International US Foreign Currency Exchange Rates Predictor

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#### Author: Andrew Tran

## Blog Post Inspiration and Objectives

In this blog post, I was hoping to investigate using Machine Learning to make a financial prediction system. Initially, I was hoping to imitate the ones used for stock prediction. However, since there were too many tutorials on this topic, I decided to investigate 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.

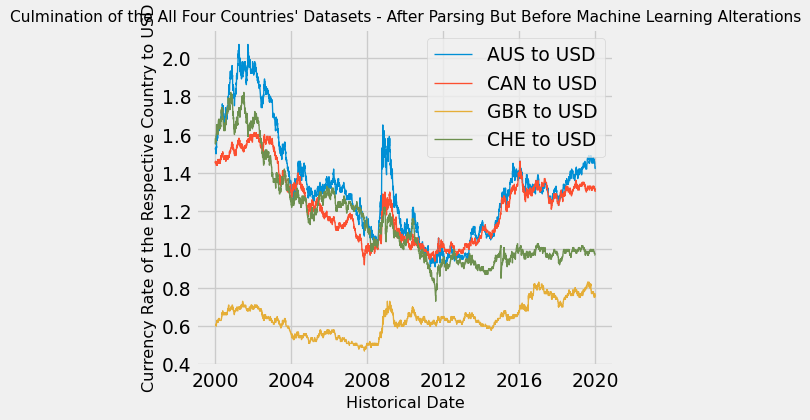
```{python}  
def windowed\_df\_to\_date\_X\_y(windowed\_dataframe: pd.DataFrame):  
 df\_as\_np = windowed\_dataframe.to\_numpy()  
   
 dates = df\_as\_np[:, 0]  
   
 middle\_matrix = df\_as\_np[:, 1:-1]  
 X = middle\_matrix.reshape((len(dates), middle\_matrix.shape[1], 1))  
 Y = df\_as\_np[:, -1]  
   
 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!

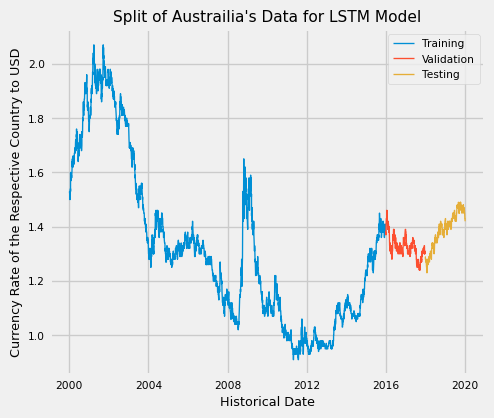
For this blog post, I worked to create Machine Learning models for each country’s dataset separately. I started with Austrailia’s data first (as shown below):

```{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)  
```

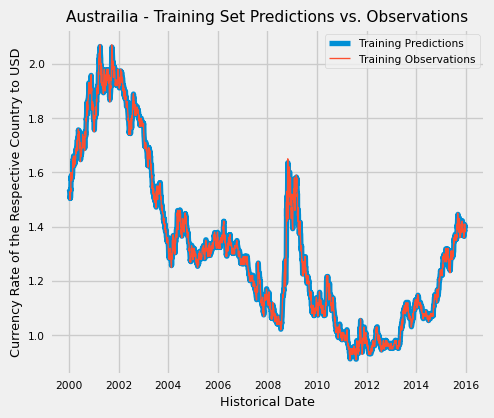
Epoch 1/100  
 1/126 [..............................] - ETA: 3:26 - loss: 1.8685 - mean\_absolute\_error: 1.3320 20/126 [===>..........................] - ETA: 0s - loss: 1.1316 - mean\_absolute\_error: 1.0152 44/126 [=========>....................] - ETA: 0s - loss: 0.5695 - mean\_absolute\_error: 0.6048 68/126 [===============>..............] - ETA: 0s - loss: 0.3720 - mean\_absolute\_error: 0.4181 91/126 [====================>.........] - ETA: 0s - loss: 0.2791 - mean\_absolute\_error: 0.3271115/126 [==========================>...] - ETA: 0s - loss: 0.2216 - mean\_absolute\_error: 0.2689126/126 [==============================] - 2s 5ms/step - loss: 0.2035 - mean\_absolute\_error: 0.2502 - val\_loss: 1.4601e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0025 - mean\_absolute\_error: 0.0410 20/126 [===>..........................] - ETA: 0s - loss: 0.0023 - mean\_absolute\_error: 0.0398 45/126 [=========>....................] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0367 68/126 [===============>..............] - ETA: 0s - loss: 0.0016 - mean\_absolute\_error: 0.0329 91/126 [====================>.........] - ETA: 0s - loss: 0.0013 - mean\_absolute\_error: 0.0293115/126 [==========================>...] - ETA: 0s - loss: 0.0012 - mean\_absolute\_error: 0.0267126/126 [==============================] - 0s 3ms/step - loss: 0.0011 - mean\_absolute\_error: 0.0257 - val\_loss: 1.7407e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7560e-04 - mean\_absolute\_error: 0.0128 25/126 [====>.........................] - ETA: 0s - loss: 2.5945e-04 - mean\_absolute\_error: 0.0123 49/126 [==========>...................] - ETA: 0s - loss: 2.5992e-04 - mean\_absolute\_error: 0.0120 72/126 [================>.............] - ETA: 0s - loss: 2.5749e-04 - mean\_absolute\_error: 0.0118 95/126 [=====================>........] - ETA: 0s - loss: 2.5358e-04 - mean\_absolute\_error: 0.0116120/126 [===========================>..] - ETA: 0s - loss: 2.4249e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4679e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.3067e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7798e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 2.3305e-04 - mean\_absolute\_error: 0.0110 44/126 [=========>....................] - ETA: 0s - loss: 2.4535e-04 - mean\_absolute\_error: 0.0114 64/126 [==============>...............] - ETA: 0s - loss: 2.3652e-04 - mean\_absolute\_error: 0.0111 87/126 [===================>..........] - ETA: 0s - loss: 2.4746e-04 - mean\_absolute\_error: 0.0112110/126 [=========================>....] - ETA: 0s - loss: 2.4139e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3750e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.3165e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2230e-04 - mean\_absolute\_error: 0.0121 23/126 [====>.........................] - ETA: 0s - loss: 2.3179e-04 - mean\_absolute\_error: 0.0113 47/126 [==========>...................] - ETA: 0s - loss: 2.2456e-04 - mean\_absolute\_error: 0.0112 71/126 [===============>..............] - ETA: 0s - loss: 2.5040e-04 - mean\_absolute\_error: 0.0113 94/126 [=====================>........] - ETA: 0s - loss: 2.3880e-04 - mean\_absolute\_error: 0.0112118/126 [===========================>..] - ETA: 0s - loss: 2.4022e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.4040e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.2269e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5364e-04 - mean\_absolute\_error: 0.0116 23/126 [====>.........................] - ETA: 0s - loss: 2.0671e-04 - mean\_absolute\_error: 0.0104 44/126 [=========>....................] - ETA: 0s - loss: 2.2864e-04 - mean\_absolute\_error: 0.0107 65/126 [==============>...............] - ETA: 0s - loss: 2.2181e-04 - mean\_absolute\_error: 0.0107 88/126 [===================>..........] - ETA: 0s - loss: 2.3870e-04 - mean\_absolute\_error: 0.0110111/126 [=========================>....] - ETA: 0s - loss: 2.3431e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3910e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.6232e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6673e-04 - mean\_absolute\_error: 0.0125 23/126 [====>.........................] - ETA: 0s - loss: 3.1593e-04 - mean\_absolute\_error: 0.0126 47/126 [==========>...................] - ETA: 0s - loss: 2.7794e-04 - mean\_absolute\_error: 0.0118 68/126 [===============>..............] - ETA: 0s - loss: 2.7520e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.7208e-04 - mean\_absolute\_error: 0.0118112/126 [=========================>....] - ETA: 0s - loss: 2.6297e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5963e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.1956e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7573e-04 - mean\_absolute\_error: 0.0105 24/126 [====>.........................] - ETA: 0s - loss: 2.0818e-04 - mean\_absolute\_error: 0.0108 48/126 [==========>...................] - ETA: 0s - loss: 2.2769e-04 - mean\_absolute\_error: 0.0109 71/126 [===============>..............] - ETA: 0s - loss: 2.4198e-04 - mean\_absolute\_error: 0.0110 93/126 [=====================>........] - ETA: 0s - loss: 2.3499e-04 - mean\_absolute\_error: 0.0110118/126 [===========================>..] - ETA: 0s - loss: 2.3134e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.3752e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.3134e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0907e-04 - mean\_absolute\_error: 0.0109 22/126 [====>.........................] - ETA: 0s - loss: 2.3049e-04 - mean\_absolute\_error: 0.0112 45/126 [=========>....................] - ETA: 0s - loss: 2.3344e-04 - mean\_absolute\_error: 0.0111 69/126 [===============>..............] - ETA: 0s - loss: 2.2888e-04 - mean\_absolute\_error: 0.0111 92/126 [====================>.........] - ETA: 0s - loss: 2.3753e-04 - mean\_absolute\_error: 0.0111113/126 [=========================>....] - ETA: 0s - loss: 2.4071e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4568e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.2461e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6332e-05 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 2.5394e-04 - mean\_absolute\_error: 0.0113 47/126 [==========>...................] - ETA: 0s - loss: 2.5247e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.4908e-04 - mean\_absolute\_error: 0.0111 91/126 [====================>.........] - ETA: 0s - loss: 2.4837e-04 - mean\_absolute\_error: 0.0112114/126 [==========================>...] - ETA: 0s - loss: 2.4215e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4398e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.7285e-04 - val\_mean\_absolute\_error: 0.0107  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 6.9300e-04 - mean\_absolute\_error: 0.0158 22/126 [====>.........................] - ETA: 0s - loss: 3.2815e-04 - mean\_absolute\_error: 0.0132 45/126 [=========>....................] - ETA: 0s - loss: 2.7950e-04 - mean\_absolute\_error: 0.0121 69/126 [===============>..............] - ETA: 0s - loss: 2.7355e-04 - mean\_absolute\_error: 0.0121 92/126 [====================>.........] - ETA: 0s - loss: 2.5980e-04 - mean\_absolute\_error: 0.0117115/126 [==========================>...] - ETA: 0s - loss: 2.5705e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5571e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.1857e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0877e-04 - mean\_absolute\_error: 0.0117 23/126 [====>.........................] - ETA: 0s - loss: 2.7404e-04 - mean\_absolute\_error: 0.0119 46/126 [=========>....................] - ETA: 0s - loss: 2.5387e-04 - mean\_absolute\_error: 0.0114 68/126 [===============>..............] - ETA: 0s - loss: 2.5051e-04 - mean\_absolute\_error: 0.0112 90/126 [====================>.........] - ETA: 0s - loss: 2.4345e-04 - mean\_absolute\_error: 0.0111112/126 [=========================>....] - ETA: 0s - loss: 2.3795e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3797e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.4732e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9624e-04 - mean\_absolute\_error: 0.0103 21/126 [====>.........................] - ETA: 0s - loss: 2.5634e-04 - mean\_absolute\_error: 0.0111 43/126 [=========>....................] - ETA: 0s - loss: 2.5074e-04 - mean\_absolute\_error: 0.0112 65/126 [==============>...............] - ETA: 0s - loss: 2.3690e-04 - mean\_absolute\_error: 0.0111 88/126 [===================>..........] - ETA: 0s - loss: 2.4070e-04 - mean\_absolute\_error: 0.0111110/126 [=========================>....] - ETA: 0s - loss: 2.3922e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3817e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.2365e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4389e-04 - mean\_absolute\_error: 0.0097 23/126 [====>.........................] - ETA: 0s - loss: 2.3024e-04 - mean\_absolute\_error: 0.0115 45/126 [=========>....................] - ETA: 0s - loss: 2.3394e-04 - mean\_absolute\_error: 0.0111 67/126 [==============>...............] - ETA: 0s - loss: 2.5618e-04 - mean\_absolute\_error: 0.0114 89/126 [====================>.........] - ETA: 0s - loss: 2.4949e-04 - mean\_absolute\_error: 0.0114114/126 [==========================>...] - ETA: 0s - loss: 2.4797e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4841e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.7663e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1925e-04 - mean\_absolute\_error: 0.0164 22/126 [====>.........................] - ETA: 0s - loss: 3.1892e-04 - mean\_absolute\_error: 0.0123 46/126 [=========>....................] - ETA: 0s - loss: 2.6957e-04 - mean\_absolute\_error: 0.0117 69/126 [===============>..............] - ETA: 0s - loss: 2.5318e-04 - mean\_absolute\_error: 0.0114 94/126 [=====================>........] - ETA: 0s - loss: 2.4939e-04 - mean\_absolute\_error: 0.0114118/126 [===========================>..] - ETA: 0s - loss: 2.4819e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4304e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.2397e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9944e-04 - mean\_absolute\_error: 0.0114 19/126 [===>..........................] - ETA: 0s - loss: 2.0219e-04 - mean\_absolute\_error: 0.0107 39/126 [========>.....................] - ETA: 0s - loss: 2.2455e-04 - mean\_absolute\_error: 0.0108 58/126 [============>.................] - ETA: 0s - loss: 2.2190e-04 - mean\_absolute\_error: 0.0107 81/126 [==================>...........] - ETA: 0s - loss: 2.3075e-04 - mean\_absolute\_error: 0.0107105/126 [========================>.....] - ETA: 0s - loss: 2.3526e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.4103e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.1869e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2474e-04 - mean\_absolute\_error: 0.0084 22/126 [====>.........................] - ETA: 0s - loss: 2.2615e-04 - mean\_absolute\_error: 0.0104 46/126 [=========>....................] - ETA: 0s - loss: 2.1748e-04 - mean\_absolute\_error: 0.0107 70/126 [===============>..............] - ETA: 0s - loss: 2.3313e-04 - mean\_absolute\_error: 0.0111 89/126 [====================>.........] - ETA: 0s - loss: 2.3834e-04 - mean\_absolute\_error: 0.0111106/126 [========================>.....] - ETA: 0s - loss: 2.3409e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.4030e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.2786e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4464e-04 - mean\_absolute\_error: 0.0126 22/126 [====>.........................] - ETA: 0s - loss: 2.7232e-04 - mean\_absolute\_error: 0.0116 44/126 [=========>....................] - ETA: 0s - loss: 2.6109e-04 - mean\_absolute\_error: 0.0115 67/126 [==============>...............] - ETA: 0s - loss: 2.5050e-04 - mean\_absolute\_error: 0.0115 92/126 [====================>.........] - ETA: 0s - loss: 2.3997e-04 - mean\_absolute\_error: 0.0112117/126 [==========================>...] - ETA: 0s - loss: 2.4084e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4993e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.6073e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6606e-04 - mean\_absolute\_error: 0.0096 17/126 [===>..........................] - ETA: 0s - loss: 3.1470e-04 - mean\_absolute\_error: 0.0131 35/126 [=======>......................] - ETA: 0s - loss: 2.9374e-04 - mean\_absolute\_error: 0.0128 56/126 [============>.................] - ETA: 0s - loss: 2.8622e-04 - mean\_absolute\_error: 0.0126 73/126 [================>.............] - ETA: 0s - loss: 2.6849e-04 - mean\_absolute\_error: 0.0121 95/126 [=====================>........] - ETA: 0s - loss: 2.6421e-04 - mean\_absolute\_error: 0.0120120/126 [===========================>..] - ETA: 0s - loss: 2.6818e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.6966e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 3.8672e-04 - val\_mean\_absolute\_error: 0.0170  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7243e-04 - mean\_absolute\_error: 0.0176 21/126 [====>.........................] - ETA: 0s - loss: 3.2551e-04 - mean\_absolute\_error: 0.0133 45/126 [=========>....................] - ETA: 0s - loss: 2.8307e-04 - mean\_absolute\_error: 0.0122 68/126 [===============>..............] - ETA: 0s - loss: 3.0573e-04 - mean\_absolute\_error: 0.0128 92/126 [====================>.........] - ETA: 0s - loss: 3.0933e-04 - mean\_absolute\_error: 0.0130114/126 [==========================>...] - ETA: 0s - loss: 3.0166e-04 - mean\_absolute\_error: 0.0128126/126 [==============================] - 0s 3ms/step - loss: 2.9674e-04 - mean\_absolute\_error: 0.0127 - val\_loss: 1.1911e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4259e-04 - mean\_absolute\_error: 0.0120 24/126 [====>.........................] - ETA: 0s - loss: 2.4733e-04 - mean\_absolute\_error: 0.0118 44/126 [=========>....................] - ETA: 0s - loss: 2.5175e-04 - mean\_absolute\_error: 0.0119 62/126 [=============>................] - ETA: 0s - loss: 2.4966e-04 - mean\_absolute\_error: 0.0117 84/126 [===================>..........] - ETA: 0s - loss: 2.5805e-04 - mean\_absolute\_error: 0.0120106/126 [========================>.....] - ETA: 0s - loss: 2.8048e-04 - mean\_absolute\_error: 0.0124126/126 [==============================] - 0s 3ms/step - loss: 2.7987e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 1.4887e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7590e-04 - mean\_absolute\_error: 0.0119 23/126 [====>.........................] - ETA: 0s - loss: 2.1949e-04 - mean\_absolute\_error: 0.0107 43/126 [=========>....................] - ETA: 0s - loss: 2.2088e-04 - mean\_absolute\_error: 0.0106 66/126 [==============>...............] - ETA: 0s - loss: 2.3564e-04 - mean\_absolute\_error: 0.0109 90/126 [====================>.........] - ETA: 0s - loss: 2.3668e-04 - mean\_absolute\_error: 0.0110112/126 [=========================>....] - ETA: 0s - loss: 2.4573e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4444e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.4645e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9945e-04 - mean\_absolute\_error: 0.0150 23/126 [====>.........................] - ETA: 0s - loss: 3.1785e-04 - mean\_absolute\_error: 0.0127 46/126 [=========>....................] - ETA: 0s - loss: 2.8212e-04 - mean\_absolute\_error: 0.0120 68/126 [===============>..............] - ETA: 0s - loss: 2.7692e-04 - mean\_absolute\_error: 0.0120 91/126 [====================>.........] - ETA: 0s - loss: 2.5907e-04 - mean\_absolute\_error: 0.0117116/126 [==========================>...] - ETA: 0s - loss: 2.7534e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.7171e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.1570e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2033e-04 - mean\_absolute\_error: 0.0101 18/126 [===>..........................] - ETA: 0s - loss: 2.6506e-04 - mean\_absolute\_error: 0.0113 40/126 [========>.....................] - ETA: 0s - loss: 2.6727e-04 - mean\_absolute\_error: 0.0118 64/126 [==============>...............] - ETA: 0s - loss: 2.7071e-04 - mean\_absolute\_error: 0.0119 88/126 [===================>..........] - ETA: 0s - loss: 2.6439e-04 - mean\_absolute\_error: 0.0117111/126 [=========================>....] - ETA: 0s - loss: 2.5823e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5431e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 2.1607e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1427e-04 - mean\_absolute\_error: 0.0145 23/126 [====>.........................] - ETA: 0s - loss: 2.6253e-04 - mean\_absolute\_error: 0.0124 47/126 [==========>...................] - ETA: 0s - loss: 2.6751e-04 - mean\_absolute\_error: 0.0121 69/126 [===============>..............] - ETA: 0s - loss: 2.6322e-04 - mean\_absolute\_error: 0.0118 91/126 [====================>.........] - ETA: 0s - loss: 2.6377e-04 - mean\_absolute\_error: 0.0119116/126 [==========================>...] - ETA: 0s - loss: 2.5853e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6019e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.6947e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1802e-04 - mean\_absolute\_error: 0.0123 21/126 [====>.........................] - ETA: 0s - loss: 2.7304e-04 - mean\_absolute\_error: 0.0126 39/126 [========>.....................] - ETA: 0s - loss: 2.6388e-04 - mean\_absolute\_error: 0.0120 61/126 [=============>................] - ETA: 0s - loss: 2.8234e-04 - mean\_absolute\_error: 0.0123 85/126 [===================>..........] - ETA: 0s - loss: 2.5871e-04 - mean\_absolute\_error: 0.0118110/126 [=========================>....] - ETA: 0s - loss: 2.4586e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5464e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.1486e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3636e-04 - mean\_absolute\_error: 0.0095 18/126 [===>..........................] - ETA: 0s - loss: 2.3579e-04 - mean\_absolute\_error: 0.0119 39/126 [========>.....................] - ETA: 0s - loss: 2.8146e-04 - mean\_absolute\_error: 0.0119 61/126 [=============>................] - ETA: 0s - loss: 2.7722e-04 - mean\_absolute\_error: 0.0120 83/126 [==================>...........] - ETA: 0s - loss: 2.7487e-04 - mean\_absolute\_error: 0.0119106/126 [========================>.....] - ETA: 0s - loss: 2.7050e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5509e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.4409e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1126e-04 - mean\_absolute\_error: 0.0112 17/126 [===>..........................] - ETA: 0s - loss: 2.1685e-04 - mean\_absolute\_error: 0.0112 38/126 [========>.....................] - ETA: 0s - loss: 2.3949e-04 - mean\_absolute\_error: 0.0113 60/126 [=============>................] - ETA: 0s - loss: 2.3975e-04 - mean\_absolute\_error: 0.0112 85/126 [===================>..........] - ETA: 0s - loss: 2.3261e-04 - mean\_absolute\_error: 0.0111110/126 [=========================>....] - ETA: 0s - loss: 2.3459e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3582e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.3746e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9668e-04 - mean\_absolute\_error: 0.0128 21/126 [====>.........................] - ETA: 0s - loss: 2.4944e-04 - mean\_absolute\_error: 0.0120 44/126 [=========>....................] - ETA: 0s - loss: 2.3375e-04 - mean\_absolute\_error: 0.0113 67/126 [==============>...............] - ETA: 0s - loss: 2.4748e-04 - mean\_absolute\_error: 0.0113 89/126 [====================>.........] - ETA: 0s - loss: 2.4202e-04 - mean\_absolute\_error: 0.0113111/126 [=========================>....] - ETA: 0s - loss: 2.4728e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4817e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.2046e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0989e-04 - mean\_absolute\_error: 0.0086 23/126 [====>.........................] - ETA: 0s - loss: 2.1775e-04 - mean\_absolute\_error: 0.0107 47/126 [==========>...................] - ETA: 0s - loss: 2.3373e-04 - mean\_absolute\_error: 0.0110 71/126 [===============>..............] - ETA: 0s - loss: 2.4481e-04 - mean\_absolute\_error: 0.0111 96/126 [=====================>........] - ETA: 0s - loss: 2.4157e-04 - mean\_absolute\_error: 0.0110119/126 [===========================>..] - ETA: 0s - loss: 2.3834e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3714e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.2355e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3533e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 2.2543e-04 - mean\_absolute\_error: 0.0112 46/126 [=========>....................] - ETA: 0s - loss: 2.4563e-04 - mean\_absolute\_error: 0.0114 69/126 [===============>..............] - ETA: 0s - loss: 2.6837e-04 - mean\_absolute\_error: 0.0118 91/126 [====================>.........] - ETA: 0s - loss: 2.6578e-04 - mean\_absolute\_error: 0.0118113/126 [=========================>....] - ETA: 0s - loss: 2.6507e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5713e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.1651e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8343e-04 - mean\_absolute\_error: 0.0130 23/126 [====>.........................] - ETA: 0s - loss: 2.7645e-04 - mean\_absolute\_error: 0.0124 45/126 [=========>....................] - ETA: 0s - loss: 2.5985e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.4754e-04 - mean\_absolute\_error: 0.0115 93/126 [=====================>........] - ETA: 0s - loss: 2.4114e-04 - mean\_absolute\_error: 0.0113118/126 [===========================>..] - ETA: 0s - loss: 2.4356e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4297e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1571e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1954e-04 - mean\_absolute\_error: 0.0108 19/126 [===>..........................] - ETA: 0s - loss: 2.3455e-04 - mean\_absolute\_error: 0.0112 41/126 [========>.....................] - ETA: 0s - loss: 2.2382e-04 - mean\_absolute\_error: 0.0108 65/126 [==============>...............] - ETA: 0s - loss: 2.4679e-04 - mean\_absolute\_error: 0.0115 90/126 [====================>.........] - ETA: 0s - loss: 2.6230e-04 - mean\_absolute\_error: 0.0118113/126 [=========================>....] - ETA: 0s - loss: 2.5561e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5087e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.2309e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7700e-04 - mean\_absolute\_error: 0.0139 21/126 [====>.........................] - ETA: 0s - loss: 2.6773e-04 - mean\_absolute\_error: 0.0121 44/126 [=========>....................] - ETA: 0s - loss: 2.5921e-04 - mean\_absolute\_error: 0.0116 69/126 [===============>..............] - ETA: 0s - loss: 2.6562e-04 - mean\_absolute\_error: 0.0120 92/126 [====================>.........] - ETA: 0s - loss: 2.6386e-04 - mean\_absolute\_error: 0.0120115/126 [==========================>...] - ETA: 0s - loss: 2.5974e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5664e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.2872e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4312e-04 - mean\_absolute\_error: 0.0142 22/126 [====>.........................] - ETA: 0s - loss: 2.9495e-04 - mean\_absolute\_error: 0.0129 45/126 [=========>....................] - ETA: 0s - loss: 2.8203e-04 - mean\_absolute\_error: 0.0125 68/126 [===============>..............] - ETA: 0s - loss: 2.6449e-04 - mean\_absolute\_error: 0.0120 90/126 [====================>.........] - ETA: 0s - loss: 2.5444e-04 - mean\_absolute\_error: 0.0116113/126 [=========================>....] - ETA: 0s - loss: 2.4702e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4836e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.7824e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5181e-04 - mean\_absolute\_error: 0.0135 24/126 [====>.........................] - ETA: 0s - loss: 2.2186e-04 - mean\_absolute\_error: 0.0105 48/126 [==========>...................] - ETA: 0s - loss: 2.3121e-04 - mean\_absolute\_error: 0.0109 72/126 [================>.............] - ETA: 0s - loss: 2.2985e-04 - mean\_absolute\_error: 0.0109 95/126 [=====================>........] - ETA: 0s - loss: 2.3538e-04 - mean\_absolute\_error: 0.0110118/126 [===========================>..] - ETA: 0s - loss: 2.5138e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5287e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2341e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4557e-04 - mean\_absolute\_error: 0.0097 22/126 [====>.........................] - ETA: 0s - loss: 3.1065e-04 - mean\_absolute\_error: 0.0126 42/126 [=========>....................] - ETA: 0s - loss: 2.7528e-04 - mean\_absolute\_error: 0.0120 64/126 [==============>...............] - ETA: 0s - loss: 2.5921e-04 - mean\_absolute\_error: 0.0118 87/126 [===================>..........] - ETA: 0s - loss: 2.6047e-04 - mean\_absolute\_error: 0.0118109/126 [========================>.....] - ETA: 0s - loss: 2.5945e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6061e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.2563e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7372e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 2.3664e-04 - mean\_absolute\_error: 0.0110 46/126 [=========>....................] - ETA: 0s - loss: 2.3223e-04 - mean\_absolute\_error: 