]. Available: https://www.kaggle.com/datasets/brunotly/foreign-exchange-rates-per-dollar-20002019. [Accessed: 04-Sep.-2023].

[2] Tutorial on Basics of LSTM and Prediction & Forecasting in Machine Learning:

Greg Hogg, “Stock Price Prediction & Forecasting with LSTM Neural Networks in Python”, *YouTube*, 26-Mar.-2022. [Online.] Available: https://www.youtube.com/watch?v=CbTU92pbDKw. [Accessed: 06-Sep.-2023].