0.0110 67/126 [==============>...............] - ETA: 0s - loss: 2.4584e-04 - mean\_absolute\_error: 0.0115 89/126 [====================>.........] - ETA: 0s - loss: 2.5471e-04 - mean\_absolute\_error: 0.0116114/126 [==========================>...] - ETA: 0s - loss: 2.4380e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4953e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1081e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1486e-04 - mean\_absolute\_error: 0.0126 16/126 [==>...........................] - ETA: 0s - loss: 2.1885e-04 - mean\_absolute\_error: 0.0110 33/126 [======>.......................] - ETA: 0s - loss: 2.5215e-04 - mean\_absolute\_error: 0.0118 52/126 [===========>..................] - ETA: 0s - loss: 2.6081e-04 - mean\_absolute\_error: 0.0119 74/126 [================>.............] - ETA: 0s - loss: 2.7338e-04 - mean\_absolute\_error: 0.0119 99/126 [======================>.......] - ETA: 0s - loss: 2.7165e-04 - mean\_absolute\_error: 0.0120123/126 [============================>.] - ETA: 0s - loss: 2.6486e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6526e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 2.1706e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4733e-04 - mean\_absolute\_error: 0.0150 21/126 [====>.........................] - ETA: 0s - loss: 2.1078e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 2.2934e-04 - mean\_absolute\_error: 0.0109 71/126 [===============>..............] - ETA: 0s - loss: 2.3583e-04 - mean\_absolute\_error: 0.0110 96/126 [=====================>........] - ETA: 0s - loss: 2.2909e-04 - mean\_absolute\_error: 0.0109120/126 [===========================>..] - ETA: 0s - loss: 2.2991e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2868e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.1602e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4252e-04 - mean\_absolute\_error: 0.0129 21/126 [====>.........................] - ETA: 0s - loss: 2.6043e-04 - mean\_absolute\_error: 0.0122 43/126 [=========>....................] - ETA: 0s - loss: 2.5797e-04 - mean\_absolute\_error: 0.0115 67/126 [==============>...............] - ETA: 0s - loss: 2.4010e-04 - mean\_absolute\_error: 0.0113 92/126 [====================>.........] - ETA: 0s - loss: 2.3678e-04 - mean\_absolute\_error: 0.0111116/126 [==========================>...] - ETA: 0s - loss: 2.3846e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.4075e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 2.5812e-04 - val\_mean\_absolute\_error: 0.0136  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0532e-04 - mean\_absolute\_error: 0.0148 22/126 [====>.........................] - ETA: 0s - loss: 2.5009e-04 - mean\_absolute\_error: 0.0116 45/126 [=========>....................] - ETA: 0s - loss: 2.5187e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.5305e-04 - mean\_absolute\_error: 0.0114 91/126 [====================>.........] - ETA: 0s - loss: 2.3822e-04 - mean\_absolute\_error: 0.0112115/126 [==========================>...] - ETA: 0s - loss: 2.4570e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4719e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.4209e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7572e-04 - mean\_absolute\_error: 0.0110 23/126 [====>.........................] - ETA: 0s - loss: 2.5876e-04 - mean\_absolute\_error: 0.0121 45/126 [=========>....................] - ETA: 0s - loss: 2.8732e-04 - mean\_absolute\_error: 0.0122 67/126 [==============>...............] - ETA: 0s - loss: 2.6985e-04 - mean\_absolute\_error: 0.0119 89/126 [====================>.........] - ETA: 0s - loss: 2.5963e-04 - mean\_absolute\_error: 0.0117113/126 [=========================>....] - ETA: 0s - loss: 2.5322e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5521e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.1576e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6466e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 2.2033e-04 - mean\_absolute\_error: 0.0111 46/126 [=========>....................] - ETA: 0s - loss: 2.3083e-04 - mean\_absolute\_error: 0.0111 71/126 [===============>..............] - ETA: 0s - loss: 2.5312e-04 - mean\_absolute\_error: 0.0118 95/126 [=====================>........] - ETA: 0s - loss: 2.5948e-04 - mean\_absolute\_error: 0.0118117/126 [==========================>...] - ETA: 0s - loss: 2.5924e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5910e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.4411e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2358e-04 - mean\_absolute\_error: 0.0148 24/126 [====>.........................] - ETA: 0s - loss: 2.9067e-04 - mean\_absolute\_error: 0.0130 49/126 [==========>...................] - ETA: 0s - loss: 3.8828e-04 - mean\_absolute\_error: 0.0151 73/126 [================>.............] - ETA: 0s - loss: 3.8825e-04 - mean\_absolute\_error: 0.0153 98/126 [======================>.......] - ETA: 0s - loss: 3.8078e-04 - mean\_absolute\_error: 0.0152122/126 [============================>.] - ETA: 0s - loss: 3.5175e-04 - mean\_absolute\_error: 0.0143126/126 [==============================] - 0s 2ms/step - loss: 3.5289e-04 - mean\_absolute\_error: 0.0143 - val\_loss: 2.7288e-04 - val\_mean\_absolute\_error: 0.0138  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3644e-04 - mean\_absolute\_error: 0.0171 19/126 [===>..........................] - ETA: 0s - loss: 3.5422e-04 - mean\_absolute\_error: 0.0141 42/126 [=========>....................] - ETA: 0s - loss: 3.1296e-04 - mean\_absolute\_error: 0.0135 64/126 [==============>...............] - ETA: 0s - loss: 3.0522e-04 - mean\_absolute\_error: 0.0130 89/126 [====================>.........] - ETA: 0s - loss: 3.0339e-04 - mean\_absolute\_error: 0.0130114/126 [==========================>...] - ETA: 0s - loss: 2.8653e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.7546e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 1.8590e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6560e-04 - mean\_absolute\_error: 0.0132 19/126 [===>..........................] - ETA: 0s - loss: 2.2262e-04 - mean\_absolute\_error: 0.0109 42/126 [=========>....................] - ETA: 0s - loss: 2.5757e-04 - mean\_absolute\_error: 0.0116 63/126 [==============>...............] - ETA: 0s - loss: 2.4501e-04 - mean\_absolute\_error: 0.0113 85/126 [===================>..........] - ETA: 0s - loss: 2.3718e-04 - mean\_absolute\_error: 0.0112107/126 [========================>.....] - ETA: 0s - loss: 2.3082e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.4225e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.7572e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6846e-04 - mean\_absolute\_error: 0.0131 23/126 [====>.........................] - ETA: 0s - loss: 2.6891e-04 - mean\_absolute\_error: 0.0121 45/126 [=========>....................] - ETA: 0s - loss: 2.3379e-04 - mean\_absolute\_error: 0.0114 67/126 [==============>...............] - ETA: 0s - loss: 2.2825e-04 - mean\_absolute\_error: 0.0111 90/126 [====================>.........] - ETA: 0s - loss: 2.3695e-04 - mean\_absolute\_error: 0.0112111/126 [=========================>....] - ETA: 0s - loss: 2.3437e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3316e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.1152e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6450e-04 - mean\_absolute\_error: 0.0127 22/126 [====>.........................] - ETA: 0s - loss: 2.8025e-04 - mean\_absolute\_error: 0.0122 47/126 [==========>...................] - ETA: 0s - loss: 3.6233e-04 - mean\_absolute\_error: 0.0142 69/126 [===============>..............] - ETA: 0s - loss: 3.4945e-04 - mean\_absolute\_error: 0.0141 93/126 [=====================>........] - ETA: 0s - loss: 3.2836e-04 - mean\_absolute\_error: 0.0135117/126 [==========================>...] - ETA: 0s - loss: 3.0280e-04 - mean\_absolute\_error: 0.0129126/126 [==============================] - 0s 3ms/step - loss: 3.0194e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 1.6744e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7333e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 3.0603e-04 - mean\_absolute\_error: 0.0129 44/126 [=========>....................] - ETA: 0s - loss: 2.8301e-04 - mean\_absolute\_error: 0.0124 67/126 [==============>...............] - ETA: 0s - loss: 2.6562e-04 - mean\_absolute\_error: 0.0121 91/126 [====================>.........] - ETA: 0s - loss: 2.7419e-04 - mean\_absolute\_error: 0.0123113/126 [=========================>....] - ETA: 0s - loss: 2.6826e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.6162e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.2081e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4076e-04 - mean\_absolute\_error: 0.0093 23/126 [====>.........................] - ETA: 0s - loss: 2.5441e-04 - mean\_absolute\_error: 0.0115 46/126 [=========>....................] - ETA: 0s - loss: 2.7485e-04 - mean\_absolute\_error: 0.0119 69/126 [===============>..............] - ETA: 0s - loss: 2.5052e-04 - mean\_absolute\_error: 0.0115 92/126 [====================>.........] - ETA: 0s - loss: 2.4731e-04 - mean\_absolute\_error: 0.0114116/126 [==========================>...] - ETA: 0s - loss: 2.4528e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4046e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.8654e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9301e-04 - mean\_absolute\_error: 0.0146 23/126 [====>.........................] - ETA: 0s - loss: 2.3968e-04 - mean\_absolute\_error: 0.0109 46/126 [=========>....................] - ETA: 0s - loss: 3.0051e-04 - mean\_absolute\_error: 0.0124 68/126 [===============>..............] - ETA: 0s - loss: 2.8020e-04 - mean\_absolute\_error: 0.0122 91/126 [====================>.........] - ETA: 0s - loss: 2.6018e-04 - mean\_absolute\_error: 0.0118114/126 [==========================>...] - ETA: 0s - loss: 2.5088e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.4456e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.0556e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6335e-04 - mean\_absolute\_error: 0.0093 22/126 [====>.........................] - ETA: 0s - loss: 2.1634e-04 - mean\_absolute\_error: 0.0105 45/126 [=========>....................] - ETA: 0s - loss: 2.2803e-04 - mean\_absolute\_error: 0.0108 69/126 [===============>..............] - ETA: 0s - loss: 2.1426e-04 - mean\_absolute\_error: 0.0108 93/126 [=====================>........] - ETA: 0s - loss: 2.2144e-04 - mean\_absolute\_error: 0.0109116/126 [==========================>...] - ETA: 0s - loss: 2.3054e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3487e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.3316e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3004e-04 - mean\_absolute\_error: 0.0084 23/126 [====>.........................] - ETA: 0s - loss: 3.1035e-04 - mean\_absolute\_error: 0.0130 46/126 [=========>....................] - ETA: 0s - loss: 2.4823e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.4937e-04 - mean\_absolute\_error: 0.0114 89/126 [====================>.........] - ETA: 0s - loss: 2.3636e-04 - mean\_absolute\_error: 0.0112111/126 [=========================>....] - ETA: 0s - loss: 2.5479e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5587e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.3075e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2326e-04 - mean\_absolute\_error: 0.0106 23/126 [====>.........................] - ETA: 0s - loss: 2.4783e-04 - mean\_absolute\_error: 0.0122 44/126 [=========>....................] - ETA: 0s - loss: 2.6437e-04 - mean\_absolute\_error: 0.0126 67/126 [==============>...............] - ETA: 0s - loss: 2.5640e-04 - mean\_absolute\_error: 0.0122 88/126 [===================>..........] - ETA: 0s - loss: 2.5553e-04 - mean\_absolute\_error: 0.0119110/126 [=========================>....] - ETA: 0s - loss: 2.5391e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6931e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.9953e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5873e-04 - mean\_absolute\_error: 0.0108 23/126 [====>.........................] - ETA: 0s - loss: 2.4929e-04 - mean\_absolute\_error: 0.0108 46/126 [=========>....................] - ETA: 0s - loss: 2.4006e-04 - mean\_absolute\_error: 0.0109 67/126 [==============>...............] - ETA: 0s - loss: 2.4536e-04 - mean\_absolute\_error: 0.0112 91/126 [====================>.........] - ETA: 0s - loss: 2.3869e-04 - mean\_absolute\_error: 0.0112114/126 [==========================>...] - ETA: 0s - loss: 2.4234e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3380e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.5339e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3433e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 2.0845e-04 - mean\_absolute\_error: 0.0107 45/126 [=========>....................] - ETA: 0s - loss: 2.0383e-04 - mean\_absolute\_error: 0.0106 68/126 [===============>..............] - ETA: 0s - loss: 2.0096e-04 - mean\_absolute\_error: 0.0105 91/126 [====================>.........] - ETA: 0s - loss: 2.3386e-04 - mean\_absolute\_error: 0.0111113/126 [=========================>....] - ETA: 0s - loss: 2.4944e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4504e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.0849e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2515e-04 - mean\_absolute\_error: 0.0094 22/126 [====>.........................] - ETA: 0s - loss: 1.8852e-04 - mean\_absolute\_error: 0.0098 47/126 [==========>...................] - ETA: 0s - loss: 2.4080e-04 - mean\_absolute\_error: 0.0109 68/126 [===============>..............] - ETA: 0s - loss: 2.4358e-04 - mean\_absolute\_error: 0.0113 90/126 [====================>.........] - ETA: 0s - loss: 2.3281e-04 - mean\_absolute\_error: 0.0110112/126 [=========================>....] - ETA: 0s - loss: 2.3647e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3788e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.1946e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6834e-04 - mean\_absolute\_error: 0.0092 23/126 [====>.........................] - ETA: 0s - loss: 2.1567e-04 - mean\_absolute\_error: 0.0106 44/126 [=========>....................] - ETA: 0s - loss: 2.2060e-04 - mean\_absolute\_error: 0.0110 67/126 [==============>...............] - ETA: 0s - loss: 2.2145e-04 - mean\_absolute\_error: 0.0111 91/126 [====================>.........] - ETA: 0s - loss: 2.2557e-04 - mean\_absolute\_error: 0.0110115/126 [==========================>...] - ETA: 0s - loss: 2.2263e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2216e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.4926e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1994e-04 - mean\_absolute\_error: 0.0085 20/126 [===>..........................] - ETA: 0s - loss: 2.7716e-04 - mean\_absolute\_error: 0.0119 44/126 [=========>....................] - ETA: 0s - loss: 2.5959e-04 - mean\_absolute\_error: 0.0119 69/126 [===============>..............] - ETA: 0s - loss: 2.3865e-04 - mean\_absolute\_error: 0.0114 93/126 [=====================>........] - ETA: 0s - loss: 2.3958e-04 - mean\_absolute\_error: 0.0114118/126 [===========================>..] - ETA: 0s - loss: 2.3324e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3419e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.0231e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8156e-04 - mean\_absolute\_error: 0.0110 19/126 [===>..........................] - ETA: 0s - loss: 1.8792e-04 - mean\_absolute\_error: 0.0098 40/126 [========>.....................] - ETA: 0s - loss: 1.8066e-04 - mean\_absolute\_error: 0.0099 63/126 [==============>...............] - ETA: 0s - loss: 2.0703e-04 - mean\_absolute\_error: 0.0105 87/126 [===================>..........] - ETA: 0s - loss: 2.3540e-04 - mean\_absolute\_error: 0.0110111/126 [=========================>....] - ETA: 0s - loss: 2.5205e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6319e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 2.6541e-04 - val\_mean\_absolute\_error: 0.0137  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6991e-04 - mean\_absolute\_error: 0.0173 20/126 [===>..........................] - ETA: 0s - loss: 2.3304e-04 - mean\_absolute\_error: 0.0115 43/126 [=========>....................] - ETA: 0s - loss: 2.1804e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.2591e-04 - mean\_absolute\_error: 0.0111 92/126 [====================>.........] - ETA: 0s - loss: 2.3667e-04 - mean\_absolute\_error: 0.0113114/126 [==========================>...] - ETA: 0s - loss: 2.4005e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4238e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.1220e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4503e-04 - mean\_absolute\_error: 0.0097 22/126 [====>.........................] - ETA: 0s - loss: 4.0898e-04 - mean\_absolute\_error: 0.0161 45/126 [=========>....................] - ETA: 0s - loss: 3.4166e-04 - mean\_absolute\_error: 0.0141 70/126 [===============>..............] - ETA: 0s - loss: 2.9341e-04 - mean\_absolute\_error: 0.0129 95/126 [=====================>........] - ETA: 0s - loss: 2.6797e-04 - mean\_absolute\_error: 0.0123118/126 [===========================>..] - ETA: 0s - loss: 2.6370e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.5797e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.2632e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0091e-04 - mean\_absolute\_error: 0.0123 22/126 [====>.........................] - ETA: 0s - loss: 2.1167e-04 - mean\_absolute\_error: 0.0103 45/126 [=========>....................] - ETA: 0s - loss: 2.4547e-04 - mean\_absolute\_error: 0.0110 67/126 [==============>...............] - ETA: 0s - loss: 2.5715e-04 - mean\_absolute\_error: 0.0115 89/126 [====================>.........] - ETA: 0s - loss: 2.5070e-04 - mean\_absolute\_error: 0.0115110/126 [=========================>....] - ETA: 0s - loss: 2.3974e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3443e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.5699e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0010 - mean\_absolute\_error: 0.0182 18/126 [===>..........................] - ETA: 0s - loss: 2.7030e-04 - mean\_absolute\_error: 0.0116 33/126 [======>.......................] - ETA: 0s - loss: 2.1948e-04 - mean\_absolute\_error: 0.0108 53/126 [===========>..................] - ETA: 0s - loss: 2.1838e-04 - mean\_absolute\_error: 0.0109 75/126 [================>.............] - ETA: 0s - loss: 2.3113e-04 - mean\_absolute\_error: 0.0112 98/126 [======================>.......] - ETA: 0s - loss: 2.4229e-04 - mean\_absolute\_error: 0.0115120/126 [===========================>..] - ETA: 0s - loss: 2.3287e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3628e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.0126e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5002e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 2.0899e-04 - mean\_absolute\_error: 0.0102 46/126 [=========>....................] - ETA: 0s - loss: 2.1581e-04 - mean\_absolute\_error: 0.0105 69/126 [===============>..............] - ETA: 0s - loss: 2.0865e-04 - mean\_absolute\_error: 0.0105 91/126 [====================>.........] - ETA: 0s - loss: 2.2509e-04 - mean\_absolute\_error: 0.0111114/126 [==========================>...] - ETA: 0s - loss: 2.3731e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3525e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 9.9596e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0525e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 2.0810e-04 - mean\_absolute\_error: 0.0104 45/126 [=========>....................] - ETA: 0s - loss: 1.9757e-04 - mean\_absolute\_error: 0.0104 69/126 [===============>..............] - ETA: 0s - loss: 1.9923e-04 - mean\_absolute\_error: 0.0103 93/126 [=====================>........] - ETA: 0s - loss: 2.0070e-04 - mean\_absolute\_error: 0.0104115/126 [==========================>...] - ETA: 0s - loss: 2.1271e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1885e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 4.4496e-04 - val\_mean\_absolute\_error: 0.0188  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7397e-04 - mean\_absolute\_error: 0.0183 21/126 [====>.........................] - ETA: 0s - loss: 2.9513e-04 - mean\_absolute\_error: 0.0129 43/126 [=========>....................] - ETA: 0s - loss: 2.6438e-04 - mean\_absolute\_error: 0.0118 66/126 [==============>...............] - ETA: 0s - loss: 2.5284e-04 - mean\_absolute\_error: 0.0117 91/126 [====================>.........] - ETA: 0s - loss: 2.3876e-04 - mean\_absolute\_error: 0.0115115/126 [==========================>...] - ETA: 0s - loss: 2.3730e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.3142e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.4697e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7880e-04 - mean\_absolute\_error: 0.0102 20/126 [===>..........................] - ETA: 0s - loss: 2.4117e-04 - mean\_absolute\_error: 0.0112 42/126 [=========>....................] - ETA: 0s - loss: 2.7603e-04 - mean\_absolute\_error: 0.0121 64/126 [==============>...............] - ETA: 0s - loss: 2.8974e-04 - mean\_absolute\_error: 0.0125 86/126 [===================>..........] - ETA: 0s - loss: 2.8014e-04 - mean\_absolute\_error: 0.0125110/126 [=========================>....] - ETA: 0s - loss: 2.6951e-04 - mean\_absolute\_error: 0.0122126/126 [==============================] - 0s 3ms/step - loss: 2.7943e-04 - mean\_absolute\_error: 0.0125 - val\_loss: 1.4166e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7091e-04 - mean\_absolute\_error: 0.0101 23/126 [====>.........................] - ETA: 0s - loss: 2.0757e-04 - mean\_absolute\_error: 0.0111 45/126 [=========>....................] - ETA: 0s - loss: 2.0238e-04 - mean\_absolute\_error: 0.0106 66/126 [==============>...............] - ETA: 0s - loss: 2.0429e-04 - mean\_absolute\_error: 0.0105 90/126 [====================>.........] - ETA: 0s - loss: 2.2112e-04 - mean\_absolute\_error: 0.0108112/126 [=========================>....] - ETA: 0s - loss: 2.2162e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.1780e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.0148e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0310e-04 - mean\_absolute\_error: 0.0087 23/126 [====>.........................] - ETA: 0s - loss: 1.9504e-04 - mean\_absolute\_error: 0.0101 48/126 [==========>...................] - ETA: 0s - loss: 1.9741e-04 - mean\_absolute\_error: 0.0103 72/126 [================>.............] - ETA: 0s - loss: 1.9600e-04 - mean\_absolute\_error: 0.0102 96/126 [=====================>........] - ETA: 0s - loss: 2.1211e-04 - mean\_absolute\_error: 0.0105121/126 [===========================>..] - ETA: 0s - loss: 2.1410e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 2ms/step - loss: 2.1268e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 1.3783e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0468e-04 - mean\_absolute\_error: 0.0105 20/126 [===>..........................] - ETA: 0s - loss: 1.9523e-04 - mean\_absolute\_error: 0.0099 44/126 [=========>....................] - ETA: 0s - loss: 2.1752e-04 - mean\_absolute\_error: 0.0105 67/126 [==============>...............] - ETA: 0s - loss: 2.1530e-04 - mean\_absolute\_error: 0.0105 90/126 [====================>.........] - ETA: 0s - loss: 2.2544e-04 - mean\_absolute\_error: 0.0108113/126 [=========================>....] - ETA: 0s - loss: 2.2241e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.2725e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.0832e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3376e-04 - mean\_absolute\_error: 0.0133 15/126 [==>...........................] - ETA: 0s - loss: 2.7655e-04 - mean\_absolute\_error: 0.0125 28/126 [=====>........................] - ETA: 0s - loss: 2.2351e-04 - mean\_absolute\_error: 0.0112 45/126 [=========>....................] - ETA: 0s - loss: 2.0648e-04 - mean\_absolute\_error: 0.0107 65/126 [==============>...............] - ETA: 0s - loss: 2.0596e-04 - mean\_absolute\_error: 0.0107 82/126 [==================>...........] - ETA: 0s - loss: 2.0971e-04 - mean\_absolute\_error: 0.0107 98/126 [======================>.......] - ETA: 0s - loss: 2.0873e-04 - mean\_absolute\_error: 0.0106117/126 [==========================>...] - ETA: 0s - loss: 2.1453e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1933e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.7399e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0566e-04 - mean\_absolute\_error: 0.0128 22/126 [====>.........................] - ETA: 0s - loss: 2.2471e-04 - mean\_absolute\_error: 0.0109 45/126 [=========>....................] - ETA: 0s - loss: 2.2004e-04 - mean\_absolute\_error: 0.0106 66/126 [==============>...............] - ETA: 0s - loss: 2.1989e-04 - mean\_absolute\_error: 0.0106 87/126 [===================>..........] - ETA: 0s - loss: 2.0645e-04 - mean\_absolute\_error: 0.0104107/126 [========================>.....] - ETA: 0s - loss: 2.0823e-04 - mean\_absolute\_error: 0.0105125/126 [============================>.] - ETA: 0s - loss: 2.1696e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1739e-04 - mean\_absolute\_error: 0.0107 - val\_loss: 1.8482e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9452e-04 - mean\_absolute\_error: 0.0129 16/126 [==>...........................] - ETA: 0s - loss: 2.3542e-04 - mean\_absolute\_error: 0.0108 34/126 [=======>......................] - ETA: 0s - loss: 2.0691e-04 - mean\_absolute\_error: 0.0102 52/126 [===========>..................] - ETA: 0s - loss: 2.0087e-04 - mean\_absolute\_error: 0.0101 75/126 [================>.............] - ETA: 0s - loss: 1.9915e-04 - mean\_absolute\_error: 0.0101 99/126 [======================>.......] - ETA: 0s - loss: 2.0222e-04 - mean\_absolute\_error: 0.0102123/126 [============================>.] - ETA: 0s - loss: 2.0452e-04 - mean\_absolute\_error: 0.0104126/126 [==============================] - 0s 3ms/step - loss: 2.0609e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 1.6175e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8151e-04 - mean\_absolute\_error: 0.0164 22/126 [====>.........................] - ETA: 0s - loss: 2.2535e-04 - mean\_absolute\_error: 0.0102 44/126 [=========>....................] - ETA: 0s - loss: 2.2387e-04 - mean\_absolute\_error: 0.0105 66/126 [==============>...............] - ETA: 0s - loss: 2.1703e-04 - mean\_absolute\_error: 0.0105 88/126 [===================>..........] - ETA: 0s - loss: 2.0943e-04 - mean\_absolute\_error: 0.0103109/126 [========================>.....] - ETA: 0s - loss: 1.9985e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 3ms/step - loss: 2.0154e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.2837e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9091e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 1.8072e-04 - mean\_absolute\_error: 0.0098 45/126 [=========>....................] - ETA: 0s - loss: 1.9970e-04 - mean\_absolute\_error: 0.0101 69/126 [===============>..............] - ETA: 0s - loss: 1.8931e-04 - mean\_absolute\_error: 0.0099 93/126 [=====================>........] - ETA: 0s - loss: 1.9357e-04 - mean\_absolute\_error: 0.0100116/126 [==========================>...] - ETA: 0s - loss: 2.0043e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9831e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 9.3924e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6610e-04 - mean\_absolute\_error: 0.0109 24/126 [====>.........................] - ETA: 0s - loss: 2.0139e-04 - mean\_absolute\_error: 0.0107 46/126 [=========>....................] - ETA: 0s - loss: 1.8997e-04 - mean\_absolute\_error: 0.0102 69/126 [===============>..............] - ETA: 0s - loss: 2.1904e-04 - mean\_absolute\_error: 0.0108 92/126 [====================>.........] - ETA: 0s - loss: 2.3694e-04 - mean\_absolute\_error: 0.0111116/126 [==========================>...] - ETA: 0s - loss: 2.2404e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2277e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.0739e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1738e-04 - mean\_absolute\_error: 0.0084 22/126 [====>.........................] - ETA: 0s - loss: 1.9313e-04 - mean\_absolute\_error: 0.0098 44/126 [=========>....................] - ETA: 0s - loss: 1.7440e-04 - mean\_absolute\_error: 0.0096 66/126 [==============>...............] - ETA: 0s - loss: 1.9234e-04 - mean\_absolute\_error: 0.0102 88/126 [===================>..........] - ETA: 0s - loss: 1.9309e-04 - mean\_absolute\_error: 0.0102110/126 [=========================>....] - ETA: 0s - loss: 2.0034e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 3ms/step - loss: 2.0530e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 9.7690e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7796e-05 - mean\_absolute\_error: 0.0066 22/126 [====>.........................] - ETA: 0s - loss: 1.8886e-04 - mean\_absolute\_error: 0.0100 46/126 [=========>....................] - ETA: 0s - loss: 2.0484e-04 - mean\_absolute\_error: 0.0103 70/126 [===============>..............] - ETA: 0s - loss: 2.1118e-04 - mean\_absolute\_error: 0.0105 93/126 [=====================>........] - ETA: 0s - loss: 2.2055e-04 - mean\_absolute\_error: 0.0108116/126 [==========================>...] - ETA: 0s - loss: 2.1778e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.1863e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 9.2182e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5331e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 3.2325e-04 - mean\_absolute\_error: 0.0128 45/126 [=========>....................] - ETA: 0s - loss: 2.9269e-04 - mean\_absolute\_error: 0.0124 67/126 [==============>...............] - ETA: 0s - loss: 2.6036e-04 - mean\_absolute\_error: 0.0118 89/126 [====================>.........] - ETA: 0s - loss: 2.3528e-04 - mean\_absolute\_error: 0.0112112/126 [=========================>....] - ETA: 0s - loss: 2.2393e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.2361e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 9.6043e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1145e-04 - mean\_absolute\_error: 0.0070 23/126 [====>.........................] - ETA: 0s - loss: 2.2544e-04 - mean\_absolute\_error: 0.0108 45/126 [=========>....................] - ETA: 0s - loss: 2.0506e-04 - mean\_absolute\_error: 0.0106 67/126 [==============>...............] - ETA: 0s - loss: 1.9842e-04 - mean\_absolute\_error: 0.0104 89/126 [====================>.........] - ETA: 0s - loss: 2.2017e-04 - mean\_absolute\_error: 0.0109112/126 [=========================>....] - ETA: 0s - loss: 2.2895e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.2661e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.4132e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5149e-04 - mean\_absolute\_error: 0.0104 23/126 [====>.........................] - ETA: 0s - loss: 2.1421e-04 - mean\_absolute\_error: 0.0109 46/126 [=========>....................] - ETA: 0s - loss: 2.1706e-04 - mean\_absolute\_error: 0.0104 68/126 [===============>..............] - ETA: 0s - loss: 2.2439e-04 - mean\_absolute\_error: 0.0109 90/126 [====================>.........] - ETA: 0s - loss: 2.1316e-04 - mean\_absolute\_error: 0.0106112/126 [=========================>....] - ETA: 0s - loss: 2.0971e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.0676e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 1.3096e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 6.5123e-04 - mean\_absolute\_error: 0.0152 23/126 [====>.........................] - ETA: 0s - loss: 1.9800e-04 - mean\_absolute\_error: 0.0099 47/126 [==========>...................] - ETA: 0s - loss: 2.0333e-04 - mean\_absolute\_error: 0.0103 70/126 [===============>..............] - ETA: 0s - loss: 2.0191e-04 - mean\_absolute\_error: 0.0102 94/126 [=====================>........] - ETA: 0s - loss: 1.9903e-04 - mean\_absolute\_error: 0.0102118/126 [===========================>..] - ETA: 0s - loss: 1.9950e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9765e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 9.4594e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0913e-04 - mean\_absolute\_error: 0.0098 21/126 [====>.........................] - ETA: 0s - loss: 2.1053e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 1.9681e-04 - mean\_absolute\_error: 0.0104 67/126 [==============>...............] - ETA: 0s - loss: 2.1186e-04 - mean\_absolute\_error: 0.0106 88/126 [===================>..........] - ETA: 0s - loss: 2.0968e-04 - mean\_absolute\_error: 0.0106112/126 [=========================>....] - ETA: 0s - loss: 2.0550e-04 - mean\_absolute\_error: 0.0104126/126 [==============================] - 0s 3ms/step - loss: 2.0083e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 9.9786e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3889e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 1.6349e-04 - mean\_absolute\_error: 0.0094 44/126 [=========>....................] - ETA: 0s - loss: 1.8002e-04 - mean\_absolute\_error: 0.0098 67/126 [==============>...............] - ETA: 0s - loss: 1.9789e-04 - mean\_absolute\_error: 0.0103 91/126 [====================>.........] - ETA: 0s - loss: 1.9601e-04 - mean\_absolute\_error: 0.0102114/126 [==========================>...] - ETA: 0s - loss: 2.0852e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0403e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 9.0361e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1220e-04 - mean\_absolute\_error: 0.0085 21/126 [====>.........................] - ETA: 0s - loss: 2.1251e-04 - mean\_absolute\_error: 0.0104 42/126 [=========>....................] - ETA: 0s - loss: 2.2447e-04 - mean\_absolute\_error: 0.0108 64/126 [==============>...............] - ETA: 0s - loss: 2.1365e-04 - mean\_absolute\_error: 0.0108 86/126 [===================>..........] - ETA: 0s - loss: 2.4195e-04 - mean\_absolute\_error: 0.0115107/126 [========================>.....] - ETA: 0s - loss: 2.3566e-04 - mean\_absolute\_error: 0.0114119/126 [===========================>..] - ETA: 0s - loss: 2.4086e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.3586e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.0290e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6507e-04 - mean\_absolute\_error: 0.0089 22/126 [====>.........................] - ETA: 0s - loss: 2.3293e-04 - mean\_absolute\_error: 0.0108 45/126 [=========>....................] - ETA: 0s - loss: 2.2734e-04 - mean\_absolute\_error: 0.0106 67/126 [==============>...............] - ETA: 0s - loss: 2.3689e-04 - mean\_absolute\_error: 0.0110 91/126 [====================>.........] - ETA: 0s - loss: 2.3593e-04 - mean\_absolute\_error: 0.0111114/126 [==========================>...] - ETA: 0s - loss: 2.1787e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1283e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 1.3144e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5996e-04 - mean\_absolute\_error: 0.0101 25/126 [====>.........................] - ETA: 0s - loss: 1.7335e-04 - mean\_absolute\_error: 0.0095 42/126 [=========>....................] - ETA: 0s - loss: 1.7154e-04 - mean\_absolute\_error: 0.0097 65/126 [==============>...............] - ETA: 0s - loss: 1.7876e-04 - mean\_absolute\_error: 0.0097 90/126 [====================>.........] - ETA: 0s - loss: 1.9203e-04 - mean\_absolute\_error: 0.0100114/126 [==========================>...] - ETA: 0s - loss: 1.9677e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 2.0009e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.2296e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9800e-04 - mean\_absolute\_error: 0.0140 21/126 [====>.........................] - ETA: 0s - loss: 2.5085e-04 - mean\_absolute\_error: 0.0125 43/126 [=========>....................] - ETA: 0s - loss: 2.1445e-04 - mean\_absolute\_error: 0.0110 63/126 [==============>...............] - ETA: 0s - loss: 2.3297e-04 - mean\_absolute\_error: 0.0116 82/126 [==================>...........] - ETA: 0s - loss: 2.2732e-04 - mean\_absolute\_error: 0.0113101/126 [=======================>......] - ETA: 0s - loss: 2.2021e-04 - mean\_absolute\_error: 0.0110122/126 [============================>.] - ETA: 0s - loss: 2.2132e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.1937e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 9.2043e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2218e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 1.8200e-04 - mean\_absolute\_error: 0.0096 45/126 [=========>....................] - ETA: 0s - loss: 1.6963e-04 - mean\_absolute\_error: 0.0097 68/126 [===============>..............] - ETA: 0s - loss: 1.9399e-04 - mean\_absolute\_error: 0.0103 92/126 [====================>.........] - ETA: 0s - loss: 2.0099e-04 - mean\_absolute\_error: 0.0103116/126 [==========================>...] - ETA: 0s - loss: 1.9726e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9951e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.1446e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4839e-04 - mean\_absolute\_error: 0.0087 25/126 [====>.........................] - ETA: 0s - loss: 1.8533e-04 - mean\_absolute\_error: 0.0099 47/126 [==========>...................] - ETA: 0s - loss: 2.0183e-04 - mean\_absolute\_error: 0.0101 70/126 [===============>..............] - ETA: 0s - loss: 1.9709e-04 - mean\_absolute\_error: 0.0101 93/126 [=====================>........] - ETA: 0s - loss: 1.8916e-04 - mean\_absolute\_error: 0.0099118/126 [===========================>..] - ETA: 0s - loss: 1.9730e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9706e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 8.9540e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1808e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 1.8615e-04 - mean\_absolute\_error: 0.0097 45/126 [=========>....................] - ETA: 0s - loss: 1.7349e-04 - mean\_absolute\_error: 0.0096 69/126 [===============>..............] - ETA: 0s - loss: 1.7942e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.8603e-04 - mean\_absolute\_error: 0.0097111/126 [=========================>....] - ETA: 0s - loss: 1.8634e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.8270e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 1.2311e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3800e-04 - mean\_absolute\_error: 0.0112 24/126 [====>.........................] - ETA: 0s - loss: 1.8782e-04 - mean\_absolute\_error: 0.0103 49/126 [==========>...................] - ETA: 0s - loss: 1.9563e-04 - mean\_absolute\_error: 0.0104 70/126 [===============>..............] - ETA: 0s - loss: 2.0649e-04 - mean\_absolute\_error: 0.0103 93/126 [=====================>........] - ETA: 0s - loss: 1.9075e-04 - mean\_absolute\_error: 0.0100118/126 [===========================>..] - ETA: 0s - loss: 1.8337e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.8149e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 1.8461e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8865e-04 - mean\_absolute\_error: 0.0133 19/126 [===>..........................] - ETA: 0s - loss: 2.1127e-04 - mean\_absolute\_error: 0.0104 41/126 [========>.....................] - ETA: 0s - loss: 2.1992e-04 - mean\_absolute\_error: 0.0109 63/126 [==============>...............] - ETA: 0s - loss: 2.0761e-04 - mean\_absolute\_error: 0.0105 85/126 [===================>..........] - ETA: 0s - loss: 1.9708e-04 - mean\_absolute\_error: 0.0103107/126 [========================>.....] - ETA: 0s - loss: 1.9389e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 3ms/step - loss: 1.9374e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 1.1432e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2229e-04 - mean\_absolute\_error: 0.0129 23/126 [====>.........................] - ETA: 0s - loss: 2.0660e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 2.0718e-04 - mean\_absolute\_error: 0.0102 67/126 [==============>...............] - ETA: 0s - loss: 2.1112e-04 - mean\_absolute\_error: 0.0105 89/126 [====================>.........] - ETA: 0s - loss: 2.1673e-04 - mean\_absolute\_error: 0.0107112/126 [=========================>....] - ETA: 0s - loss: 2.1115e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1224e-04 - mean\_absolute\_error: 0.0107 - val\_loss: 1.2471e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6947e-04 - mean\_absolute\_error: 0.0106 24/126 [====>.........................] - ETA: 0s - loss: 1.9017e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 2.0089e-04 - mean\_absolute\_error: 0.0106 67/126 [==============>...............] - ETA: 0s - loss: 1.9399e-04 - mean\_absolute\_error: 0.0104 89/126 [====================>.........] - ETA: 0s - loss: 1.9306e-04 - mean\_absolute\_error: 0.0102111/126 [=========================>....] - ETA: 0s - loss: 2.0683e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1829e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.2804e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2504e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 2.5700e-04 - mean\_absolute\_error: 0.0121 47/126 [==========>...................] - ETA: 0s - loss: 2.2842e-04 - mean\_absolute\_error: 0.0114 70/126 [===============>..............] - ETA: 0s - loss: 2.0875e-04 - mean\_absolute\_error: 0.0109 93/126 [=====================>........] - ETA: 0s - loss: 2.1531e-04 - mean\_absolute\_error: 0.0109117/126 [==========================>...] - ETA: 0s - loss: 2.0949e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.0942e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 9.9510e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4623e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 1.6518e-04 - mean\_absolute\_error: 0.0095 47/126 [==========>...................] - ETA: 0s - loss: 1.6799e-04 - mean\_absolute\_error: 0.0095 66/126 [==============>...............] - ETA: 0s - loss: 2.0822e-04 - mean\_absolute\_error: 0.0105 84/126 [===================>..........] - ETA: 0s - loss: 2.0566e-04 - mean\_absolute\_error: 0.0105103/126 [=======================>......] - ETA: 0s - loss: 1.9869e-04 - mean\_absolute\_error: 0.0102125/126 [============================>.] - ETA: 0s - loss: 1.9402e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 3ms/step - loss: 1.9416e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 9.2657e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9577e-05 - mean\_absolute\_error: 0.0083 22/126 [====>.........................] - ETA: 0s - loss: 1.4944e-04 - mean\_absolute\_error: 0.0093 45/126 [=========>....................] - ETA: 0s - loss: 1.7228e-04 - mean\_absolute\_error: 0.0096 68/126 [===============>..............] - ETA: 0s - loss: 1.9299e-04 - mean\_absolute\_error: 0.0099 92/126 [====================>.........] - ETA: 0s - loss: 1.8336e-04 - mean\_absolute\_error: 0.0097117/126 [==========================>...] - ETA: 0s - loss: 1.8133e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.8038e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 8.9189e-05 - val\_mean\_absolute\_error: 0.0073

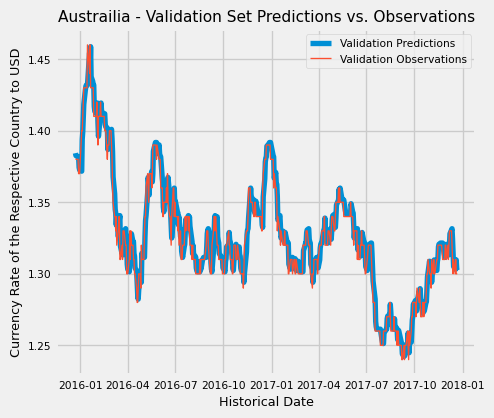
<keras.src.callbacks.History at 0x253cd6a1ad0>

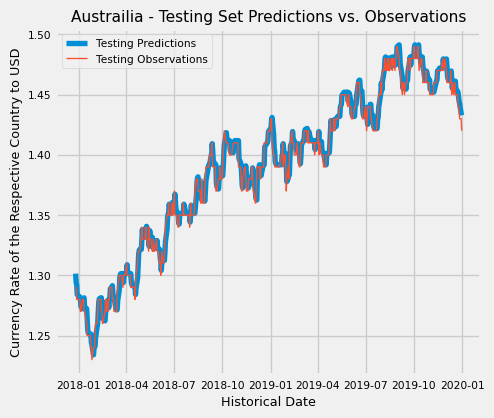
After the training and fitting of the Machine Learning model for Austrailia, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 41s 32/126 [======>.......................] - ETA: 0s 70/126 [===============>..............] - ETA: 0s113/126 [=========================>....] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

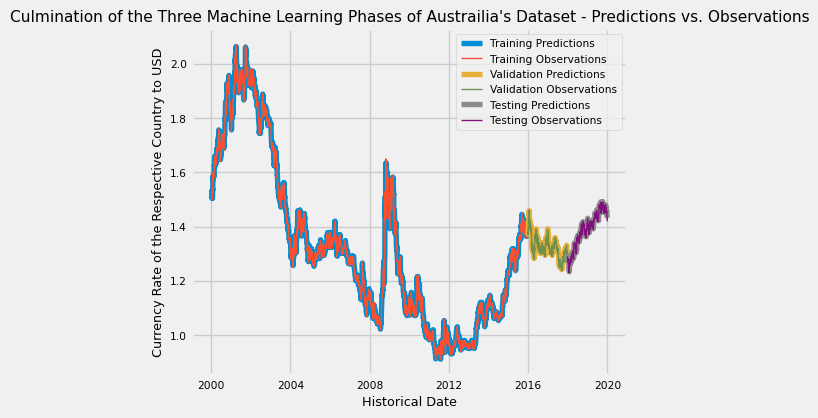






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

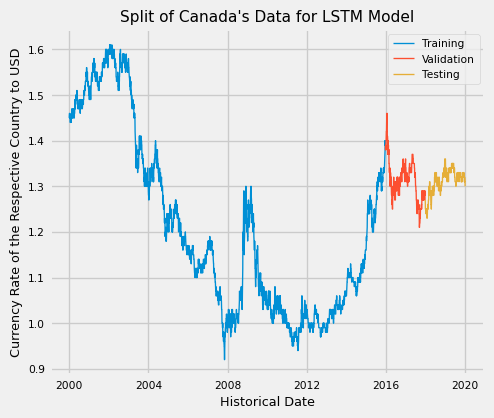
```{python}  
# Plotting Austrailia's observational (reference) data with the predictions of   
# its Machine Learning Model (as a way to visually inspect the effectiveness of   
# the model)   
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_train, 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)  
```

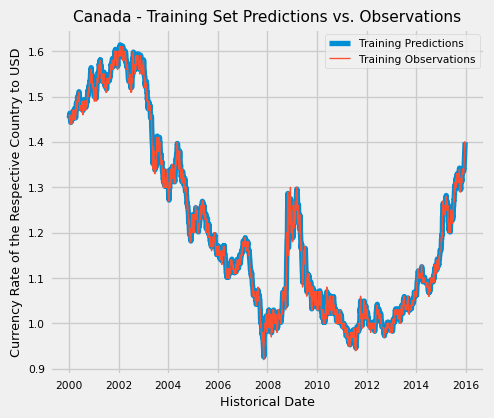
Epoch 1/100  
 1/126 [..............................] - ETA: 3:25 - loss: 1.3168 - mean\_absolute\_error: 1.1325 20/126 [===>..........................] - ETA: 0s - loss: 0.9186 - mean\_absolute\_error: 0.9307 44/126 [=========>....................] - ETA: 0s - loss: 0.4623 - mean\_absolute\_error: 0.5542 62/126 [=============>................] - ETA: 0s - loss: 0.3306 - mean\_absolute\_error: 0.4143 82/126 [==================>...........] - ETA: 0s - loss: 0.2509 - mean\_absolute\_error: 0.3268106/126 [========================>.....] - ETA: 0s - loss: 0.1948 - mean\_absolute\_error: 0.2632126/126 [==============================] - 2s 6ms/step - loss: 0.1651 - mean\_absolute\_error: 0.2293 - val\_loss: 6.6395e-04 - val\_mean\_absolute\_error: 0.0222  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0017 - mean\_absolute\_error: 0.0347 21/126 [====>.........................] - ETA: 0s - loss: 0.0022 - mean\_absolute\_error: 0.0409 45/126 [=========>....................] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0395 69/126 [===============>..............] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0382 91/126 [====================>.........] - ETA: 0s - loss: 0.0018 - mean\_absolute\_error: 0.0373115/126 [==========================>...] - ETA: 0s - loss: 0.0017 - mean\_absolute\_error: 0.0358126/126 [==============================] - 0s 3ms/step - loss: 0.0017 - mean\_absolute\_error: 0.0354 - val\_loss: 4.3856e-04 - val\_mean\_absolute\_error: 0.0181  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0011 - mean\_absolute\_error: 0.0279 23/126 [====>.........................] - ETA: 0s - loss: 9.2917e-04 - mean\_absolute\_error: 0.0263 46/126 [=========>....................] - ETA: 0s - loss: 8.3649e-04 - mean\_absolute\_error: 0.0248 69/126 [===============>..............] - ETA: 0s - loss: 7.6912e-04 - mean\_absolute\_error: 0.0239 93/126 [=====================>........] - ETA: 0s - loss: 7.0190e-04 - mean\_absolute\_error: 0.0227115/126 [==========================>...] - ETA: 0s - loss: 6.3443e-04 - mean\_absolute\_error: 0.0214126/126 [==============================] - 0s 3ms/step - loss: 6.1124e-04 - mean\_absolute\_error: 0.0210 - val\_loss: 1.1947e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2541e-04 - mean\_absolute\_error: 0.0119 24/126 [====>.........................] - ETA: 0s - loss: 2.7695e-04 - mean\_absolute\_error: 0.0139 48/126 [==========>...................] - ETA: 0s - loss: 2.6766e-04 - mean\_absolute\_error: 0.0135 72/126 [================>.............] - ETA: 0s - loss: 2.4070e-04 - mean\_absolute\_error: 0.0127 97/126 [======================>.......] - ETA: 0s - loss: 2.2039e-04 - mean\_absolute\_error: 0.0121121/126 [===========================>..] - ETA: 0s - loss: 1.9988e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 2ms/step - loss: 1.9692e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.4970e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6912e-04 - mean\_absolute\_error: 0.0107 23/126 [====>.........................] - ETA: 0s - loss: 1.2292e-04 - mean\_absolute\_error: 0.0087 48/126 [==========>...................] - ETA: 0s - loss: 1.1221e-04 - mean\_absolute\_error: 0.0084 72/126 [================>.............] - ETA: 0s - loss: 1.0966e-04 - mean\_absolute\_error: 0.0082 96/126 [=====================>........] - ETA: 0s - loss: 1.1280e-04 - mean\_absolute\_error: 0.0082119/126 [===========================>..] - ETA: 0s - loss: 1.0947e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.0892e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1341e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2305e-05 - mean\_absolute\_error: 0.0067 24/126 [====>.........................] - ETA: 0s - loss: 1.0284e-04 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 9.7124e-05 - mean\_absolute\_error: 0.0075 71/126 [===============>..............] - ETA: 0s - loss: 1.0358e-04 - mean\_absolute\_error: 0.0076 95/126 [=====================>........] - ETA: 0s - loss: 9.9361e-05 - mean\_absolute\_error: 0.0075118/126 [===========================>..] - ETA: 0s - loss: 9.9220e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8726e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0932e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3809e-05 - mean\_absolute\_error: 0.0066 23/126 [====>.........................] - ETA: 0s - loss: 8.1947e-05 - mean\_absolute\_error: 0.0069 46/126 [=========>....................] - ETA: 0s - loss: 9.1142e-05 - mean\_absolute\_error: 0.0071 68/126 [===============>..............] - ETA: 0s - loss: 9.4222e-05 - mean\_absolute\_error: 0.0073 91/126 [====================>.........] - ETA: 0s - loss: 9.3074e-05 - mean\_absolute\_error: 0.0073115/126 [==========================>...] - ETA: 0s - loss: 9.7967e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.7551e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1757e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4393e-05 - mean\_absolute\_error: 0.0075 23/126 [====>.........................] - ETA: 0s - loss: 1.0280e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 9.8032e-05 - mean\_absolute\_error: 0.0075 70/126 [===============>..............] - ETA: 0s - loss: 9.8209e-05 - mean\_absolute\_error: 0.0075 94/126 [=====================>........] - ETA: 0s - loss: 9.8020e-05 - mean\_absolute\_error: 0.0075116/126 [==========================>...] - ETA: 0s - loss: 9.7577e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8003e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.3311e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0019e-04 - mean\_absolute\_error: 0.0078 24/126 [====>.........................] - ETA: 0s - loss: 1.0870e-04 - mean\_absolute\_error: 0.0077 48/126 [==========>...................] - ETA: 0s - loss: 1.0072e-04 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 1.0308e-04 - mean\_absolute\_error: 0.0076 89/126 [====================>.........] - ETA: 0s - loss: 1.0076e-04 - mean\_absolute\_error: 0.0075112/126 [=========================>....] - ETA: 0s - loss: 1.0008e-04 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9857e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1559e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1250e-05 - mean\_absolute\_error: 0.0066 23/126 [====>.........................] - ETA: 0s - loss: 9.2657e-05 - mean\_absolute\_error: 0.0074 45/126 [=========>....................] - ETA: 0s - loss: 9.6306e-05 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 9.7588e-05 - mean\_absolute\_error: 0.0075 92/126 [====================>.........] - ETA: 0s - loss: 9.7679e-05 - mean\_absolute\_error: 0.0075114/126 [==========================>...] - ETA: 0s - loss: 9.8463e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8217e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2105e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2739e-04 - mean\_absolute\_error: 0.0086 22/126 [====>.........................] - ETA: 0s - loss: 9.9713e-05 - mean\_absolute\_error: 0.0073 47/126 [==========>...................] - ETA: 0s - loss: 9.8647e-05 - mean\_absolute\_error: 0.0074 72/126 [================>.............] - ETA: 0s - loss: 9.8704e-05 - mean\_absolute\_error: 0.0075 95/126 [=====================>........] - ETA: 0s - loss: 9.9355e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 9.9385e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9094e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2793e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1857e-04 - mean\_absolute\_error: 0.0083 19/126 [===>..........................] - ETA: 0s - loss: 9.2347e-05 - mean\_absolute\_error: 0.0072 41/126 [========>.....................] - ETA: 0s - loss: 1.0010e-04 - mean\_absolute\_error: 0.0074 63/126 [==============>...............] - ETA: 0s - loss: 1.0173e-04 - mean\_absolute\_error: 0.0076 86/126 [===================>..........] - ETA: 0s - loss: 9.8019e-05 - mean\_absolute\_error: 0.0075111/126 [=========================>....] - ETA: 0s - loss: 1.0193e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0262e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.2186e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2132e-04 - mean\_absolute\_error: 0.0084 21/126 [====>.........................] - ETA: 0s - loss: 9.9716e-05 - mean\_absolute\_error: 0.0076 44/126 [=========>....................] - ETA: 0s - loss: 1.0400e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.0089e-04 - mean\_absolute\_error: 0.0076 94/126 [=====================>........] - ETA: 0s - loss: 9.9941e-05 - mean\_absolute\_error: 0.0076119/126 [===========================>..] - ETA: 0s - loss: 1.0117e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0044e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.3264e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7382e-05 - mean\_absolute\_error: 0.0079 22/126 [====>.........................] - ETA: 0s - loss: 9.6425e-05 - mean\_absolute\_error: 0.0075 48/126 [==========>...................] - ETA: 0s - loss: 9.8725e-05 - mean\_absolute\_error: 0.0076 72/126 [================>.............] - ETA: 0s - loss: 1.0067e-04 - mean\_absolute\_error: 0.0077 95/126 [=====================>........] - ETA: 0s - loss: 9.8787e-05 - mean\_absolute\_error: 0.0076120/126 [===========================>..] - ETA: 0s - loss: 1.0108e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0135e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0578e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7741e-04 - mean\_absolute\_error: 0.0103 20/126 [===>..........................] - ETA: 0s - loss: 1.0682e-04 - mean\_absolute\_error: 0.0079 44/126 [=========>....................] - ETA: 0s - loss: 9.5012e-05 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 9.5686e-05 - mean\_absolute\_error: 0.0075 93/126 [=====================>........] - ETA: 0s - loss: 1.0388e-04 - mean\_absolute\_error: 0.0078117/126 [==========================>...] - ETA: 0s - loss: 1.0292e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0156e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1963e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4131e-04 - mean\_absolute\_error: 0.0091 22/126 [====>.........................] - ETA: 0s - loss: 9.6178e-05 - mean\_absolute\_error: 0.0075 44/126 [=========>....................] - ETA: 0s - loss: 9.4598e-05 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 9.6543e-05 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 9.7717e-05 - mean\_absolute\_error: 0.0076116/126 [==========================>...] - ETA: 0s - loss: 9.9141e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0018e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.3435e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5979e-05 - mean\_absolute\_error: 0.0078 22/126 [====>.........................] - ETA: 0s - loss: 9.3849e-05 - mean\_absolute\_error: 0.0075 45/126 [=========>....................] - ETA: 0s - loss: 9.7731e-05 - mean\_absolute\_error: 0.0076 66/126 [==============>...............] - ETA: 0s - loss: 1.0444e-04 - mean\_absolute\_error: 0.0077 87/126 [===================>..........] - ETA: 0s - loss: 1.0877e-04 - mean\_absolute\_error: 0.0079111/126 [=========================>....] - ETA: 0s - loss: 1.0608e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0436e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0604e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1771e-04 - mean\_absolute\_error: 0.0084 19/126 [===>..........................] - ETA: 0s - loss: 8.7116e-05 - mean\_absolute\_error: 0.0073 42/126 [=========>....................] - ETA: 0s - loss: 9.5781e-05 - mean\_absolute\_error: 0.0074 67/126 [==============>...............] - ETA: 0s - loss: 1.0412e-04 - mean\_absolute\_error: 0.0077 92/126 [====================>.........] - ETA: 0s - loss: 1.0602e-04 - mean\_absolute\_error: 0.0078117/126 [==========================>...] - ETA: 0s - loss: 1.0800e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0668e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.2045e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1658e-04 - mean\_absolute\_error: 0.0083 21/126 [====>.........................] - ETA: 0s - loss: 1.0171e-04 - mean\_absolute\_error: 0.0077 44/126 [=========>....................] - ETA: 0s - loss: 9.3205e-05 - mean\_absolute\_error: 0.0074 67/126 [==============>...............] - ETA: 0s - loss: 9.3396e-05 - mean\_absolute\_error: 0.0074 90/126 [====================>.........] - ETA: 0s - loss: 9.6156e-05 - mean\_absolute\_error: 0.0074112/126 [=========================>....] - ETA: 0s - loss: 1.0051e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9983e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.2095e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1356e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 9.7293e-05 - mean\_absolute\_error: 0.0076 47/126 [==========>...................] - ETA: 0s - loss: 1.0014e-04 - mean\_absolute\_error: 0.0076 70/126 [===============>..............] - ETA: 0s - loss: 9.8928e-05 - mean\_absolute\_error: 0.0076 93/126 [=====================>........] - ETA: 0s - loss: 9.8329e-05 - mean\_absolute\_error: 0.0076117/126 [==========================>...] - ETA: 0s - loss: 1.0436e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0465e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1442e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1805e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 9.1939e-05 - mean\_absolute\_error: 0.0074 44/126 [=========>....................] - ETA: 0s - loss: 1.0466e-04 - mean\_absolute\_error: 0.0080 68/126 [===============>..............] - ETA: 0s - loss: 1.0594e-04 - mean\_absolute\_error: 0.0079 92/126 [====================>.........] - ETA: 0s - loss: 1.0433e-04 - mean\_absolute\_error: 0.0078116/126 [==========================>...] - ETA: 0s - loss: 1.0268e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0245e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.2443e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0611e-04 - mean\_absolute\_error: 0.0082 21/126 [====>.........................] - ETA: 0s - loss: 9.7612e-05 - mean\_absolute\_error: 0.0076 43/126 [=========>....................] - ETA: 0s - loss: 9.9967e-05 - mean\_absolute\_error: 0.0075 67/126 [==============>...............] - ETA: 0s - loss: 9.8287e-05 - mean\_absolute\_error: 0.0075 91/126 [====================>.........] - ETA: 0s - loss: 1.0295e-04 - mean\_absolute\_error: 0.0076106/126 [========================>.....] - ETA: 0s - loss: 9.9896e-05 - mean\_absolute\_error: 0.0076125/126 [============================>.] - ETA: 0s - loss: 9.8866e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8756e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0592e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5086e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 1.0251e-04 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 1.0072e-04 - mean\_absolute\_error: 0.0076 70/126 [===============>..............] - ETA: 0s - loss: 9.6736e-05 - mean\_absolute\_error: 0.0075 95/126 [=====================>........] - ETA: 0s - loss: 9.7265e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 1.0121e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 2ms/step - loss: 1.0122e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.5198e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7929e-04 - mean\_absolute\_error: 0.0091 21/126 [====>.........................] - ETA: 0s - loss: 1.1527e-04 - mean\_absolute\_error: 0.0083 42/126 [=========>....................] - ETA: 0s - loss: 1.0923e-04 - mean\_absolute\_error: 0.0079 67/126 [==============>...............] - ETA: 0s - loss: 1.1086e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.1073e-04 - mean\_absolute\_error: 0.0080111/126 [=========================>....] - ETA: 0s - loss: 1.0664e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0570e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1929e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0653e-05 - mean\_absolute\_error: 0.0069 22/126 [====>.........................] - ETA: 0s - loss: 8.7843e-05 - mean\_absolute\_error: 0.0073 45/126 [=========>....................] - ETA: 0s - loss: 9.7372e-05 - mean\_absolute\_error: 0.0075 67/126 [==============>...............] - ETA: 0s - loss: 9.9644e-05 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 1.0143e-04 - mean\_absolute\_error: 0.0077117/126 [==========================>...] - ETA: 0s - loss: 1.0441e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0253e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1626e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 7.2261e-05 - mean\_absolute\_error: 0.0065 18/126 [===>..........................] - ETA: 0s - loss: 9.4263e-05 - mean\_absolute\_error: 0.0076 39/126 [========>.....................] - ETA: 0s - loss: 1.0946e-04 - mean\_absolute\_error: 0.0081 64/126 [==============>...............] - ETA: 0s - loss: 1.1591e-04 - mean\_absolute\_error: 0.0084 88/126 [===================>..........] - ETA: 0s - loss: 1.2311e-04 - mean\_absolute\_error: 0.0086112/126 [=========================>....] - ETA: 0s - loss: 1.2066e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2022e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.2871e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0381e-05 - mean\_absolute\_error: 0.0070 21/126 [====>.........................] - ETA: 0s - loss: 9.5308e-05 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 9.1355e-05 - mean\_absolute\_error: 0.0074 66/126 [==============>...............] - ETA: 0s - loss: 9.9752e-05 - mean\_absolute\_error: 0.0077 90/126 [====================>.........] - ETA: 0s - loss: 1.0034e-04 - mean\_absolute\_error: 0.0077114/126 [==========================>...] - ETA: 0s - loss: 1.0158e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0348e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1235e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3642e-05 - mean\_absolute\_error: 0.0067 23/126 [====>.........................] - ETA: 0s - loss: 1.1483e-04 - mean\_absolute\_error: 0.0082 46/126 [=========>....................] - ETA: 0s - loss: 1.1760e-04 - mean\_absolute\_error: 0.0083 71/126 [===============>..............] - ETA: 0s - loss: 1.1542e-04 - mean\_absolute\_error: 0.0082 95/126 [=====================>........] - ETA: 0s - loss: 1.1784e-04 - mean\_absolute\_error: 0.0083118/126 [===========================>..] - ETA: 0s - loss: 1.1459e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1299e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0469e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7995e-04 - mean\_absolute\_error: 0.0102 24/126 [====>.........................] - ETA: 0s - loss: 9.7202e-05 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 1.0424e-04 - mean\_absolute\_error: 0.0078 72/126 [================>.............] - ETA: 0s - loss: 1.0616e-04 - mean\_absolute\_error: 0.0078 95/126 [=====================>........] - ETA: 0s - loss: 1.0698e-04 - mean\_absolute\_error: 0.0079120/126 [===========================>..] - ETA: 0s - loss: 1.0455e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0475e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.3694e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7545e-05 - mean\_absolute\_error: 0.0075 23/126 [====>.........................] - ETA: 0s - loss: 1.0201e-04 - mean\_absolute\_error: 0.0076 46/126 [=========>....................] - ETA: 0s - loss: 1.0409e-04 - mean\_absolute\_error: 0.0077 71/126 [===============>..............] - ETA: 0s - loss: 1.0119e-04 - mean\_absolute\_error: 0.0076 95/126 [=====================>........] - ETA: 0s - loss: 9.9299e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 9.7489e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 2ms/step - loss: 9.8473e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2230e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5034e-05 - mean\_absolute\_error: 0.0070 23/126 [====>.........................] - ETA: 0s - loss: 9.5887e-05 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 1.0399e-04 - mean\_absolute\_error: 0.0078 70/126 [===============>..............] - ETA: 0s - loss: 1.0444e-04 - mean\_absolute\_error: 0.0079 94/126 [=====================>........] - ETA: 0s - loss: 1.0404e-04 - mean\_absolute\_error: 0.0078118/126 [===========================>..] - ETA: 0s - loss: 1.0627e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0875e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.9207e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1106e-04 - mean\_absolute\_error: 0.0114 24/126 [====>.........................] - ETA: 0s - loss: 1.4131e-04 - mean\_absolute\_error: 0.0093 49/126 [==========>...................] - ETA: 0s - loss: 1.1904e-04 - mean\_absolute\_error: 0.0084 74/126 [================>.............] - ETA: 0s - loss: 1.1449e-04 - mean\_absolute\_error: 0.0081 99/126 [======================>.......] - ETA: 0s - loss: 1.1175e-04 - mean\_absolute\_error: 0.0080123/126 [============================>.] - ETA: 0s - loss: 1.0820e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0810e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0491e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3780e-05 - mean\_absolute\_error: 0.0072 20/126 [===>..........................] - ETA: 0s - loss: 9.0524e-05 - mean\_absolute\_error: 0.0075 44/126 [=========>....................] - ETA: 0s - loss: 1.0140e-04 - mean\_absolute\_error: 0.0079 67/126 [==============>...............] - ETA: 0s - loss: 1.0785e-04 - mean\_absolute\_error: 0.0080 89/126 [====================>.........] - ETA: 0s - loss: 1.1031e-04 - mean\_absolute\_error: 0.0081114/126 [==========================>...] - ETA: 0s - loss: 1.1094e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1207e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 2.9981e-04 - val\_mean\_absolute\_error: 0.0150  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1826e-04 - mean\_absolute\_error: 0.0109 20/126 [===>..........................] - ETA: 0s - loss: 1.2957e-04 - mean\_absolute\_error: 0.0087 41/126 [========>.....................] - ETA: 0s - loss: 1.1905e-04 - mean\_absolute\_error: 0.0083 65/126 [==============>...............] - ETA: 0s - loss: 1.1908e-04 - mean\_absolute\_error: 0.0083 90/126 [====================>.........] - ETA: 0s - loss: 1.1284e-04 - mean\_absolute\_error: 0.0081115/126 [==========================>...] - ETA: 0s - loss: 1.1046e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0817e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1437e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6769e-04 - mean\_absolute\_error: 0.0097 18/126 [===>..........................] - ETA: 0s - loss: 1.1373e-04 - mean\_absolute\_error: 0.0080 41/126 [========>.....................] - ETA: 0s - loss: 1.2776e-04 - mean\_absolute\_error: 0.0085 66/126 [==============>...............] - ETA: 0s - loss: 1.3679e-04 - mean\_absolute\_error: 0.0089 91/126 [====================>.........] - ETA: 0s - loss: 1.3440e-04 - mean\_absolute\_error: 0.0089115/126 [==========================>...] - ETA: 0s - loss: 1.2892e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2582e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.0789e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7358e-05 - mean\_absolute\_error: 0.0076 23/126 [====>.........................] - ETA: 0s - loss: 1.0500e-04 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 1.0480e-04 - mean\_absolute\_error: 0.0078 70/126 [===============>..............] - ETA: 0s - loss: 1.2046e-04 - mean\_absolute\_error: 0.0084 95/126 [=====================>........] - ETA: 0s - loss: 1.3910e-04 - mean\_absolute\_error: 0.0091119/126 [===========================>..] - ETA: 0s - loss: 1.3699e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.3780e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 1.3645e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3547e-04 - mean\_absolute\_error: 0.0096 19/126 [===>..........................] - ETA: 0s - loss: 1.2501e-04 - mean\_absolute\_error: 0.0087 39/126 [========>.....................] - ETA: 0s - loss: 1.1906e-04 - mean\_absolute\_error: 0.0083 63/126 [==============>...............] - ETA: 0s - loss: 1.0939e-04 - mean\_absolute\_error: 0.0079 88/126 [===================>..........] - ETA: 0s - loss: 1.0485e-04 - mean\_absolute\_error: 0.0078113/126 [=========================>....] - ETA: 0s - loss: 1.0299e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0140e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1736e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8257e-05 - mean\_absolute\_error: 0.0076 17/126 [===>..........................] - ETA: 0s - loss: 9.6732e-05 - mean\_absolute\_error: 0.0077 37/126 [=======>......................] - ETA: 0s - loss: 9.7314e-05 - mean\_absolute\_error: 0.0077 60/126 [=============>................] - ETA: 0s - loss: 1.0148e-04 - mean\_absolute\_error: 0.0078 83/126 [==================>...........] - ETA: 0s - loss: 1.0406e-04 - mean\_absolute\_error: 0.0078108/126 [========================>.....] - ETA: 0s - loss: 1.0334e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0256e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.5054e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9910e-05 - mean\_absolute\_error: 0.0072 21/126 [====>.........................] - ETA: 0s - loss: 9.9321e-05 - mean\_absolute\_error: 0.0077 46/126 [=========>....................] - ETA: 0s - loss: 1.0072e-04 - mean\_absolute\_error: 0.0076 69/126 [===============>..............] - ETA: 0s - loss: 1.2707e-04 - mean\_absolute\_error: 0.0086 91/126 [====================>.........] - ETA: 0s - loss: 1.3690e-04 - mean\_absolute\_error: 0.0090114/126 [==========================>...] - ETA: 0s - loss: 1.5254e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.4793e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.1079e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9035e-04 - mean\_absolute\_error: 0.0108 23/126 [====>.........................] - ETA: 0s - loss: 1.0874e-04 - mean\_absolute\_error: 0.0077 46/126 [=========>....................] - ETA: 0s - loss: 1.1119e-04 - mean\_absolute\_error: 0.0079 69/126 [===============>..............] - ETA: 0s - loss: 1.0142e-04 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 1.0878e-04 - mean\_absolute\_error: 0.0079115/126 [==========================>...] - ETA: 0s - loss: 1.0921e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1009e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.6003e-04 - val\_mean\_absolute\_error: 0.0137  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9905e-04 - mean\_absolute\_error: 0.0115 24/126 [====>.........................] - ETA: 0s - loss: 1.4440e-04 - mean\_absolute\_error: 0.0091 49/126 [==========>...................] - ETA: 0s - loss: 1.3072e-04 - mean\_absolute\_error: 0.0089 74/126 [================>.............] - ETA: 0s - loss: 1.2176e-04 - mean\_absolute\_error: 0.0085 98/126 [======================>.......] - ETA: 0s - loss: 1.1479e-04 - mean\_absolute\_error: 0.0083123/126 [============================>.] - ETA: 0s - loss: 1.1323e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 2ms/step - loss: 1.1236e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.3579e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0763e-04 - mean\_absolute\_error: 0.0079 18/126 [===>..........................] - ETA: 0s - loss: 1.2826e-04 - mean\_absolute\_error: 0.0087 41/126 [========>.....................] - ETA: 0s - loss: 1.0740e-04 - mean\_absolute\_error: 0.0080 66/126 [==============>...............] - ETA: 0s - loss: 1.1954e-04 - mean\_absolute\_error: 0.0084 88/126 [===================>..........] - ETA: 0s - loss: 1.2144e-04 - mean\_absolute\_error: 0.0085112/126 [=========================>....] - ETA: 0s - loss: 1.2704e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2465e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.6239e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8155e-05 - mean\_absolute\_error: 0.0071 23/126 [====>.........................] - ETA: 0s - loss: 1.0866e-04 - mean\_absolute\_error: 0.0081 48/126 [==========>...................] - ETA: 0s - loss: 1.2007e-04 - mean\_absolute\_error: 0.0085 73/126 [================>.............] - ETA: 0s - loss: 1.1884e-04 - mean\_absolute\_error: 0.0083 98/126 [======================>.......] - ETA: 0s - loss: 1.1843e-04 - mean\_absolute\_error: 0.0083123/126 [============================>.] - ETA: 0s - loss: 1.1923e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.1838e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.0288e-04 - val\_mean\_absolute\_error: 0.0077  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9150e-05 - mean\_absolute\_error: 0.0075 20/126 [===>..........................] - ETA: 0s - loss: 1.4098e-04 - mean\_absolute\_error: 0.0096 43/126 [=========>....................] - ETA: 0s - loss: 1.2199e-04 - mean\_absolute\_error: 0.0087 68/126 [===============>..............] - ETA: 0s - loss: 1.1501e-04 - mean\_absolute\_error: 0.0084 93/126 [=====================>........] - ETA: 0s - loss: 1.1546e-04 - mean\_absolute\_error: 0.0083118/126 [===========================>..] - ETA: 0s - loss: 1.1591e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1803e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.1124e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1168e-04 - mean\_absolute\_error: 0.0082 18/126 [===>..........................] - ETA: 0s - loss: 9.2684e-05 - mean\_absolute\_error: 0.0073 39/126 [========>.....................] - ETA: 0s - loss: 1.0601e-04 - mean\_absolute\_error: 0.0078 62/126 [=============>................] - ETA: 0s - loss: 1.0618e-04 - mean\_absolute\_error: 0.0079 86/126 [===================>..........] - ETA: 0s - loss: 1.0466e-04 - mean\_absolute\_error: 0.0078110/126 [=========================>....] - ETA: 0s - loss: 1.0746e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0833e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.0208e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0513e-05 - mean\_absolute\_error: 0.0084 18/126 [===>..........................] - ETA: 0s - loss: 9.0369e-05 - mean\_absolute\_error: 0.0072 40/126 [========>.....................] - ETA: 0s - loss: 1.0536e-04 - mean\_absolute\_error: 0.0077 63/126 [==============>...............] - ETA: 0s - loss: 1.0900e-04 - mean\_absolute\_error: 0.0079 86/126 [===================>..........] - ETA: 0s - loss: 1.0700e-04 - mean\_absolute\_error: 0.0079109/126 [========================>.....] - ETA: 0s - loss: 1.0797e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0755e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.2086e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5538e-05 - mean\_absolute\_error: 0.0057 25/126 [====>.........................] - ETA: 0s - loss: 1.2331e-04 - mean\_absolute\_error: 0.0086 49/126 [==========>...................] - ETA: 0s - loss: 1.1470e-04 - mean\_absolute\_error: 0.0081 74/126 [================>.............] - ETA: 0s - loss: 1.0925e-04 - mean\_absolute\_error: 0.0079 99/126 [======================>.......] - ETA: 0s - loss: 1.0912e-04 - mean\_absolute\_error: 0.0079123/126 [============================>.] - ETA: 0s - loss: 1.1366e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 2ms/step - loss: 1.1396e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.4403e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8832e-05 - mean\_absolute\_error: 0.0080 21/126 [====>.........................] - ETA: 0s - loss: 1.3014e-04 - mean\_absolute\_error: 0.0089 45/126 [=========>....................] - ETA: 0s - loss: 1.3109e-04 - mean\_absolute\_error: 0.0089 69/126 [===============>..............] - ETA: 0s - loss: 1.2832e-04 - mean\_absolute\_error: 0.0089 93/126 [=====================>........] - ETA: 0s - loss: 1.2723e-04 - mean\_absolute\_error: 0.0089115/126 [==========================>...] - ETA: 0s - loss: 1.2357e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2300e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.3787e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3161e-05 - mean\_absolute\_error: 0.0070 22/126 [====>.........................] - ETA: 0s - loss: 1.1574e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.2689e-04 - mean\_absolute\_error: 0.0088 70/126 [===============>..............] - ETA: 0s - loss: 1.1865e-04 - mean\_absolute\_error: 0.0084 93/126 [=====================>........] - ETA: 0s - loss: 1.1786e-04 - mean\_absolute\_error: 0.0084117/126 [==========================>...] - ETA: 0s - loss: 1.1665e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1546e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0162e-04 - val\_mean\_absolute\_error: 0.0077  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0408e-04 - mean\_absolute\_error: 0.0082 21/126 [====>.........................] - ETA: 0s - loss: 1.0565e-04 - mean\_absolute\_error: 0.0079 44/126 [=========>....................] - ETA: 0s - loss: 1.0259e-04 - mean\_absolute\_error: 0.0077 66/126 [==============>...............] - ETA: 0s - loss: 1.0329e-04 - mean\_absolute\_error: 0.0078 89/126 [====================>.........] - ETA: 0s - loss: 1.0299e-04 - mean\_absolute\_error: 0.0078111/126 [=========================>....] - ETA: 0s - loss: 1.0347e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0311e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0718e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7128e-05 - mean\_absolute\_error: 0.0053 22/126 [====>.........................] - ETA: 0s - loss: 9.5059e-05 - mean\_absolute\_error: 0.0073 46/126 [=========>....................] - ETA: 0s - loss: 9.3915e-05 - mean\_absolute\_error: 0.0074 69/126 [===============>..............] - ETA: 0s - loss: 9.3401e-05 - mean\_absolute\_error: 0.0073 93/126 [=====================>........] - ETA: 0s - loss: 9.3270e-05 - mean\_absolute\_error: 0.0073116/126 [==========================>...] - ETA: 0s - loss: 9.4790e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.8972e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.4124e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6137e-05 - mean\_absolute\_error: 0.0077 23/126 [====>.........................] - ETA: 0s - loss: 9.1916e-05 - mean\_absolute\_error: 0.0073 47/126 [==========>...................] - ETA: 0s - loss: 1.3719e-04 - mean\_absolute\_error: 0.0090 69/126 [===============>..............] - ETA: 0s - loss: 1.2607e-04 - mean\_absolute\_error: 0.0086 92/126 [====================>.........] - ETA: 0s - loss: 1.2243e-04 - mean\_absolute\_error: 0.0085115/126 [==========================>...] - ETA: 0s - loss: 1.1708e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1481e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.6767e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0521e-04 - mean\_absolute\_error: 0.0119 22/126 [====>.........................] - ETA: 0s - loss: 1.3439e-04 - mean\_absolute\_error: 0.0092 45/126 [=========>....................] - ETA: 0s - loss: 1.4925e-04 - mean\_absolute\_error: 0.0097 67/126 [==============>...............] - ETA: 0s - loss: 1.4805e-04 - mean\_absolute\_error: 0.0095 90/126 [====================>.........] - ETA: 0s - loss: 1.3767e-04 - mean\_absolute\_error: 0.0091112/126 [=========================>....] - ETA: 0s - loss: 1.3141e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.2604e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.0080e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5161e-05 - mean\_absolute\_error: 0.0069 24/126 [====>.........................] - ETA: 0s - loss: 1.2762e-04 - mean\_absolute\_error: 0.0087 49/126 [==========>...................] - ETA: 0s - loss: 1.2311e-04 - mean\_absolute\_error: 0.0084 73/126 [================>.............] - ETA: 0s - loss: 1.1469e-04 - mean\_absolute\_error: 0.0082 96/126 [=====================>........] - ETA: 0s - loss: 1.1229e-04 - mean\_absolute\_error: 0.0081119/126 [===========================>..] - ETA: 0s - loss: 1.1550e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1797e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 9.9986e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6563e-05 - mean\_absolute\_error: 0.0078 24/126 [====>.........................] - ETA: 0s - loss: 1.0341e-04 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 1.0182e-04 - mean\_absolute\_error: 0.0077 70/126 [===============>..............] - ETA: 0s - loss: 9.7540e-05 - mean\_absolute\_error: 0.0076 93/126 [=====================>........] - ETA: 0s - loss: 1.0041e-04 - mean\_absolute\_error: 0.0077116/126 [==========================>...] - ETA: 0s - loss: 9.8521e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0040e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0501e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3680e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 9.5468e-05 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 9.6514e-05 - mean\_absolute\_error: 0.0076 71/126 [===============>..............] - ETA: 0s - loss: 9.5374e-05 - mean\_absolute\_error: 0.0076 94/126 [=====================>........] - ETA: 0s - loss: 9.7547e-05 - mean\_absolute\_error: 0.0076119/126 [===========================>..] - ETA: 0s - loss: 1.0267e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0245e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 9.9749e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3753e-05 - mean\_absolute\_error: 0.0066 22/126 [====>.........................] - ETA: 0s - loss: 1.1756e-04 - mean\_absolute\_error: 0.0083 45/126 [=========>....................] - ETA: 0s - loss: 1.3967e-04 - mean\_absolute\_error: 0.0093 70/126 [===============>..............] - ETA: 0s - loss: 1.6059e-04 - mean\_absolute\_error: 0.0101 94/126 [=====================>........] - ETA: 0s - loss: 1.5858e-04 - mean\_absolute\_error: 0.0100119/126 [===========================>..] - ETA: 0s - loss: 1.5503e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.5401e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 1.0754e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7921e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 1.2428e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.1032e-04 - mean\_absolute\_error: 0.0080 69/126 [===============>..............] - ETA: 0s - loss: 1.0335e-04 - mean\_absolute\_error: 0.0078 94/126 [=====================>........] - ETA: 0s - loss: 1.0130e-04 - mean\_absolute\_error: 0.0077119/126 [===========================>..] - ETA: 0s - loss: 1.0536e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0694e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.4992e-04 - val\_mean\_absolute\_error: 0.0135  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8052e-04 - mean\_absolute\_error: 0.0109 24/126 [====>.........................] - ETA: 0s - loss: 1.4212e-04 - mean\_absolute\_error: 0.0093 49/126 [==========>...................] - ETA: 0s - loss: 1.1759e-04 - mean\_absolute\_error: 0.0084 74/126 [================>.............] - ETA: 0s - loss: 1.1102e-04 - mean\_absolute\_error: 0.0081 98/126 [======================>.......] - ETA: 0s - loss: 1.0731e-04 - mean\_absolute\_error: 0.0079122/126 [============================>.] - ETA: 0s - loss: 1.0851e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0723e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.4817e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3328e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 1.0096e-04 - mean\_absolute\_error: 0.0075 48/126 [==========>...................] - ETA: 0s - loss: 1.2156e-04 - mean\_absolute\_error: 0.0086 73/126 [================>.............] - ETA: 0s - loss: 1.2775e-04 - mean\_absolute\_error: 0.0088 97/126 [======================>.......] - ETA: 0s - loss: 1.1707e-04 - mean\_absolute\_error: 0.0084120/126 [===========================>..] - ETA: 0s - loss: 1.1500e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.1458e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.2042e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1508e-04 - mean\_absolute\_error: 0.0080 22/126 [====>.........................] - ETA: 0s - loss: 1.3099e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.2883e-04 - mean\_absolute\_error: 0.0088 70/126 [===============>..............] - ETA: 0s - loss: 1.2676e-04 - mean\_absolute\_error: 0.0087 94/126 [=====================>........] - ETA: 0s - loss: 1.2101e-04 - mean\_absolute\_error: 0.0085118/126 [===========================>..] - ETA: 0s - loss: 1.1640e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1578e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.7604e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4868e-04 - mean\_absolute\_error: 0.0101 23/126 [====>.........................] - ETA: 0s - loss: 8.5559e-05 - mean\_absolute\_error: 0.0072 48/126 [==========>...................] - ETA: 0s - loss: 8.6512e-05 - mean\_absolute\_error: 0.0072 72/126 [================>.............] - ETA: 0s - loss: 9.6751e-05 - mean\_absolute\_error: 0.0075 97/126 [======================>.......] - ETA: 0s - loss: 1.0091e-04 - mean\_absolute\_error: 0.0076122/126 [============================>.] - ETA: 0s - loss: 1.1177e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 2ms/step - loss: 1.1396e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 2.9558e-04 - val\_mean\_absolute\_error: 0.0147  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4976e-04 - mean\_absolute\_error: 0.0140 19/126 [===>..........................] - ETA: 0s - loss: 1.4316e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 1.1712e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.0961e-04 - mean\_absolute\_error: 0.0081 91/126 [====================>.........] - ETA: 0s - loss: 1.0830e-04 - mean\_absolute\_error: 0.0080112/126 [=========================>....] - ETA: 0s - loss: 1.0477e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0668e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.2517e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2394e-05 - mean\_absolute\_error: 0.0072 24/126 [====>.........................] - ETA: 0s - loss: 9.9372e-05 - mean\_absolute\_error: 0.0078 49/126 [==========>...................] - ETA: 0s - loss: 1.0796e-04 - mean\_absolute\_error: 0.0080 75/126 [================>.............] - ETA: 0s - loss: 1.0479e-04 - mean\_absolute\_error: 0.0079 99/126 [======================>.......] - ETA: 0s - loss: 1.1197e-04 - mean\_absolute\_error: 0.0082123/126 [============================>.] - ETA: 0s - loss: 1.2375e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.2305e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.8078e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0673e-04 - mean\_absolute\_error: 0.0068 19/126 [===>..........................] - ETA: 0s - loss: 1.0960e-04 - mean\_absolute\_error: 0.0081 41/126 [========>.....................] - ETA: 0s - loss: 1.0368e-04 - mean\_absolute\_error: 0.0078 65/126 [==============>...............] - ETA: 0s - loss: 1.0038e-04 - mean\_absolute\_error: 0.0076 87/126 [===================>..........] - ETA: 0s - loss: 9.8881e-05 - mean\_absolute\_error: 0.0076109/126 [========================>.....] - ETA: 0s - loss: 9.7874e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.8610e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 9.7835e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8062e-05 - mean\_absolute\_error: 0.0073 22/126 [====>.........................] - ETA: 0s - loss: 9.8417e-05 - mean\_absolute\_error: 0.0075 45/126 [=========>....................] - ETA: 0s - loss: 8.6691e-05 - mean\_absolute\_error: 0.0071 67/126 [==============>...............] - ETA: 0s - loss: 1.0854e-04 - mean\_absolute\_error: 0.0080 89/126 [====================>.........] - ETA: 0s - loss: 1.2605e-04 - mean\_absolute\_error: 0.0086109/126 [========================>.....] - ETA: 0s - loss: 1.1919e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1666e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0078e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3134e-05 - mean\_absolute\_error: 0.0070 22/126 [====>.........................] - ETA: 0s - loss: 9.8662e-05 - mean\_absolute\_error: 0.0074 44/126 [=========>....................] - ETA: 0s - loss: 1.1134e-04 - mean\_absolute\_error: 0.0082 67/126 [==============>...............] - ETA: 0s - loss: 1.1574e-04 - mean\_absolute\_error: 0.0084 89/126 [====================>.........] - ETA: 0s - loss: 1.1627e-04 - mean\_absolute\_error: 0.0084112/126 [=========================>....] - ETA: 0s - loss: 1.1432e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1575e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 9.9211e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1305e-04 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.0279e-04 - mean\_absolute\_error: 0.0076 46/126 [=========>....................] - ETA: 0s - loss: 1.0716e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.0600e-04 - mean\_absolute\_error: 0.0078 92/126 [====================>.........] - ETA: 0s - loss: 1.0528e-04 - mean\_absolute\_error: 0.0078116/126 [==========================>...] - ETA: 0s - loss: 1.0289e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0641e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.4341e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3555e-04 - mean\_absolute\_error: 0.0096 19/126 [===>..........................] - ETA: 0s - loss: 1.0603e-04 - mean\_absolute\_error: 0.0080 41/126 [========>.....................] - ETA: 0s - loss: 1.1064e-04 - mean\_absolute\_error: 0.0082 65/126 [==============>...............] - ETA: 0s - loss: 1.0214e-04 - mean\_absolute\_error: 0.0078 89/126 [====================>.........] - ETA: 0s - loss: 1.0316e-04 - mean\_absolute\_error: 0.0078113/126 [=========================>....] - ETA: 0s - loss: 1.0212e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0416e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0624e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5764e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 8.8887e-05 - mean\_absolute\_error: 0.0073 46/126 [=========>....................] - ETA: 0s - loss: 9.3197e-05 - mean\_absolute\_error: 0.0074 71/126 [===============>..............] - ETA: 0s - loss: 9.4819e-05 - mean\_absolute\_error: 0.0075 95/126 [=====================>........] - ETA: 0s - loss: 9.4717e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 9.6202e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.6649e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 9.6604e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5834e-05 - mean\_absolute\_error: 0.0068 19/126 [===>..........................] - ETA: 0s - loss: 1.1622e-04 - mean\_absolute\_error: 0.0082 41/126 [========>.....................] - ETA: 0s - loss: 1.1021e-04 - mean\_absolute\_error: 0.0080 65/126 [==============>...............] - ETA: 0s - loss: 1.0822e-04 - mean\_absolute\_error: 0.0080 89/126 [====================>.........] - ETA: 0s - loss: 1.1151e-04 - mean\_absolute\_error: 0.0081113/126 [=========================>....] - ETA: 0s - loss: 1.1948e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.2514e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.6387e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4631e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 1.0984e-04 - mean\_absolute\_error: 0.0083 47/126 [==========>...................] - ETA: 0s - loss: 1.0844e-04 - mean\_absolute\_error: 0.0081 71/126 [===============>..............] - ETA: 0s - loss: 1.0655e-04 - mean\_absolute\_error: 0.0080 95/126 [=====================>........] - ETA: 0s - loss: 1.0660e-04 - mean\_absolute\_error: 0.0080120/126 [===========================>..] - ETA: 0s - loss: 1.1636e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1749e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 3.6315e-04 - val\_mean\_absolute\_error: 0.0169  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7500e-04 - mean\_absolute\_error: 0.0144 19/126 [===>..........................] - ETA: 0s - loss: 1.8580e-04 - mean\_absolute\_error: 0.0109 39/126 [========>.....................] - ETA: 0s - loss: 1.4485e-04 - mean\_absolute\_error: 0.0094 62/126 [=============>................] - ETA: 0s - loss: 1.2299e-04 - mean\_absolute\_error: 0.0086 86/126 [===================>..........] - ETA: 0s - loss: 1.1505e-04 - mean\_absolute\_error: 0.0083111/126 [=========================>....] - ETA: 0s - loss: 1.1334e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1230e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.2950e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4566e-04 - mean\_absolute\_error: 0.0088 19/126 [===>..........................] - ETA: 0s - loss: 1.2130e-04 - mean\_absolute\_error: 0.0085 39/126 [========>.....................] - ETA: 0s - loss: 1.3320e-04 - mean\_absolute\_error: 0.0090 59/126 [=============>................] - ETA: 0s - loss: 1.3639e-04 - mean\_absolute\_error: 0.0091 78/126 [=================>............] - ETA: 0s - loss: 1.2997e-04 - mean\_absolute\_error: 0.0089 99/126 [======================>.......] - ETA: 0s - loss: 1.2042e-04 - mean\_absolute\_error: 0.0085124/126 [============================>.] - ETA: 0s - loss: 1.1363e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1327e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 9.6276e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4458e-04 - mean\_absolute\_error: 0.0088 20/126 [===>..........................] - ETA: 0s - loss: 9.8607e-05 - mean\_absolute\_error: 0.0078 41/126 [========>.....................] - ETA: 0s - loss: 9.1842e-05 - mean\_absolute\_error: 0.0074 58/126 [============>.................] - ETA: 0s - loss: 9.2382e-05 - mean\_absolute\_error: 0.0074 79/126 [=================>............] - ETA: 0s - loss: 9.9604e-05 - mean\_absolute\_error: 0.0077 99/126 [======================>.......] - ETA: 0s - loss: 9.8323e-05 - mean\_absolute\_error: 0.0077118/126 [===========================>..] - ETA: 0s - loss: 1.0188e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0153e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.5043e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0977e-04 - mean\_absolute\_error: 0.0093 22/126 [====>.........................] - ETA: 0s - loss: 8.4297e-05 - mean\_absolute\_error: 0.0070 43/126 [=========>....................] - ETA: 0s - loss: 9.9667e-05 - mean\_absolute\_error: 0.0075 60/126 [=============>................] - ETA: 0s - loss: 9.5990e-05 - mean\_absolute\_error: 0.0074 79/126 [=================>............] - ETA: 0s - loss: 9.9902e-05 - mean\_absolute\_error: 0.0076103/126 [=======================>......] - ETA: 0s - loss: 1.0200e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - ETA: 0s - loss: 1.0253e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0253e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.3077e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 77/100  
 1/126 [..............................] - ETA: 1s - loss: 1.2113e-04 - mean\_absolute\_error: 0.0087 22/126 [====>.........................] - ETA: 0s - loss: 1.0409e-04 - mean\_absolute\_error: 0.0077 45/126 [=========>....................] - ETA: 0s - loss: 9.8803e-05 - mean\_absolute\_error: 0.0077 66/126 [==============>...............] - ETA: 0s - loss: 9.7402e-05 - mean\_absolute\_error: 0.0076 82/126 [==================>...........] - ETA: 0s - loss: 1.0544e-04 - mean\_absolute\_error: 0.0078 99/126 [======================>.......] - ETA: 0s - loss: 1.0581e-04 - mean\_absolute\_error: 0.0079113/126 [=========================>....] - ETA: 0s - loss: 1.0568e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0506e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 9.6881e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9591e-05 - mean\_absolute\_error: 0.0073 17/126 [===>..........................] - ETA: 0s - loss: 9.0400e-05 - mean\_absolute\_error: 0.0074 33/126 [======>.......................] - ETA: 0s - loss: 8.8292e-05 - mean\_absolute\_error: 0.0073 48/126 [==========>...................] - ETA: 0s - loss: 9.5164e-05 - mean\_absolute\_error: 0.0076 61/126 [=============>................] - ETA: 0s - loss: 1.0006e-04 - mean\_absolute\_error: 0.0078 79/126 [=================>............] - ETA: 0s - loss: 9.8044e-05 - mean\_absolute\_error: 0.0077100/126 [======================>.......] - ETA: 0s - loss: 9.5646e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 9.5606e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 4ms/step - loss: 9.5054e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.2134e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 79/100  
 1/126 [..............................] - ETA: 1s - loss: 8.3467e-05 - mean\_absolute\_error: 0.0072 20/126 [===>..........................] - ETA: 0s - loss: 9.9116e-05 - mean\_absolute\_error: 0.0076 45/126 [=========>....................] - ETA: 0s - loss: 9.5076e-05 - mean\_absolute\_error: 0.0074 69/126 [===============>..............] - ETA: 0s - loss: 1.0771e-04 - mean\_absolute\_error: 0.0080 87/126 [===================>..........] - ETA: 0s - loss: 1.0376e-04 - mean\_absolute\_error: 0.0078109/126 [========================>.....] - ETA: 0s - loss: 1.1238e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.2211e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.4158e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6460e-04 - mean\_absolute\_error: 0.0108 15/126 [==>...........................] - ETA: 0s - loss: 1.0848e-04 - mean\_absolute\_error: 0.0076 30/126 [======>.......................] - ETA: 0s - loss: 1.0436e-04 - mean\_absolute\_error: 0.0077 43/126 [=========>....................] - ETA: 0s - loss: 1.0497e-04 - mean\_absolute\_error: 0.0079 60/126 [=============>................] - ETA: 0s - loss: 9.9512e-05 - mean\_absolute\_error: 0.0077 78/126 [=================>............] - ETA: 0s - loss: 9.9127e-05 - mean\_absolute\_error: 0.0077 96/126 [=====================>........] - ETA: 0s - loss: 9.7980e-05 - mean\_absolute\_error: 0.0076112/126 [=========================>....] - ETA: 0s - loss: 9.9956e-05 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 4ms/step - loss: 9.8307e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 9.6285e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5751e-05 - mean\_absolute\_error: 0.0064 16/126 [==>...........................] - ETA: 0s - loss: 8.2496e-05 - mean\_absolute\_error: 0.0072 31/126 [======>.......................] - ETA: 0s - loss: 9.4268e-05 - mean\_absolute\_error: 0.0073 50/126 [==========>...................] - ETA: 0s - loss: 9.7922e-05 - mean\_absolute\_error: 0.0075 73/126 [================>.............] - ETA: 0s - loss: 9.7082e-05 - mean\_absolute\_error: 0.0075 97/126 [======================>.......] - ETA: 0s - loss: 9.9856e-05 - mean\_absolute\_error: 0.0076120/126 [===========================>..] - ETA: 0s - loss: 1.0011e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 9.9457e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0218e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4569e-05 - mean\_absolute\_error: 0.0054 23/126 [====>.........................] - ETA: 0s - loss: 1.3142e-04 - mean\_absolute\_error: 0.0087 43/126 [=========>....................] - ETA: 0s - loss: 1.2057e-04 - mean\_absolute\_error: 0.0085 63/126 [==============>...............] - ETA: 0s - loss: 1.2582e-04 - mean\_absolute\_error: 0.0088 83/126 [==================>...........] - ETA: 0s - loss: 1.2341e-04 - mean\_absolute\_error: 0.0088104/126 [=======================>......] - ETA: 0s - loss: 1.2314e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - ETA: 0s - loss: 1.1849e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.1849e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.0738e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1525e-05 - mean\_absolute\_error: 0.0073 20/126 [===>..........................] - ETA: 0s - loss: 1.0699e-04 - mean\_absolute\_error: 0.0080 41/126 [========>.....................] - ETA: 0s - loss: 9.6263e-05 - mean\_absolute\_error: 0.0076 62/126 [=============>................] - ETA: 0s - loss: 1.0187e-04 - mean\_absolute\_error: 0.0077 83/126 [==================>...........] - ETA: 0s - loss: 1.0798e-04 - mean\_absolute\_error: 0.0080103/126 [=======================>......] - ETA: 0s - loss: 1.0331e-04 - mean\_absolute\_error: 0.0078119/126 [===========================>..] - ETA: 0s - loss: 1.0507e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0748e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.6907e-04 - val\_mean\_absolute\_error: 0.0107  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5583e-04 - mean\_absolute\_error: 0.0103 21/126 [====>.........................] - ETA: 0s - loss: 1.4211e-04 - mean\_absolute\_error: 0.0097 41/126 [========>.....................] - ETA: 0s - loss: 1.2684e-04 - mean\_absolute\_error: 0.0089 59/126 [=============>................] - ETA: 0s - loss: 1.1562e-04 - mean\_absolute\_error: 0.0084 80/126 [==================>...........] - ETA: 0s - loss: 1.1216e-04 - mean\_absolute\_error: 0.0082 91/126 [====================>.........] - ETA: 0s - loss: 1.0932e-04 - mean\_absolute\_error: 0.0080101/126 [=======================>......] - ETA: 0s - loss: 1.0597e-04 - mean\_absolute\_error: 0.0079111/126 [=========================>....] - ETA: 0s - loss: 1.0532e-04 - mean\_absolute\_error: 0.0079121/126 [===========================>..] - ETA: 0s - loss: 1.0374e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 1s 4ms/step - loss: 1.0355e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.3494e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0545e-04 - mean\_absolute\_error: 0.0083 11/126 [=>............................] - ETA: 0s - loss: 1.1040e-04 - mean\_absolute\_error: 0.0083 21/126 [====>.........................] - ETA: 0s - loss: 9.0144e-05 - mean\_absolute\_error: 0.0074 30/126 [======>.......................] - ETA: 0s - loss: 9.8160e-05 - mean\_absolute\_error: 0.0076 40/126 [========>.....................] - ETA: 0s - loss: 1.0144e-04 - mean\_absolute\_error: 0.0076 50/126 [==========>...................] - ETA: 0s - loss: 9.5998e-05 - mean\_absolute\_error: 0.0074 61/126 [=============>................] - ETA: 0s - loss: 9.4316e-05 - mean\_absolute\_error: 0.0073 72/126 [================>.............] - ETA: 0s - loss: 9.3156e-05 - mean\_absolute\_error: 0.0073 83/126 [==================>...........] - ETA: 0s - loss: 1.0354e-04 - mean\_absolute\_error: 0.0077 94/126 [=====================>........] - ETA: 0s - loss: 1.0421e-04 - mean\_absolute\_error: 0.0077105/126 [========================>.....] - ETA: 0s - loss: 1.0485e-04 - mean\_absolute\_error: 0.0078117/126 [==========================>...] - ETA: 0s - loss: 1.0298e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 1s 5ms/step - loss: 1.0264e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.3391e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1209e-05 - mean\_absolute\_error: 0.0067 20/126 [===>..........................] - ETA: 0s - loss: 1.0196e-04 - mean\_absolute\_error: 0.0080 44/126 [=========>....................] - ETA: 0s - loss: 9.2860e-05 - mean\_absolute\_error: 0.0076 68/126 [===============>..............] - ETA: 0s - loss: 9.4322e-05 - mean\_absolute\_error: 0.0076 91/126 [====================>.........] - ETA: 0s - loss: 9.6758e-05 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 9.5043e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.4586e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0595e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9193e-05 - mean\_absolute\_error: 0.0084 24/126 [====>.........................] - ETA: 0s - loss: 1.0305e-04 - mean\_absolute\_error: 0.0076 47/126 [==========>...................] - ETA: 0s - loss: 1.0317e-04 - mean\_absolute\_error: 0.0076 71/126 [===============>..............] - ETA: 0s - loss: 9.8288e-05 - mean\_absolute\_error: 0.0075 94/126 [=====================>........] - ETA: 0s - loss: 9.9627e-05 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 9.7893e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.8620e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0079e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 8.1703e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 9.3273e-05 - mean\_absolute\_error: 0.0073 48/126 [==========>...................] - ETA: 0s - loss: 9.4938e-05 - mean\_absolute\_error: 0.0074 72/126 [================>.............] - ETA: 0s - loss: 9.8393e-05 - mean\_absolute\_error: 0.0075 94/126 [=====================>........] - ETA: 0s - loss: 9.5454e-05 - mean\_absolute\_error: 0.0074116/126 [==========================>...] - ETA: 0s - loss: 9.9788e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.8150e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1115e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9927e-05 - mean\_absolute\_error: 0.0064 21/126 [====>.........................] - ETA: 0s - loss: 9.0174e-05 - mean\_absolute\_error: 0.0072 42/126 [=========>....................] - ETA: 0s - loss: 9.2275e-05 - mean\_absolute\_error: 0.0073 63/126 [==============>...............] - ETA: 0s - loss: 9.8540e-05 - mean\_absolute\_error: 0.0075 85/126 [===================>..........] - ETA: 0s - loss: 9.4968e-05 - mean\_absolute\_error: 0.0074109/126 [========================>.....] - ETA: 0s - loss: 9.7184e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.7938e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 5.1969e-04 - val\_mean\_absolute\_error: 0.0208  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0551e-04 - mean\_absolute\_error: 0.0192 23/126 [====>.........................] - ETA: 0s - loss: 1.3874e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.3726e-04 - mean\_absolute\_error: 0.0093 68/126 [===============>..............] - ETA: 0s - loss: 1.3812e-04 - mean\_absolute\_error: 0.0092 91/126 [====================>.........] - ETA: 0s - loss: 1.2729e-04 - mean\_absolute\_error: 0.0088114/126 [==========================>...] - ETA: 0s - loss: 1.2363e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2310e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 2.0898e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2494e-04 - mean\_absolute\_error: 0.0094 24/126 [====>.........................] - ETA: 0s - loss: 1.1651e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 9.8411e-05 - mean\_absolute\_error: 0.0076 70/126 [===============>..............] - ETA: 0s - loss: 9.8564e-05 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 9.7763e-05 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 9.8534e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0068e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 2.0318e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0348e-04 - mean\_absolute\_error: 0.0123 22/126 [====>.........................] - ETA: 0s - loss: 1.0993e-04 - mean\_absolute\_error: 0.0082 43/126 [=========>....................] - ETA: 0s - loss: 1.1139e-04 - mean\_absolute\_error: 0.0081 64/126 [==============>...............] - ETA: 0s - loss: 1.0708e-04 - mean\_absolute\_error: 0.0079 84/126 [===================>..........] - ETA: 0s - loss: 1.1824e-04 - mean\_absolute\_error: 0.0084103/126 [=======================>......] - ETA: 0s - loss: 1.1595e-04 - mean\_absolute\_error: 0.0083124/126 [============================>.] - ETA: 0s - loss: 1.1179e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1156e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.3206e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8098e-05 - mean\_absolute\_error: 0.0079 21/126 [====>.........................] - ETA: 0s - loss: 9.8096e-05 - mean\_absolute\_error: 0.0075 43/126 [=========>....................] - ETA: 0s - loss: 1.2643e-04 - mean\_absolute\_error: 0.0086 64/126 [==============>...............] - ETA: 0s - loss: 1.1395e-04 - mean\_absolute\_error: 0.0082 87/126 [===================>..........] - ETA: 0s - loss: 1.0928e-04 - mean\_absolute\_error: 0.0080110/126 [=========================>....] - ETA: 0s - loss: 1.0605e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0433e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 9.3133e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9905e-05 - mean\_absolute\_error: 0.0066 25/126 [====>.........................] - ETA: 0s - loss: 8.7673e-05 - mean\_absolute\_error: 0.0072 48/126 [==========>...................] - ETA: 0s - loss: 8.7133e-05 - mean\_absolute\_error: 0.0072 71/126 [===============>..............] - ETA: 0s - loss: 9.3478e-05 - mean\_absolute\_error: 0.0075 92/126 [====================>.........] - ETA: 0s - loss: 1.1640e-04 - mean\_absolute\_error: 0.0084113/126 [=========================>....] - ETA: 0s - loss: 1.2523e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2324e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 1.4470e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0040e-04 - mean\_absolute\_error: 0.0087 21/126 [====>.........................] - ETA: 0s - loss: 8.2919e-05 - mean\_absolute\_error: 0.0070 41/126 [========>.....................] - ETA: 0s - loss: 8.9655e-05 - mean\_absolute\_error: 0.0074 62/126 [=============>................] - ETA: 0s - loss: 9.5951e-05 - mean\_absolute\_error: 0.0076 82/126 [==================>...........] - ETA: 0s - loss: 9.8748e-05 - mean\_absolute\_error: 0.0077103/126 [=======================>......] - ETA: 0s - loss: 9.6829e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - ETA: 0s - loss: 9.4527e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.4527e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1883e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 8.1474e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 1.0625e-04 - mean\_absolute\_error: 0.0080 45/126 [=========>....................] - ETA: 0s - loss: 9.9466e-05 - mean\_absolute\_error: 0.0076 67/126 [==============>...............] - ETA: 0s - loss: 9.7873e-05 - mean\_absolute\_error: 0.0075 85/126 [===================>..........] - ETA: 0s - loss: 9.7258e-05 - mean\_absolute\_error: 0.0075105/126 [========================>.....] - ETA: 0s - loss: 9.2315e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.3493e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 9.9643e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3963e-05 - mean\_absolute\_error: 0.0062 23/126 [====>.........................] - ETA: 0s - loss: 9.9075e-05 - mean\_absolute\_error: 0.0076 44/126 [=========>....................] - ETA: 0s - loss: 1.0014e-04 - mean\_absolute\_error: 0.0077 66/126 [==============>...............] - ETA: 0s - loss: 1.0605e-04 - mean\_absolute\_error: 0.0080 89/126 [====================>.........] - ETA: 0s - loss: 1.0337e-04 - mean\_absolute\_error: 0.0078112/126 [=========================>....] - ETA: 0s - loss: 1.0136e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0111e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 9.3721e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0617e-05 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 8.3430e-05 - mean\_absolute\_error: 0.0069 49/126 [==========>...................] - ETA: 0s - loss: 1.1115e-04 - mean\_absolute\_error: 0.0081 74/126 [================>.............] - ETA: 0s - loss: 1.2064e-04 - mean\_absolute\_error: 0.0085 99/126 [======================>.......] - ETA: 0s - loss: 1.1842e-04 - mean\_absolute\_error: 0.0084121/126 [===========================>..] - ETA: 0s - loss: 1.1300e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1090e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 9.2142e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5083e-05 - mean\_absolute\_error: 0.0067 18/126 [===>..........................] - ETA: 0s - loss: 8.0127e-05 - mean\_absolute\_error: 0.0068 37/126 [=======>......................] - ETA: 0s - loss: 9.1942e-05 - mean\_absolute\_error: 0.0073 58/126 [============>.................] - ETA: 0s - loss: 1.1636e-04 - mean\_absolute\_error: 0.0083 74/126 [================>.............] - ETA: 0s - loss: 1.2432e-04 - mean\_absolute\_error: 0.0087 94/126 [=====================>........] - ETA: 0s - loss: 1.1533e-04 - mean\_absolute\_error: 0.0083116/126 [==========================>...] - ETA: 0s - loss: 1.1216e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.0918e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 9.1180e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2807e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 8.1457e-05 - mean\_absolute\_error: 0.0068 48/126 [==========>...................] - ETA: 0s - loss: 1.0074e-04 - mean\_absolute\_error: 0.0075 72/126 [================>.............] - ETA: 0s - loss: 1.1311e-04 - mean\_absolute\_error: 0.0081 94/126 [=====================>........] - ETA: 0s - loss: 1.1710e-04 - mean\_absolute\_error: 0.0083118/126 [===========================>..] - ETA: 0s - loss: 1.1190e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.0997e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 9.7646e-05 - val\_mean\_absolute\_error: 0.0077

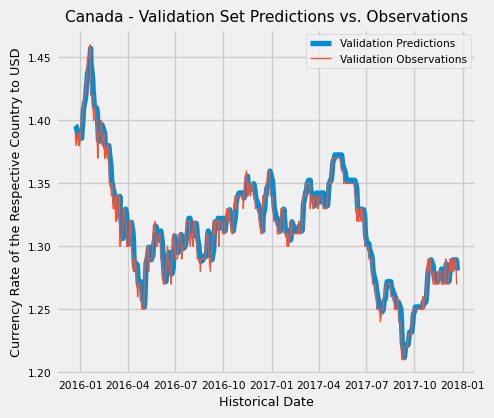
<keras.src.callbacks.History at 0x253ba835e50>

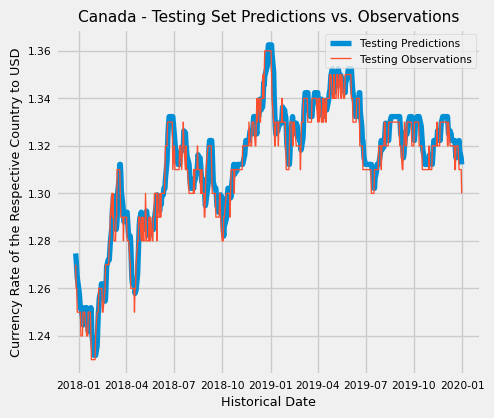
After the training and fitting of the Machine Learning model for Canada, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue 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: 50s 36/126 [=======>......................] - ETA: 0s 75/126 [================>.............] - ETA: 0s110/126 [=========================>....] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 3ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

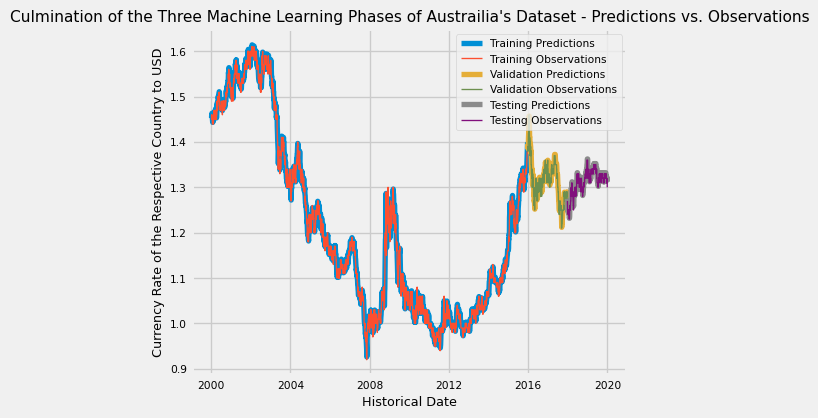






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

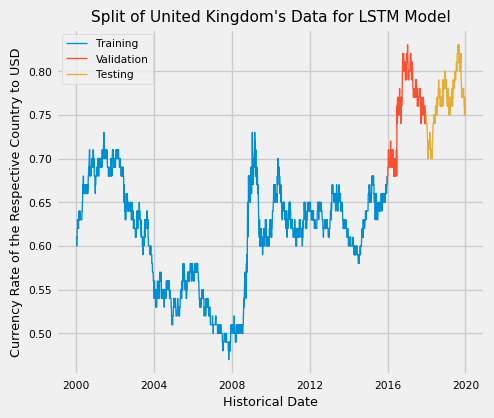
```{python}  
# Plotting Canada's observational (reference) data with the predictions of its   
# Machine Learning Model (as a way to visually inspect the effectiveness of the   
# model)   
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4)  
plt.plot(dates\_canada\_train, y\_canada\_train, 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)  
```

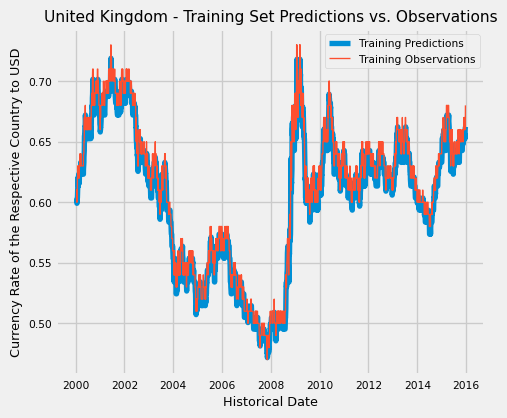
Epoch 1/100  
 1/126 [..............................] - ETA: 3:29 - loss: 0.3776 - mean\_absolute\_error: 0.6115 19/126 [===>..........................] - ETA: 0s - loss: 0.2258 - mean\_absolute\_error: 0.4632 43/126 [=========>....................] - ETA: 0s - loss: 0.1098 - mean\_absolute\_error: 0.2674 67/126 [==============>...............] - ETA: 0s - loss: 0.0711 - mean\_absolute\_error: 0.1839 91/126 [====================>.........] - ETA: 0s - loss: 0.0525 - mean\_absolute\_error: 0.1413116/126 [==========================>...] - ETA: 0s - loss: 0.0414 - mean\_absolute\_error: 0.1156126/126 [==============================] - 2s 5ms/step - loss: 0.0383 - mean\_absolute\_error: 0.1086 - val\_loss: 0.0044 - val\_mean\_absolute\_error: 0.0635  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1235e-04 - mean\_absolute\_error: 0.0233 21/126 [====>.........................] - ETA: 0s - loss: 6.7734e-04 - mean\_absolute\_error: 0.0213 43/126 [=========>....................] - ETA: 0s - loss: 6.8350e-04 - mean\_absolute\_error: 0.0213 59/126 [=============>................] - ETA: 0s - loss: 6.7491e-04 - mean\_absolute\_error: 0.0214 71/126 [===============>..............] - ETA: 0s - loss: 6.6948e-04 - mean\_absolute\_error: 0.0211 87/126 [===================>..........] - ETA: 0s - loss: 6.6050e-04 - mean\_absolute\_error: 0.0209108/126 [========================>.....] - ETA: 0s - loss: 6.3943e-04 - mean\_absolute\_error: 0.0205126/126 [==============================] - 0s 3ms/step - loss: 6.2844e-04 - mean\_absolute\_error: 0.0204 - val\_loss: 0.0034 - val\_mean\_absolute\_error: 0.0556  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0539e-04 - mean\_absolute\_error: 0.0212 18/126 [===>..........................] - ETA: 0s - loss: 5.6222e-04 - mean\_absolute\_error: 0.0195 40/126 [========>.....................] - ETA: 0s - loss: 5.2801e-04 - mean\_absolute\_error: 0.0186 63/126 [==============>...............] - ETA: 0s - loss: 5.1364e-04 - mean\_absolute\_error: 0.0183 84/126 [===================>..........] - ETA: 0s - loss: 4.9634e-04 - mean\_absolute\_error: 0.0181105/126 [========================>.....] - ETA: 0s - loss: 4.8338e-04 - mean\_absolute\_error: 0.0178126/126 [==============================] - 0s 3ms/step - loss: 4.7149e-04 - mean\_absolute\_error: 0.0176 - val\_loss: 0.0018 - val\_mean\_absolute\_error: 0.0403  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9255e-04 - mean\_absolute\_error: 0.0176 21/126 [====>.........................] - ETA: 0s - loss: 3.6275e-04 - mean\_absolute\_error: 0.0154 44/126 [=========>....................] - ETA: 0s - loss: 3.6702e-04 - mean\_absolute\_error: 0.0155 67/126 [==============>...............] - ETA: 0s - loss: 3.5116e-04 - mean\_absolute\_error: 0.0152 91/126 [====================>.........] - ETA: 0s - loss: 3.3267e-04 - mean\_absolute\_error: 0.0148115/126 [==========================>...] - ETA: 0s - loss: 3.1526e-04 - mean\_absolute\_error: 0.0143126/126 [==============================] - 0s 3ms/step - loss: 3.1071e-04 - mean\_absolute\_error: 0.0142 - val\_loss: 0.0011 - val\_mean\_absolute\_error: 0.0318  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1666e-04 - mean\_absolute\_error: 0.0106 23/126 [====>.........................] - ETA: 0s - loss: 2.1696e-04 - mean\_absolute\_error: 0.0119 48/126 [==========>...................] - ETA: 0s - loss: 2.0110e-04 - mean\_absolute\_error: 0.0114 73/126 [================>.............] - ETA: 0s - loss: 1.9507e-04 - mean\_absolute\_error: 0.0113 97/126 [======================>.......] - ETA: 0s - loss: 1.8764e-04 - mean\_absolute\_error: 0.0110121/126 [===========================>..] - ETA: 0s - loss: 1.7801e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 2ms/step - loss: 1.7728e-04 - mean\_absolute\_error: 0.0107 - val\_loss: 6.4130e-04 - val\_mean\_absolute\_error: 0.0236  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5932e-04 - mean\_absolute\_error: 0.0109 20/126 [===>..........................] - ETA: 0s - loss: 1.1953e-04 - mean\_absolute\_error: 0.0087 40/126 [========>.....................] - ETA: 0s - loss: 1.1566e-04 - mean\_absolute\_error: 0.0086 62/126 [=============>................] - ETA: 0s - loss: 1.1035e-04 - mean\_absolute\_error: 0.0083 85/126 [===================>..........] - ETA: 0s - loss: 1.0277e-04 - mean\_absolute\_error: 0.0080107/126 [========================>.....] - ETA: 0s - loss: 9.7945e-05 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 9.4643e-05 - mean\_absolute\_error: 0.0077 - val\_loss: 1.3503e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3788e-05 - mean\_absolute\_error: 0.0076 22/126 [====>.........................] - ETA: 0s - loss: 6.5107e-05 - mean\_absolute\_error: 0.0063 44/126 [=========>....................] - ETA: 0s - loss: 6.3517e-05 - mean\_absolute\_error: 0.0062 66/126 [==============>...............] - ETA: 0s - loss: 6.0649e-05 - mean\_absolute\_error: 0.0061 88/126 [===================>..........] - ETA: 0s - loss: 5.8220e-05 - mean\_absolute\_error: 0.0060110/126 [=========================>....] - ETA: 0s - loss: 5.4824e-05 - mean\_absolute\_error: 0.0058126/126 [==============================] - 0s 3ms/step - loss: 5.4556e-05 - mean\_absolute\_error: 0.0057 - val\_loss: 9.2552e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7401e-05 - mean\_absolute\_error: 0.0067 23/126 [====>.........................] - ETA: 0s - loss: 4.7880e-05 - mean\_absolute\_error: 0.0053 45/126 [=========>....................] - ETA: 0s - loss: 4.3989e-05 - mean\_absolute\_error: 0.0050 66/126 [==============>...............] - ETA: 0s - loss: 4.1765e-05 - mean\_absolute\_error: 0.0049 87/126 [===================>..........] - ETA: 0s - loss: 4.1629e-05 - mean\_absolute\_error: 0.0048110/126 [=========================>....] - ETA: 0s - loss: 4.0211e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9508e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 8.0288e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7462e-05 - mean\_absolute\_error: 0.0038 17/126 [===>..........................] - ETA: 0s - loss: 3.0017e-05 - mean\_absolute\_error: 0.0039 40/126 [========>.....................] - ETA: 0s - loss: 3.1131e-05 - mean\_absolute\_error: 0.0040 62/126 [=============>................] - ETA: 0s - loss: 3.3428e-05 - mean\_absolute\_error: 0.0041 85/126 [===================>..........] - ETA: 0s - loss: 3.4937e-05 - mean\_absolute\_error: 0.0042109/126 [========================>.....] - ETA: 0s - loss: 3.4993e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.5339e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 7.5329e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0689e-05 - mean\_absolute\_error: 0.0043 19/126 [===>..........................] - ETA: 0s - loss: 3.9462e-05 - mean\_absolute\_error: 0.0043 41/126 [========>.....................] - ETA: 0s - loss: 3.8984e-05 - mean\_absolute\_error: 0.0044 63/126 [==============>...............] - ETA: 0s - loss: 3.7605e-05 - mean\_absolute\_error: 0.0043 85/126 [===================>..........] - ETA: 0s - loss: 3.6262e-05 - mean\_absolute\_error: 0.0043110/126 [=========================>....] - ETA: 0s - loss: 3.6436e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5692e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.3650e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4611e-05 - mean\_absolute\_error: 0.0058 23/126 [====>.........................] - ETA: 0s - loss: 3.8571e-05 - mean\_absolute\_error: 0.0043 47/126 [==========>...................] - ETA: 0s - loss: 3.6227e-05 - mean\_absolute\_error: 0.0043 70/126 [===============>..............] - ETA: 0s - loss: 3.7549e-05 - mean\_absolute\_error: 0.0044 92/126 [====================>.........] - ETA: 0s - loss: 3.6968e-05 - mean\_absolute\_error: 0.0044117/126 [==========================>...] - ETA: 0s - loss: 3.6582e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6459e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 9.0199e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4346e-05 - mean\_absolute\_error: 0.0043 18/126 [===>..........................] - ETA: 0s - loss: 3.4694e-05 - mean\_absolute\_error: 0.0043 34/126 [=======>......................] - ETA: 0s - loss: 3.6736e-05 - mean\_absolute\_error: 0.0043 55/126 [============>.................] - ETA: 0s - loss: 3.6309e-05 - mean\_absolute\_error: 0.0043 77/126 [=================>............] - ETA: 0s - loss: 3.6383e-05 - mean\_absolute\_error: 0.0043 99/126 [======================>.......] - ETA: 0s - loss: 3.6262e-05 - mean\_absolute\_error: 0.0043122/126 [============================>.] - ETA: 0s - loss: 3.6261e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.6062e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 9.5043e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9640e-05 - mean\_absolute\_error: 0.0049 22/126 [====>.........................] - ETA: 0s - loss: 3.9607e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.6510e-05 - mean\_absolute\_error: 0.0043 70/126 [===============>..............] - ETA: 0s - loss: 3.6259e-05 - mean\_absolute\_error: 0.0042 92/126 [====================>.........] - ETA: 0s - loss: 3.7699e-05 - mean\_absolute\_error: 0.0044114/126 [==========================>...] - ETA: 0s - loss: 3.6541e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6494e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 9.1533e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6195e-05 - mean\_absolute\_error: 0.0038 23/126 [====>.........................] - ETA: 0s - loss: 3.1849e-05 - mean\_absolute\_error: 0.0042 46/126 [=========>....................] - ETA: 0s - loss: 3.2684e-05 - mean\_absolute\_error: 0.0041 69/126 [===============>..............] - ETA: 0s - loss: 3.5083e-05 - mean\_absolute\_error: 0.0043 91/126 [====================>.........] - ETA: 0s - loss: 3.5939e-05 - mean\_absolute\_error: 0.0043115/126 [==========================>...] - ETA: 0s - loss: 3.6040e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6821e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.5822e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1990e-05 - mean\_absolute\_error: 0.0035 20/126 [===>..........................] - ETA: 0s - loss: 3.3682e-05 - mean\_absolute\_error: 0.0042 42/126 [=========>....................] - ETA: 0s - loss: 3.3955e-05 - mean\_absolute\_error: 0.0042 66/126 [==============>...............] - ETA: 0s - loss: 3.5052e-05 - mean\_absolute\_error: 0.0043 90/126 [====================>.........] - ETA: 0s - loss: 3.5624e-05 - mean\_absolute\_error: 0.0043114/126 [==========================>...] - ETA: 0s - loss: 3.5272e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.5595e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 8.3686e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3929e-05 - mean\_absolute\_error: 0.0036 19/126 [===>..........................] - ETA: 0s - loss: 3.9267e-05 - mean\_absolute\_error: 0.0048 40/126 [========>.....................] - ETA: 0s - loss: 3.8276e-05 - mean\_absolute\_error: 0.0046 64/126 [==============>...............] - ETA: 0s - loss: 3.6500e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.5905e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.6110e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.6287e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.5890e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0413e-05 - mean\_absolute\_error: 0.0033 20/126 [===>..........................] - ETA: 0s - loss: 3.4976e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.6074e-05 - mean\_absolute\_error: 0.0042 60/126 [=============>................] - ETA: 0s - loss: 3.5390e-05 - mean\_absolute\_error: 0.0042 79/126 [=================>............] - ETA: 0s - loss: 3.5797e-05 - mean\_absolute\_error: 0.0042102/126 [=======================>......] - ETA: 0s - loss: 3.5878e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.5463e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 8.1467e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7873e-05 - mean\_absolute\_error: 0.0048 22/126 [====>.........................] - ETA: 0s - loss: 4.4036e-05 - mean\_absolute\_error: 0.0049 43/126 [=========>....................] - ETA: 0s - loss: 4.2985e-05 - mean\_absolute\_error: 0.0049 65/126 [==============>...............] - ETA: 0s - loss: 4.2187e-05 - mean\_absolute\_error: 0.0049 88/126 [===================>..........] - ETA: 0s - loss: 3.9818e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.8550e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8031e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.0565e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2011e-05 - mean\_absolute\_error: 0.0045 22/126 [====>.........................] - ETA: 0s - loss: 4.1289e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.9587e-05 - mean\_absolute\_error: 0.0046 70/126 [===============>..............] - ETA: 0s - loss: 3.7074e-05 - mean\_absolute\_error: 0.0044 95/126 [=====================>........] - ETA: 0s - loss: 3.5484e-05 - mean\_absolute\_error: 0.0043118/126 [===========================>..] - ETA: 0s - loss: 3.5762e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5740e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.4062e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2116e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.8753e-05 - mean\_absolute\_error: 0.0048 40/126 [========>.....................] - ETA: 0s - loss: 4.2150e-05 - mean\_absolute\_error: 0.0049 51/126 [===========>..................] - ETA: 0s - loss: 4.1534e-05 - mean\_absolute\_error: 0.0049 64/126 [==============>...............] - ETA: 0s - loss: 4.0354e-05 - mean\_absolute\_error: 0.0048 78/126 [=================>............] - ETA: 0s - loss: 4.0895e-05 - mean\_absolute\_error: 0.0048 91/126 [====================>.........] - ETA: 0s - loss: 4.0241e-05 - mean\_absolute\_error: 0.0048107/126 [========================>.....] - ETA: 0s - loss: 4.0581e-05 - mean\_absolute\_error: 0.0048123/126 [============================>.] - ETA: 0s - loss: 3.9637e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 4ms/step - loss: 3.9520e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.3659e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8087e-05 - mean\_absolute\_error: 0.0048 17/126 [===>..........................] - ETA: 0s - loss: 4.4412e-05 - mean\_absolute\_error: 0.0049 38/126 [========>.....................] - ETA: 0s - loss: 3.7416e-05 - mean\_absolute\_error: 0.0046 59/126 [=============>................] - ETA: 0s - loss: 3.8003e-05 - mean\_absolute\_error: 0.0046 77/126 [=================>............] - ETA: 0s - loss: 3.7128e-05 - mean\_absolute\_error: 0.0046 95/126 [=====================>........] - ETA: 0s - loss: 3.8045e-05 - mean\_absolute\_error: 0.0046111/126 [=========================>....] - ETA: 0s - loss: 3.7946e-05 - mean\_absolute\_error: 0.0045121/126 [===========================>..] - ETA: 0s - loss: 3.8445e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 4ms/step - loss: 3.8198e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.6763e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3165e-05 - mean\_absolute\_error: 0.0043 13/126 [==>...........................] - ETA: 0s - loss: 3.5623e-05 - mean\_absolute\_error: 0.0044 25/126 [====>.........................] - ETA: 0s - loss: 3.3274e-05 - mean\_absolute\_error: 0.0042 37/126 [=======>......................] - ETA: 0s - loss: 3.5110e-05 - mean\_absolute\_error: 0.0042 50/126 [==========>...................] - ETA: 0s - loss: 3.4638e-05 - mean\_absolute\_error: 0.0042 60/126 [=============>................] - ETA: 0s - loss: 3.6098e-05 - mean\_absolute\_error: 0.0043 74/126 [================>.............] - ETA: 0s - loss: 3.5589e-05 - mean\_absolute\_error: 0.0043 88/126 [===================>..........] - ETA: 0s - loss: 3.5463e-05 - mean\_absolute\_error: 0.0043101/126 [=======================>......] - ETA: 0s - loss: 3.5275e-05 - mean\_absolute\_error: 0.0043114/126 [==========================>...] - ETA: 0s - loss: 3.5624e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 1s 5ms/step - loss: 3.6300e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 1.0132e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5079e-05 - mean\_absolute\_error: 0.0055 14/126 [==>...........................] - ETA: 0s - loss: 4.5540e-05 - mean\_absolute\_error: 0.0050 27/126 [=====>........................] - ETA: 0s - loss: 4.7783e-05 - mean\_absolute\_error: 0.0052 41/126 [========>.....................] - ETA: 0s - loss: 4.5330e-05 - mean\_absolute\_error: 0.0051 56/126 [============>.................] - ETA: 0s - loss: 4.2351e-05 - mean\_absolute\_error: 0.0048 72/126 [================>.............] - ETA: 0s - loss: 3.9809e-05 - mean\_absolute\_error: 0.0046 88/126 [===================>..........] - ETA: 0s - loss: 4.0063e-05 - mean\_absolute\_error: 0.0047107/126 [========================>.....] - ETA: 0s - loss: 3.9824e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 4ms/step - loss: 3.8768e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.5100e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8805e-05 - mean\_absolute\_error: 0.0027 22/126 [====>.........................] - ETA: 0s - loss: 3.4039e-05 - mean\_absolute\_error: 0.0042 40/126 [========>.....................] - ETA: 0s - loss: 3.4560e-05 - mean\_absolute\_error: 0.0043 59/126 [=============>................] - ETA: 0s - loss: 3.4025e-05 - mean\_absolute\_error: 0.0043 76/126 [=================>............] - ETA: 0s - loss: 3.3834e-05 - mean\_absolute\_error: 0.0042 93/126 [=====================>........] - ETA: 0s - loss: 3.4780e-05 - mean\_absolute\_error: 0.0043109/126 [========================>.....] - ETA: 0s - loss: 3.5108e-05 - mean\_absolute\_error: 0.0043123/126 [============================>.] - ETA: 0s - loss: 3.5842e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 4ms/step - loss: 3.6008e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 9.7354e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1584e-05 - mean\_absolute\_error: 0.0037 17/126 [===>..........................] - ETA: 0s - loss: 3.8844e-05 - mean\_absolute\_error: 0.0046 35/126 [=======>......................] - ETA: 0s - loss: 3.7124e-05 - mean\_absolute\_error: 0.0044 53/126 [===========>..................] - ETA: 0s - loss: 3.4861e-05 - mean\_absolute\_error: 0.0043 71/126 [===============>..............] - ETA: 0s - loss: 3.5977e-05 - mean\_absolute\_error: 0.0044 91/126 [====================>.........] - ETA: 0s - loss: 3.6284e-05 - mean\_absolute\_error: 0.0044111/126 [=========================>....] - ETA: 0s - loss: 3.8205e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8340e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.3113e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5261e-05 - mean\_absolute\_error: 0.0048 22/126 [====>.........................] - ETA: 0s - loss: 3.3323e-05 - mean\_absolute\_error: 0.0043 41/126 [========>.....................] - ETA: 0s - loss: 3.5418e-05 - mean\_absolute\_error: 0.0045 57/126 [============>.................] - ETA: 0s - loss: 3.5283e-05 - mean\_absolute\_error: 0.0044 73/126 [================>.............] - ETA: 0s - loss: 3.5920e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.5147e-05 - mean\_absolute\_error: 0.0044 97/126 [======================>.......] - ETA: 0s - loss: 3.5898e-05 - mean\_absolute\_error: 0.0044111/126 [=========================>....] - ETA: 0s - loss: 3.6388e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - ETA: 0s - loss: 3.7031e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 4ms/step - loss: 3.7031e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 1.4860e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6717e-05 - mean\_absolute\_error: 0.0059 16/126 [==>...........................] - ETA: 0s - loss: 3.5010e-05 - mean\_absolute\_error: 0.0044 26/126 [=====>........................] - ETA: 0s - loss: 3.9716e-05 - mean\_absolute\_error: 0.0046 37/126 [=======>......................] - ETA: 0s - loss: 3.6737e-05 - mean\_absolute\_error: 0.0044 50/126 [==========>...................] - ETA: 0s - loss: 3.4865e-05 - mean\_absolute\_error: 0.0043 63/126 [==============>...............] - ETA: 0s - loss: 3.6794e-05 - mean\_absolute\_error: 0.0044 76/126 [=================>............] - ETA: 0s - loss: 3.7651e-05 - mean\_absolute\_error: 0.0044 86/126 [===================>..........] - ETA: 0s - loss: 3.6870e-05 - mean\_absolute\_error: 0.0044 98/126 [======================>.......] - ETA: 0s - loss: 3.8760e-05 - mean\_absolute\_error: 0.0045108/126 [========================>.....] - ETA: 0s - loss: 3.8874e-05 - mean\_absolute\_error: 0.0046118/126 [===========================>..] - ETA: 0s - loss: 3.8899e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 1s 5ms/step - loss: 3.9357e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 1.2191e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1516e-05 - mean\_absolute\_error: 0.0052 13/126 [==>...........................] - ETA: 0s - loss: 5.0620e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 4.7435e-05 - mean\_absolute\_error: 0.0053 38/126 [========>.....................] - ETA: 0s - loss: 4.7037e-05 - mean\_absolute\_error: 0.0052 49/126 [==========>...................] - ETA: 0s - loss: 4.5860e-05 - mean\_absolute\_error: 0.0052 59/126 [=============>................] - ETA: 0s - loss: 4.5199e-05 - mean\_absolute\_error: 0.0052 68/126 [===============>..............] - ETA: 0s - loss: 4.3740e-05 - mean\_absolute\_error: 0.0051 78/126 [=================>............] - ETA: 0s - loss: 4.1906e-05 - mean\_absolute\_error: 0.0049 87/126 [===================>..........] - ETA: 0s - loss: 4.0952e-05 - mean\_absolute\_error: 0.0048 98/126 [======================>.......] - ETA: 0s - loss: 4.0485e-05 - mean\_absolute\_error: 0.0048108/126 [========================>.....] - ETA: 0s - loss: 3.9963e-05 - mean\_absolute\_error: 0.0048121/126 [===========================>..] - ETA: 0s - loss: 4.0192e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 1s 5ms/step - loss: 4.0356e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.8081e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4751e-05 - mean\_absolute\_error: 0.0043 13/126 [==>...........................] - ETA: 0s - loss: 4.0430e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 4.1825e-05 - mean\_absolute\_error: 0.0051 36/126 [=======>......................] - ETA: 0s - loss: 3.8744e-05 - mean\_absolute\_error: 0.0049 48/126 [==========>...................] - ETA: 0s - loss: 4.0068e-05 - mean\_absolute\_error: 0.0049 60/126 [=============>................] - ETA: 0s - loss: 4.1320e-05 - mean\_absolute\_error: 0.0049 74/126 [================>.............] - ETA: 0s - loss: 4.1233e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 3.9306e-05 - mean\_absolute\_error: 0.0047103/126 [=======================>......] - ETA: 0s - loss: 4.0312e-05 - mean\_absolute\_error: 0.0048117/126 [==========================>...] - ETA: 0s - loss: 3.9587e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 1s 5ms/step - loss: 3.9809e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.2471e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6610e-05 - mean\_absolute\_error: 0.0045 13/126 [==>...........................] - ETA: 0s - loss: 3.6929e-05 - mean\_absolute\_error: 0.0046 25/126 [====>.........................] - ETA: 0s - loss: 4.0445e-05 - mean\_absolute\_error: 0.0046 37/126 [=======>......................] - ETA: 0s - loss: 4.1219e-05 - mean\_absolute\_error: 0.0047 51/126 [===========>..................] - ETA: 0s - loss: 4.1065e-05 - mean\_absolute\_error: 0.0047 66/126 [==============>...............] - ETA: 0s - loss: 3.8889e-05 - mean\_absolute\_error: 0.0045 82/126 [==================>...........] - ETA: 0s - loss: 3.8266e-05 - mean\_absolute\_error: 0.0045 98/126 [======================>.......] - ETA: 0s - loss: 3.7716e-05 - mean\_absolute\_error: 0.0045111/126 [=========================>....] - ETA: 0s - loss: 3.7272e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 1s 4ms/step - loss: 3.9331e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.2875e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5672e-05 - mean\_absolute\_error: 0.0058 16/126 [==>...........................] - ETA: 0s - loss: 4.9697e-05 - mean\_absolute\_error: 0.0054 32/126 [======>.......................] - ETA: 0s - loss: 4.5042e-05 - mean\_absolute\_error: 0.0050 47/126 [==========>...................] - ETA: 0s - loss: 4.3223e-05 - mean\_absolute\_error: 0.0050 61/126 [=============>................] - ETA: 0s - loss: 4.4939e-05 - mean\_absolute\_error: 0.0051 73/126 [================>.............] - ETA: 0s - loss: 4.2731e-05 - mean\_absolute\_error: 0.0049 85/126 [===================>..........] - ETA: 0s - loss: 4.2009e-05 - mean\_absolute\_error: 0.0048 99/126 [======================>.......] - ETA: 0s - loss: 4.0653e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 4.0028e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 1s 4ms/step - loss: 3.9492e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.0762e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4679e-05 - mean\_absolute\_error: 0.0053 15/126 [==>...........................] - ETA: 0s - loss: 3.8004e-05 - mean\_absolute\_error: 0.0046 26/126 [=====>........................] - ETA: 0s - loss: 3.5518e-05 - mean\_absolute\_error: 0.0044 40/126 [========>.....................] - ETA: 0s - loss: 3.4005e-05 - mean\_absolute\_error: 0.0043 55/126 [============>.................] - ETA: 0s - loss: 3.6243e-05 - mean\_absolute\_error: 0.0045 72/126 [================>.............] - ETA: 0s - loss: 4.1024e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 3.9568e-05 - mean\_absolute\_error: 0.0047103/126 [=======================>......] - ETA: 0s - loss: 3.9356e-05 - mean\_absolute\_error: 0.0047118/126 [===========================>..] - ETA: 0s - loss: 3.9636e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 4ms/step - loss: 3.9654e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 9.1361e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1589e-05 - mean\_absolute\_error: 0.0045 14/126 [==>...........................] - ETA: 0s - loss: 3.4952e-05 - mean\_absolute\_error: 0.0045 29/126 [=====>........................] - ETA: 0s - loss: 4.2497e-05 - mean\_absolute\_error: 0.0049 48/126 [==========>...................] - ETA: 0s - loss: 3.9853e-05 - mean\_absolute\_error: 0.0047 62/126 [=============>................] - ETA: 0s - loss: 3.8738e-05 - mean\_absolute\_error: 0.0046 76/126 [=================>............] - ETA: 0s - loss: 4.1703e-05 - mean\_absolute\_error: 0.0049 92/126 [====================>.........] - ETA: 0s - loss: 4.3436e-05 - mean\_absolute\_error: 0.0049108/126 [========================>.....] - ETA: 0s - loss: 4.1899e-05 - mean\_absolute\_error: 0.0049125/126 [============================>.] - ETA: 0s - loss: 4.0659e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 4ms/step - loss: 4.0600e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.1382e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7983e-05 - mean\_absolute\_error: 0.0040 17/126 [===>..........................] - ETA: 0s - loss: 3.8280e-05 - mean\_absolute\_error: 0.0045 35/126 [=======>......................] - ETA: 0s - loss: 3.9894e-05 - mean\_absolute\_error: 0.0046 54/126 [===========>..................] - ETA: 0s - loss: 3.7350e-05 - mean\_absolute\_error: 0.0045 71/126 [===============>..............] - ETA: 0s - loss: 3.8236e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.9067e-05 - mean\_absolute\_error: 0.0046106/126 [========================>.....] - ETA: 0s - loss: 3.8417e-05 - mean\_absolute\_error: 0.0045124/126 [============================>.] - ETA: 0s - loss: 3.7881e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7864e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 8.3192e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5503e-05 - mean\_absolute\_error: 0.0057 18/126 [===>..........................] - ETA: 0s - loss: 4.4531e-05 - mean\_absolute\_error: 0.0051 37/126 [=======>......................] - ETA: 0s - loss: 4.9792e-05 - mean\_absolute\_error: 0.0055 55/126 [============>.................] - ETA: 0s - loss: 4.8184e-05 - mean\_absolute\_error: 0.0054 74/126 [================>.............] - ETA: 0s - loss: 4.5916e-05 - mean\_absolute\_error: 0.0051 93/126 [=====================>........] - ETA: 0s - loss: 4.4527e-05 - mean\_absolute\_error: 0.0051111/126 [=========================>....] - ETA: 0s - loss: 4.4149e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2969e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 8.4598e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4950e-05 - mean\_absolute\_error: 0.0036 14/126 [==>...........................] - ETA: 0s - loss: 4.4682e-05 - mean\_absolute\_error: 0.0049 28/126 [=====>........................] - ETA: 0s - loss: 4.7983e-05 - mean\_absolute\_error: 0.0052 44/126 [=========>....................] - ETA: 0s - loss: 4.2206e-05 - mean\_absolute\_error: 0.0048 62/126 [=============>................] - ETA: 0s - loss: 4.2210e-05 - mean\_absolute\_error: 0.0049 77/126 [=================>............] - ETA: 0s - loss: 4.2593e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.1546e-05 - mean\_absolute\_error: 0.0048111/126 [=========================>....] - ETA: 0s - loss: 4.0628e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 4ms/step - loss: 4.0385e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.2182e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 9.2956e-05 - mean\_absolute\_error: 0.0065 24/126 [====>.........................] - ETA: 0s - loss: 4.4555e-05 - mean\_absolute\_error: 0.0051 49/126 [==========>...................] - ETA: 0s - loss: 4.3059e-05 - mean\_absolute\_error: 0.0050 70/126 [===============>..............] - ETA: 0s - loss: 4.2280e-05 - mean\_absolute\_error: 0.0049 88/126 [===================>..........] - ETA: 0s - loss: 4.1720e-05 - mean\_absolute\_error: 0.0049102/126 [=======================>......] - ETA: 0s - loss: 4.1363e-05 - mean\_absolute\_error: 0.0049119/126 [===========================>..] - ETA: 0s - loss: 4.0010e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1054e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 1.8703e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3746e-05 - mean\_absolute\_error: 0.0085 20/126 [===>..........................] - ETA: 0s - loss: 5.3540e-05 - mean\_absolute\_error: 0.0059 37/126 [=======>......................] - ETA: 0s - loss: 5.0458e-05 - mean\_absolute\_error: 0.0057 56/126 [============>.................] - ETA: 0s - loss: 4.6938e-05 - mean\_absolute\_error: 0.0053 70/126 [===============>..............] - ETA: 0s - loss: 4.5786e-05 - mean\_absolute\_error: 0.0052 86/126 [===================>..........] - ETA: 0s - loss: 4.4299e-05 - mean\_absolute\_error: 0.0051105/126 [========================>.....] - ETA: 0s - loss: 4.3753e-05 - mean\_absolute\_error: 0.0050121/126 [===========================>..] - ETA: 0s - loss: 4.3062e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2980e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 1.1635e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2853e-05 - mean\_absolute\_error: 0.0044 17/126 [===>..........................] - ETA: 0s - loss: 4.5950e-05 - mean\_absolute\_error: 0.0053 35/126 [=======>......................] - ETA: 0s - loss: 3.8339e-05 - mean\_absolute\_error: 0.0046 52/126 [===========>..................] - ETA: 0s - loss: 3.7487e-05 - mean\_absolute\_error: 0.0046 70/126 [===============>..............] - ETA: 0s - loss: 3.8778e-05 - mean\_absolute\_error: 0.0047 88/126 [===================>..........] - ETA: 0s - loss: 3.8886e-05 - mean\_absolute\_error: 0.0047109/126 [========================>.....] - ETA: 0s - loss: 3.9603e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1129e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.6920e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0222e-05 - mean\_absolute\_error: 0.0044 19/126 [===>..........................] - ETA: 0s - loss: 4.8618e-05 - mean\_absolute\_error: 0.0055 34/126 [=======>......................] - ETA: 0s - loss: 4.7410e-05 - mean\_absolute\_error: 0.0053 52/126 [===========>..................] - ETA: 0s - loss: 5.1110e-05 - mean\_absolute\_error: 0.0056 71/126 [===============>..............] - ETA: 0s - loss: 4.7933e-05 - mean\_absolute\_error: 0.0054 93/126 [=====================>........] - ETA: 0s - loss: 4.5959e-05 - mean\_absolute\_error: 0.0052114/126 [==========================>...] - ETA: 0s - loss: 4.4558e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.4326e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 8.8432e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0557e-05 - mean\_absolute\_error: 0.0051 24/126 [====>.........................] - ETA: 0s - loss: 3.9034e-05 - mean\_absolute\_error: 0.0048 47/126 [==========>...................] - ETA: 0s - loss: 4.0298e-05 - mean\_absolute\_error: 0.0048 63/126 [==============>...............] - ETA: 0s - loss: 4.1627e-05 - mean\_absolute\_error: 0.0049 79/126 [=================>............] - ETA: 0s - loss: 4.0529e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 3.9741e-05 - mean\_absolute\_error: 0.0047114/126 [==========================>...] - ETA: 0s - loss: 3.8637e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8585e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.6815e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1444e-05 - mean\_absolute\_error: 0.0052 22/126 [====>.........................] - ETA: 0s - loss: 4.2059e-05 - mean\_absolute\_error: 0.0050 42/126 [=========>....................] - ETA: 0s - loss: 4.2135e-05 - mean\_absolute\_error: 0.0049 65/126 [==============>...............] - ETA: 0s - loss: 4.1697e-05 - mean\_absolute\_error: 0.0049 87/126 [===================>..........] - ETA: 0s - loss: 4.4223e-05 - mean\_absolute\_error: 0.0050109/126 [========================>.....] - ETA: 0s - loss: 4.1956e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0705e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.1119e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9945e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.7792e-05 - mean\_absolute\_error: 0.0045 48/126 [==========>...................] - ETA: 0s - loss: 3.9913e-05 - mean\_absolute\_error: 0.0047 69/126 [===============>..............] - ETA: 0s - loss: 4.1979e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.1430e-05 - mean\_absolute\_error: 0.0049115/126 [==========================>...] - ETA: 0s - loss: 3.9936e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.1249e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 1.1136e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0477e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 3.8330e-05 - mean\_absolute\_error: 0.0046 47/126 [==========>...................] - ETA: 0s - loss: 4.0452e-05 - mean\_absolute\_error: 0.0047 68/126 [===============>..............] - ETA: 0s - loss: 3.9006e-05 - mean\_absolute\_error: 0.0046 87/126 [===================>..........] - ETA: 0s - loss: 3.9025e-05 - mean\_absolute\_error: 0.0047110/126 [=========================>....] - ETA: 0s - loss: 4.2090e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1642e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.5691e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3744e-05 - mean\_absolute\_error: 0.0045 25/126 [====>.........................] - ETA: 0s - loss: 3.8687e-05 - mean\_absolute\_error: 0.0046 48/126 [==========>...................] - ETA: 0s - loss: 3.8249e-05 - mean\_absolute\_error: 0.0046 71/126 [===============>..............] - ETA: 0s - loss: 4.0065e-05 - mean\_absolute\_error: 0.0048 95/126 [=====================>........] - ETA: 0s - loss: 4.2163e-05 - mean\_absolute\_error: 0.0049120/126 [===========================>..] - ETA: 0s - loss: 4.0935e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0389e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.3889e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9041e-05 - mean\_absolute\_error: 0.0037 17/126 [===>..........................] - ETA: 0s - loss: 3.6165e-05 - mean\_absolute\_error: 0.0045 37/126 [=======>......................] - ETA: 0s - loss: 3.3620e-05 - mean\_absolute\_error: 0.0042 57/126 [============>.................] - ETA: 0s - loss: 3.3174e-05 - mean\_absolute\_error: 0.0042 78/126 [=================>............] - ETA: 0s - loss: 3.5010e-05 - mean\_absolute\_error: 0.0043 99/126 [======================>.......] - ETA: 0s - loss: 3.6554e-05 - mean\_absolute\_error: 0.0044120/126 [===========================>..] - ETA: 0s - loss: 3.9927e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0075e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 8.1149e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 4.2572e-05 - mean\_absolute\_error: 0.0053 24/126 [====>.........................] - ETA: 0s - loss: 3.4900e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 3.6149e-05 - mean\_absolute\_error: 0.0044 66/126 [==============>...............] - ETA: 0s - loss: 3.6280e-05 - mean\_absolute\_error: 0.0045 89/126 [====================>.........] - ETA: 0s - loss: 3.7344e-05 - mean\_absolute\_error: 0.0045111/126 [=========================>....] - ETA: 0s - loss: 3.7311e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8024e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.5534e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5691e-05 - mean\_absolute\_error: 0.0051 21/126 [====>.........................] - ETA: 0s - loss: 4.3943e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 5.3151e-05 - mean\_absolute\_error: 0.0057 68/126 [===============>..............] - ETA: 0s - loss: 4.9587e-05 - mean\_absolute\_error: 0.0055 92/126 [====================>.........] - ETA: 0s - loss: 4.9146e-05 - mean\_absolute\_error: 0.0055115/126 [==========================>...] - ETA: 0s - loss: 4.6970e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 4.5690e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 7.2636e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6593e-05 - mean\_absolute\_error: 0.0053 20/126 [===>..........................] - ETA: 0s - loss: 4.6155e-05 - mean\_absolute\_error: 0.0054 42/126 [=========>....................] - ETA: 0s - loss: 4.3632e-05 - mean\_absolute\_error: 0.0051 58/126 [============>.................] - ETA: 0s - loss: 4.2338e-05 - mean\_absolute\_error: 0.0050 74/126 [================>.............] - ETA: 0s - loss: 4.0703e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 4.0699e-05 - mean\_absolute\_error: 0.0048104/126 [=======================>......] - ETA: 0s - loss: 3.9870e-05 - mean\_absolute\_error: 0.0047121/126 [===========================>..] - ETA: 0s - loss: 3.8887e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.9130e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.1152e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5303e-05 - mean\_absolute\_error: 0.0041 15/126 [==>...........................] - ETA: 0s - loss: 4.0016e-05 - mean\_absolute\_error: 0.0048 30/126 [======>.......................] - ETA: 0s - loss: 3.8633e-05 - mean\_absolute\_error: 0.0048 47/126 [==========>...................] - ETA: 0s - loss: 3.9292e-05 - mean\_absolute\_error: 0.0049 64/126 [==============>...............] - ETA: 0s - loss: 3.9509e-05 - mean\_absolute\_error: 0.0048 83/126 [==================>...........] - ETA: 0s - loss: 4.0252e-05 - mean\_absolute\_error: 0.0049100/126 [======================>.......] - ETA: 0s - loss: 3.9859e-05 - mean\_absolute\_error: 0.0049121/126 [===========================>..] - ETA: 0s - loss: 4.0978e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1125e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.8238e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 51/100  
 1/126 [..............................] - ETA: 1s - loss: 4.7483e-05 - mean\_absolute\_error: 0.0048 12/126 [=>............................] - ETA: 0s - loss: 4.1495e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.7973e-05 - mean\_absolute\_error: 0.0046 34/126 [=======>......................] - ETA: 0s - loss: 4.1617e-05 - mean\_absolute\_error: 0.0049 47/126 [==========>...................] - ETA: 0s - loss: 4.2392e-05 - mean\_absolute\_error: 0.0049 61/126 [=============>................] - ETA: 0s - loss: 4.2766e-05 - mean\_absolute\_error: 0.0049 74/126 [================>.............] - ETA: 0s - loss: 4.3668e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.3768e-05 - mean\_absolute\_error: 0.0050108/126 [========================>.....] - ETA: 0s - loss: 4.2504e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - ETA: 0s - loss: 4.2185e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 1s 4ms/step - loss: 4.2185e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.7428e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3515e-05 - mean\_absolute\_error: 0.0043 20/126 [===>..........................] - ETA: 0s - loss: 2.8534e-05 - mean\_absolute\_error: 0.0039 38/126 [========>.....................] - ETA: 0s - loss: 3.2159e-05 - mean\_absolute\_error: 0.0042 56/126 [============>.................] - ETA: 0s - loss: 3.8245e-05 - mean\_absolute\_error: 0.0046 76/126 [=================>............] - ETA: 0s - loss: 3.6428e-05 - mean\_absolute\_error: 0.0045 99/126 [======================>.......] - ETA: 0s - loss: 3.9625e-05 - mean\_absolute\_error: 0.0047122/126 [============================>.] - ETA: 0s - loss: 4.0670e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0485e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.6914e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0404e-05 - mean\_absolute\_error: 0.0044 21/126 [====>.........................] - ETA: 0s - loss: 3.7891e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 3.8845e-05 - mean\_absolute\_error: 0.0046 69/126 [===============>..............] - ETA: 0s - loss: 3.7659e-05 - mean\_absolute\_error: 0.0045 91/126 [====================>.........] - ETA: 0s - loss: 3.8038e-05 - mean\_absolute\_error: 0.0046107/126 [========================>.....] - ETA: 0s - loss: 3.8304e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - ETA: 0s - loss: 3.7732e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7732e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.0053e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1024e-05 - mean\_absolute\_error: 0.0053 19/126 [===>..........................] - ETA: 0s - loss: 4.2624e-05 - mean\_absolute\_error: 0.0050 42/126 [=========>....................] - ETA: 0s - loss: 4.3826e-05 - mean\_absolute\_error: 0.0051 64/126 [==============>...............] - ETA: 0s - loss: 4.1229e-05 - mean\_absolute\_error: 0.0049 82/126 [==================>...........] - ETA: 0s - loss: 4.3154e-05 - mean\_absolute\_error: 0.0050101/126 [=======================>......] - ETA: 0s - loss: 4.3559e-05 - mean\_absolute\_error: 0.0051120/126 [===========================>..] - ETA: 0s - loss: 4.2710e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.3158e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 1.0943e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7233e-05 - mean\_absolute\_error: 0.0052 16/126 [==>...........................] - ETA: 0s - loss: 4.6159e-05 - mean\_absolute\_error: 0.0052 36/126 [=======>......................] - ETA: 0s - loss: 4.0228e-05 - mean\_absolute\_error: 0.0047 51/126 [===========>..................] - ETA: 0s - loss: 3.7251e-05 - mean\_absolute\_error: 0.0046 63/126 [==============>...............] - ETA: 0s - loss: 3.8266e-05 - mean\_absolute\_error: 0.0047 76/126 [=================>............] - ETA: 0s - loss: 4.2426e-05 - mean\_absolute\_error: 0.0049 90/126 [====================>.........] - ETA: 0s - loss: 4.4348e-05 - mean\_absolute\_error: 0.0051106/126 [========================>.....] - ETA: 0s - loss: 4.4978e-05 - mean\_absolute\_error: 0.0051119/126 [===========================>..] - ETA: 0s - loss: 4.3295e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 1s 4ms/step - loss: 4.3341e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 9.8259e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8915e-05 - mean\_absolute\_error: 0.0043 13/126 [==>...........................] - ETA: 0s - loss: 3.0217e-05 - mean\_absolute\_error: 0.0041 24/126 [====>.........................] - ETA: 0s - loss: 3.5297e-05 - mean\_absolute\_error: 0.0044 38/126 [========>.....................] - ETA: 0s - loss: 3.9447e-05 - mean\_absolute\_error: 0.0047 50/126 [==========>...................] - ETA: 0s - loss: 4.1128e-05 - mean\_absolute\_error: 0.0049 62/126 [=============>................] - ETA: 0s - loss: 4.1668e-05 - mean\_absolute\_error: 0.0049 75/126 [================>.............] - ETA: 0s - loss: 4.1688e-05 - mean\_absolute\_error: 0.0049 86/126 [===================>..........] - ETA: 0s - loss: 4.1120e-05 - mean\_absolute\_error: 0.0049 97/126 [======================>.......] - ETA: 0s - loss: 4.0082e-05 - mean\_absolute\_error: 0.0048110/126 [=========================>....] - ETA: 0s - loss: 4.0178e-05 - mean\_absolute\_error: 0.0048122/126 [============================>.] - ETA: 0s - loss: 4.0308e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 1s 5ms/step - loss: 4.0237e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.2280e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5193e-05 - mean\_absolute\_error: 0.0039 12/126 [=>............................] - ETA: 0s - loss: 3.5108e-05 - mean\_absolute\_error: 0.0042 22/126 [====>.........................] - ETA: 0s - loss: 3.4049e-05 - mean\_absolute\_error: 0.0042 34/126 [=======>......................] - ETA: 0s - loss: 3.7399e-05 - mean\_absolute\_error: 0.0045 47/126 [==========>...................] - ETA: 0s - loss: 3.8897e-05 - mean\_absolute\_error: 0.0046 61/126 [=============>................] - ETA: 0s - loss: 3.7458e-05 - mean\_absolute\_error: 0.0046 75/126 [================>.............] - ETA: 0s - loss: 3.7423e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.7972e-05 - mean\_absolute\_error: 0.0046104/126 [=======================>......] - ETA: 0s - loss: 3.8821e-05 - mean\_absolute\_error: 0.0047117/126 [==========================>...] - ETA: 0s - loss: 3.8383e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 1s 5ms/step - loss: 3.8067e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.0639e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2469e-05 - mean\_absolute\_error: 0.0050 13/126 [==>...........................] - ETA: 0s - loss: 3.1008e-05 - mean\_absolute\_error: 0.0040 26/126 [=====>........................] - ETA: 0s - loss: 3.4967e-05 - mean\_absolute\_error: 0.0044 41/126 [========>.....................] - ETA: 0s - loss: 3.4667e-05 - mean\_absolute\_error: 0.0044 56/126 [============>.................] - ETA: 0s - loss: 3.4339e-05 - mean\_absolute\_error: 0.0044 70/126 [===============>..............] - ETA: 0s - loss: 3.5842e-05 - mean\_absolute\_error: 0.0045 83/126 [==================>...........] - ETA: 0s - loss: 3.8843e-05 - mean\_absolute\_error: 0.0047 98/126 [======================>.......] - ETA: 0s - loss: 3.9965e-05 - mean\_absolute\_error: 0.0048115/126 [==========================>...] - ETA: 0s - loss: 4.2203e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 1s 4ms/step - loss: 4.1895e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.6565e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1255e-05 - mean\_absolute\_error: 0.0042 19/126 [===>..........................] - ETA: 0s - loss: 3.8054e-05 - mean\_absolute\_error: 0.0047 36/126 [=======>......................] - ETA: 0s - loss: 3.6185e-05 - mean\_absolute\_error: 0.0044 53/126 [===========>..................] - ETA: 0s - loss: 3.6329e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.7960e-05 - mean\_absolute\_error: 0.0046 85/126 [===================>..........] - ETA: 0s - loss: 3.7504e-05 - mean\_absolute\_error: 0.0045 99/126 [======================>.......] - ETA: 0s - loss: 3.6554e-05 - mean\_absolute\_error: 0.0045114/126 [==========================>...] - ETA: 0s - loss: 3.7358e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 4ms/step - loss: 3.8413e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 1.5410e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0556e-04 - mean\_absolute\_error: 0.0091 18/126 [===>..........................] - ETA: 0s - loss: 5.4828e-05 - mean\_absolute\_error: 0.0059 39/126 [========>.....................] - ETA: 0s - loss: 5.4464e-05 - mean\_absolute\_error: 0.0058 61/126 [=============>................] - ETA: 0s - loss: 5.4151e-05 - mean\_absolute\_error: 0.0058 85/126 [===================>..........] - ETA: 0s - loss: 4.9873e-05 - mean\_absolute\_error: 0.0055102/126 [=======================>......] - ETA: 0s - loss: 4.7618e-05 - mean\_absolute\_error: 0.0053115/126 [==========================>...] - ETA: 0s - loss: 4.6493e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.5911e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 7.1847e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9943e-05 - mean\_absolute\_error: 0.0063 19/126 [===>..........................] - ETA: 0s - loss: 3.8358e-05 - mean\_absolute\_error: 0.0047 35/126 [=======>......................] - ETA: 0s - loss: 3.5833e-05 - mean\_absolute\_error: 0.0046 52/126 [===========>..................] - ETA: 0s - loss: 3.6158e-05 - mean\_absolute\_error: 0.0046 67/126 [==============>...............] - ETA: 0s - loss: 3.7230e-05 - mean\_absolute\_error: 0.0046 85/126 [===================>..........] - ETA: 0s - loss: 3.7176e-05 - mean\_absolute\_error: 0.0046 99/126 [======================>.......] - ETA: 0s - loss: 3.7503e-05 - mean\_absolute\_error: 0.0046115/126 [==========================>...] - ETA: 0s - loss: 3.8581e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 4ms/step - loss: 3.8921e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.0006e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6092e-05 - mean\_absolute\_error: 0.0062 15/126 [==>...........................] - ETA: 0s - loss: 4.2635e-05 - mean\_absolute\_error: 0.0050 30/126 [======>.......................] - ETA: 0s - loss: 3.6611e-05 - mean\_absolute\_error: 0.0046 47/126 [==========>...................] - ETA: 0s - loss: 3.5469e-05 - mean\_absolute\_error: 0.0044 61/126 [=============>................] - ETA: 0s - loss: 3.6348e-05 - mean\_absolute\_error: 0.0045 77/126 [=================>............] - ETA: 0s - loss: 3.5843e-05 - mean\_absolute\_error: 0.0045 93/126 [=====================>........] - ETA: 0s - loss: 3.6665e-05 - mean\_absolute\_error: 0.0045108/126 [========================>.....] - ETA: 0s - loss: 3.6601e-05 - mean\_absolute\_error: 0.0045125/126 [============================>.] - ETA: 0s - loss: 3.7137e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 4ms/step - loss: 3.7088e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.6311e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3287e-05 - mean\_absolute\_error: 0.0038 16/126 [==>...........................] - ETA: 0s - loss: 3.1353e-05 - mean\_absolute\_error: 0.0042 30/126 [======>.......................] - ETA: 0s - loss: 3.2438e-05 - mean\_absolute\_error: 0.0042 44/126 [=========>....................] - ETA: 0s - loss: 3.1587e-05 - mean\_absolute\_error: 0.0041 58/126 [============>.................] - ETA: 0s - loss: 3.4416e-05 - mean\_absolute\_error: 0.0043 73/126 [================>.............] - ETA: 0s - loss: 3.8813e-05 - mean\_absolute\_error: 0.0046 92/126 [====================>.........] - ETA: 0s - loss: 3.8403e-05 - mean\_absolute\_error: 0.0046107/126 [========================>.....] - ETA: 0s - loss: 3.8935e-05 - mean\_absolute\_error: 0.0047124/126 [============================>.] - ETA: 0s - loss: 4.0366e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 4ms/step - loss: 4.0864e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 2.0355e-04 - val\_mean\_absolute\_error: 0.0125  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2430e-04 - mean\_absolute\_error: 0.0098 17/126 [===>..........................] - ETA: 0s - loss: 4.7383e-05 - mean\_absolute\_error: 0.0051 33/126 [======>.......................] - ETA: 0s - loss: 3.9939e-05 - mean\_absolute\_error: 0.0047 49/126 [==========>...................] - ETA: 0s - loss: 3.8238e-05 - mean\_absolute\_error: 0.0045 64/126 [==============>...............] - ETA: 0s - loss: 3.7268e-05 - mean\_absolute\_error: 0.0045 79/126 [=================>............] - ETA: 0s - loss: 3.8724e-05 - mean\_absolute\_error: 0.0046 96/126 [=====================>........] - ETA: 0s - loss: 3.7914e-05 - mean\_absolute\_error: 0.0045114/126 [==========================>...] - ETA: 0s - loss: 3.7698e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 4ms/step - loss: 3.8423e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2735e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7781e-05 - mean\_absolute\_error: 0.0040 17/126 [===>..........................] - ETA: 0s - loss: 4.9361e-05 - mean\_absolute\_error: 0.0054 30/126 [======>.......................] - ETA: 0s - loss: 4.7723e-05 - mean\_absolute\_error: 0.0053 42/126 [=========>....................] - ETA: 0s - loss: 4.3776e-05 - mean\_absolute\_error: 0.0050 55/126 [============>.................] - ETA: 0s - loss: 4.1445e-05 - mean\_absolute\_error: 0.0048 75/126 [================>.............] - ETA: 0s - loss: 4.2235e-05 - mean\_absolute\_error: 0.0049 95/126 [=====================>........] - ETA: 0s - loss: 4.1277e-05 - mean\_absolute\_error: 0.0048117/126 [==========================>...] - ETA: 0s - loss: 4.1278e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0701e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.5189e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7029e-05 - mean\_absolute\_error: 0.0041 18/126 [===>..........................] - ETA: 0s - loss: 3.8066e-05 - mean\_absolute\_error: 0.0045 37/126 [=======>......................] - ETA: 0s - loss: 3.8052e-05 - mean\_absolute\_error: 0.0046 58/126 [============>.................] - ETA: 0s - loss: 4.2245e-05 - mean\_absolute\_error: 0.0050 81/126 [==================>...........] - ETA: 0s - loss: 4.4978e-05 - mean\_absolute\_error: 0.0052100/126 [======================>.......] - ETA: 0s - loss: 4.2470e-05 - mean\_absolute\_error: 0.0050120/126 [===========================>..] - ETA: 0s - loss: 4.2524e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.2019e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.2489e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4761e-05 - mean\_absolute\_error: 0.0041 20/126 [===>..........................] - ETA: 0s - loss: 4.2865e-05 - mean\_absolute\_error: 0.0051 39/126 [========>.....................] - ETA: 0s - loss: 4.5301e-05 - mean\_absolute\_error: 0.0052 55/126 [============>.................] - ETA: 0s - loss: 4.4196e-05 - mean\_absolute\_error: 0.0052 73/126 [================>.............] - ETA: 0s - loss: 4.5213e-05 - mean\_absolute\_error: 0.0052 88/126 [===================>..........] - ETA: 0s - loss: 4.5904e-05 - mean\_absolute\_error: 0.0053100/126 [======================>.......] - ETA: 0s - loss: 4.3679e-05 - mean\_absolute\_error: 0.0051118/126 [===========================>..] - ETA: 0s - loss: 4.4682e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 4ms/step - loss: 4.5932e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 6.3121e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9040e-05 - mean\_absolute\_error: 0.0036 16/126 [==>...........................] - ETA: 0s - loss: 4.6441e-05 - mean\_absolute\_error: 0.0053 32/126 [======>.......................] - ETA: 0s - loss: 4.1463e-05 - mean\_absolute\_error: 0.0050 47/126 [==========>...................] - ETA: 0s - loss: 3.9823e-05 - mean\_absolute\_error: 0.0049 60/126 [=============>................] - ETA: 0s - loss: 3.9241e-05 - mean\_absolute\_error: 0.0049 74/126 [================>.............] - ETA: 0s - loss: 4.0210e-05 - mean\_absolute\_error: 0.0049 88/126 [===================>..........] - ETA: 0s - loss: 4.0703e-05 - mean\_absolute\_error: 0.0049106/126 [========================>.....] - ETA: 0s - loss: 4.0123e-05 - mean\_absolute\_error: 0.0048123/126 [============================>.] - ETA: 0s - loss: 3.9504e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 4ms/step - loss: 3.9524e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 8.2000e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7663e-05 - mean\_absolute\_error: 0.0043 11/126 [=>............................] - ETA: 0s - loss: 3.8257e-05 - mean\_absolute\_error: 0.0046 22/126 [====>.........................] - ETA: 0s - loss: 3.9114e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 4.4819e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 4.6214e-05 - mean\_absolute\_error: 0.0052 89/126 [====================>.........] - ETA: 0s - loss: 4.8682e-05 - mean\_absolute\_error: 0.0054112/126 [=========================>....] - ETA: 0s - loss: 4.6104e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.4399e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.3490e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2722e-05 - mean\_absolute\_error: 0.0043 23/126 [====>.........................] - ETA: 0s - loss: 3.9807e-05 - mean\_absolute\_error: 0.0048 47/126 [==========>...................] - ETA: 0s - loss: 3.9371e-05 - mean\_absolute\_error: 0.0047 71/126 [===============>..............] - ETA: 0s - loss: 3.7064e-05 - mean\_absolute\_error: 0.0045 96/126 [=====================>........] - ETA: 0s - loss: 3.5596e-05 - mean\_absolute\_error: 0.0044118/126 [===========================>..] - ETA: 0s - loss: 3.6349e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6436e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.3133e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5821e-05 - mean\_absolute\_error: 0.0045 24/126 [====>.........................] - ETA: 0s - loss: 3.4765e-05 - mean\_absolute\_error: 0.0043 48/126 [==========>...................] - ETA: 0s - loss: 3.7132e-05 - mean\_absolute\_error: 0.0045 71/126 [===============>..............] - ETA: 0s - loss: 3.8011e-05 - mean\_absolute\_error: 0.0045 95/126 [=====================>........] - ETA: 0s - loss: 3.5810e-05 - mean\_absolute\_error: 0.0043118/126 [===========================>..] - ETA: 0s - loss: 3.6302e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6396e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.1392e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7015e-05 - mean\_absolute\_error: 0.0062 19/126 [===>..........................] - ETA: 0s - loss: 3.7933e-05 - mean\_absolute\_error: 0.0046 41/126 [========>.....................] - ETA: 0s - loss: 3.7109e-05 - mean\_absolute\_error: 0.0046 62/126 [=============>................] - ETA: 0s - loss: 3.9077e-05 - mean\_absolute\_error: 0.0047 83/126 [==================>...........] - ETA: 0s - loss: 3.9514e-05 - mean\_absolute\_error: 0.0047104/126 [=======================>......] - ETA: 0s - loss: 3.7139e-05 - mean\_absolute\_error: 0.0045123/126 [============================>.] - ETA: 0s - loss: 3.8249e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8448e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.3705e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7264e-05 - mean\_absolute\_error: 0.0039 21/126 [====>.........................] - ETA: 0s - loss: 4.1834e-05 - mean\_absolute\_error: 0.0048 41/126 [========>.....................] - ETA: 0s - loss: 4.9932e-05 - mean\_absolute\_error: 0.0054 61/126 [=============>................] - ETA: 0s - loss: 4.6082e-05 - mean\_absolute\_error: 0.0051 75/126 [================>.............] - ETA: 0s - loss: 4.6841e-05 - mean\_absolute\_error: 0.0052 96/126 [=====================>........] - ETA: 0s - loss: 4.3184e-05 - mean\_absolute\_error: 0.0049114/126 [==========================>...] - ETA: 0s - loss: 4.2022e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0770e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.0976e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4219e-05 - mean\_absolute\_error: 0.0043 20/126 [===>..........................] - ETA: 0s - loss: 4.0113e-05 - mean\_absolute\_error: 0.0048 41/126 [========>.....................] - ETA: 0s - loss: 3.8508e-05 - mean\_absolute\_error: 0.0045 59/126 [=============>................] - ETA: 0s - loss: 3.8300e-05 - mean\_absolute\_error: 0.0046 82/126 [==================>...........] - ETA: 0s - loss: 3.7250e-05 - mean\_absolute\_error: 0.0045 96/126 [=====================>........] - ETA: 0s - loss: 3.8025e-05 - mean\_absolute\_error: 0.0046107/126 [========================>.....] - ETA: 0s - loss: 3.7627e-05 - mean\_absolute\_error: 0.0046122/126 [============================>.] - ETA: 0s - loss: 3.7386e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7386e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.3501e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1941e-05 - mean\_absolute\_error: 0.0038 18/126 [===>..........................] - ETA: 0s - loss: 4.2005e-05 - mean\_absolute\_error: 0.0050 37/126 [=======>......................] - ETA: 0s - loss: 3.9418e-05 - mean\_absolute\_error: 0.0048 58/126 [============>.................] - ETA: 0s - loss: 3.7530e-05 - mean\_absolute\_error: 0.0046 81/126 [==================>...........] - ETA: 0s - loss: 3.6186e-05 - mean\_absolute\_error: 0.0045104/126 [=======================>......] - ETA: 0s - loss: 3.6964e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - ETA: 0s - loss: 3.6883e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6883e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.5218e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8238e-05 - mean\_absolute\_error: 0.0042 21/126 [====>.........................] - ETA: 0s - loss: 3.3378e-05 - mean\_absolute\_error: 0.0043 45/126 [=========>....................] - ETA: 0s - loss: 3.5744e-05 - mean\_absolute\_error: 0.0044 69/126 [===============>..............] - ETA: 0s - loss: 3.5161e-05 - mean\_absolute\_error: 0.0044 92/126 [====================>.........] - ETA: 0s - loss: 3.6658e-05 - mean\_absolute\_error: 0.0045115/126 [==========================>...] - ETA: 0s - loss: 3.9372e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.3346e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 1.0965e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2030e-05 - mean\_absolute\_error: 0.0065 19/126 [===>..........................] - ETA: 0s - loss: 5.2710e-05 - mean\_absolute\_error: 0.0058 42/126 [=========>....................] - ETA: 0s - loss: 4.8560e-05 - mean\_absolute\_error: 0.0055 65/126 [==============>...............] - ETA: 0s - loss: 4.6826e-05 - mean\_absolute\_error: 0.0053 89/126 [====================>.........] - ETA: 0s - loss: 4.5020e-05 - mean\_absolute\_error: 0.0051112/126 [=========================>....] - ETA: 0s - loss: 4.4133e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.2684e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.3682e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1664e-05 - mean\_absolute\_error: 0.0042 22/126 [====>.........................] - ETA: 0s - loss: 3.2019e-05 - mean\_absolute\_error: 0.0042 45/126 [=========>....................] - ETA: 0s - loss: 3.7328e-05 - mean\_absolute\_error: 0.0046 70/126 [===============>..............] - ETA: 0s - loss: 3.6546e-05 - mean\_absolute\_error: 0.0045 95/126 [=====================>........] - ETA: 0s - loss: 3.6540e-05 - mean\_absolute\_error: 0.0045120/126 [===========================>..] - ETA: 0s - loss: 3.5892e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.5872e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.9586e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1409e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 3.0703e-05 - mean\_absolute\_error: 0.0041 46/126 [=========>....................] - ETA: 0s - loss: 3.5126e-05 - mean\_absolute\_error: 0.0044 71/126 [===============>..............] - ETA: 0s - loss: 3.5231e-05 - mean\_absolute\_error: 0.0044 93/126 [=====================>........] - ETA: 0s - loss: 3.5152e-05 - mean\_absolute\_error: 0.0044116/126 [==========================>...] - ETA: 0s - loss: 3.6775e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6605e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.8839e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4808e-05 - mean\_absolute\_error: 0.0047 24/126 [====>.........................] - ETA: 0s - loss: 4.0048e-05 - mean\_absolute\_error: 0.0047 49/126 [==========>...................] - ETA: 0s - loss: 3.4590e-05 - mean\_absolute\_error: 0.0042 73/126 [================>.............] - ETA: 0s - loss: 3.5151e-05 - mean\_absolute\_error: 0.0043 97/126 [======================>.......] - ETA: 0s - loss: 3.4194e-05 - mean\_absolute\_error: 0.0042121/126 [===========================>..] - ETA: 0s - loss: 3.3905e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 2ms/step - loss: 3.4225e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 6.7496e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7574e-05 - mean\_absolute\_error: 0.0040 23/126 [====>.........................] - ETA: 0s - loss: 3.6542e-05 - mean\_absolute\_error: 0.0048 46/126 [=========>....................] - ETA: 0s - loss: 3.6961e-05 - mean\_absolute\_error: 0.0047 68/126 [===============>..............] - ETA: 0s - loss: 3.5496e-05 - mean\_absolute\_error: 0.0045 92/126 [====================>.........] - ETA: 0s - loss: 3.5643e-05 - mean\_absolute\_error: 0.0044117/126 [==========================>...] - ETA: 0s - loss: 3.8686e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9796e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.0861e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9121e-05 - mean\_absolute\_error: 0.0033 24/126 [====>.........................] - ETA: 0s - loss: 3.5910e-05 - mean\_absolute\_error: 0.0045 49/126 [==========>...................] - ETA: 0s - loss: 3.6346e-05 - mean\_absolute\_error: 0.0043 72/126 [================>.............] - ETA: 0s - loss: 3.6008e-05 - mean\_absolute\_error: 0.0044 97/126 [======================>.......] - ETA: 0s - loss: 3.6251e-05 - mean\_absolute\_error: 0.0044120/126 [===========================>..] - ETA: 0s - loss: 3.5604e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6186e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.2773e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0683e-05 - mean\_absolute\_error: 0.0048 22/126 [====>.........................] - ETA: 0s - loss: 4.2855e-05 - mean\_absolute\_error: 0.0052 47/126 [==========>...................] - ETA: 0s - loss: 4.2057e-05 - mean\_absolute\_error: 0.0050 71/126 [===============>..............] - ETA: 0s - loss: 3.7679e-05 - mean\_absolute\_error: 0.0046 94/126 [=====================>........] - ETA: 0s - loss: 3.7946e-05 - mean\_absolute\_error: 0.0046119/126 [===========================>..] - ETA: 0s - loss: 3.8116e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8031e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.0223e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3433e-05 - mean\_absolute\_error: 0.0046 20/126 [===>..........................] - ETA: 0s - loss: 3.6536e-05 - mean\_absolute\_error: 0.0046 44/126 [=========>....................] - ETA: 0s - loss: 4.3973e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 5.4555e-05 - mean\_absolute\_error: 0.0057 91/126 [====================>.........] - ETA: 0s - loss: 5.2040e-05 - mean\_absolute\_error: 0.0055116/126 [==========================>...] - ETA: 0s - loss: 4.9434e-05 - mean\_absolute\_error: 0.0054126/126 [==============================] - 0s 3ms/step - loss: 4.9693e-05 - mean\_absolute\_error: 0.0054 - val\_loss: 7.1059e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0353e-05 - mean\_absolute\_error: 0.0040 20/126 [===>..........................] - ETA: 0s - loss: 3.4442e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.2608e-05 - mean\_absolute\_error: 0.0041 65/126 [==============>...............] - ETA: 0s - loss: 3.5825e-05 - mean\_absolute\_error: 0.0045 89/126 [====================>.........] - ETA: 0s - loss: 3.7562e-05 - mean\_absolute\_error: 0.0046113/126 [=========================>....] - ETA: 0s - loss: 3.6980e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7662e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 1.1964e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6890e-05 - mean\_absolute\_error: 0.0066 15/126 [==>...........................] - ETA: 0s - loss: 5.3543e-05 - mean\_absolute\_error: 0.0059 30/126 [======>.......................] - ETA: 0s - loss: 4.9046e-05 - mean\_absolute\_error: 0.0055 46/126 [=========>....................] - ETA: 0s - loss: 4.3747e-05 - mean\_absolute\_error: 0.0050 62/126 [=============>................] - ETA: 0s - loss: 4.5630e-05 - mean\_absolute\_error: 0.0051 78/126 [=================>............] - ETA: 0s - loss: 4.2735e-05 - mean\_absolute\_error: 0.0049 94/126 [=====================>........] - ETA: 0s - loss: 4.1622e-05 - mean\_absolute\_error: 0.0048109/126 [========================>.....] - ETA: 0s - loss: 4.1925e-05 - mean\_absolute\_error: 0.0049125/126 [============================>.] - ETA: 0s - loss: 4.1593e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 4ms/step - loss: 4.1553e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.1820e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9123e-05 - mean\_absolute\_error: 0.0058 17/126 [===>..........................] - ETA: 0s - loss: 3.2853e-05 - mean\_absolute\_error: 0.0043 30/126 [======>.......................] - ETA: 0s - loss: 3.4267e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.3283e-05 - mean\_absolute\_error: 0.0043 60/126 [=============>................] - ETA: 0s - loss: 3.3574e-05 - mean\_absolute\_error: 0.0042 79/126 [=================>............] - ETA: 0s - loss: 3.4397e-05 - mean\_absolute\_error: 0.0043 98/126 [======================>.......] - ETA: 0s - loss: 3.4994e-05 - mean\_absolute\_error: 0.0044118/126 [===========================>..] - ETA: 0s - loss: 3.4551e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.4521e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.6681e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0570e-05 - mean\_absolute\_error: 0.0037 23/126 [====>.........................] - ETA: 0s - loss: 3.3899e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 3.6932e-05 - mean\_absolute\_error: 0.0045 67/126 [==============>...............] - ETA: 0s - loss: 3.7749e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.5911e-05 - mean\_absolute\_error: 0.0045114/126 [==========================>...] - ETA: 0s - loss: 3.5789e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.5791e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.0884e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0308e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 4.1449e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 4.1589e-05 - mean\_absolute\_error: 0.0049 66/126 [==============>...............] - ETA: 0s - loss: 3.6550e-05 - mean\_absolute\_error: 0.0045 87/126 [===================>..........] - ETA: 0s - loss: 3.6229e-05 - mean\_absolute\_error: 0.0045108/126 [========================>.....] - ETA: 0s - loss: 3.5007e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.4690e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 5.9358e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9107e-05 - mean\_absolute\_error: 0.0047 22/126 [====>.........................] - ETA: 0s - loss: 3.6999e-05 - mean\_absolute\_error: 0.0047 43/126 [=========>....................] - ETA: 0s - loss: 3.8642e-05 - mean\_absolute\_error: 0.0048 64/126 [==============>...............] - ETA: 0s - loss: 3.5775e-05 - mean\_absolute\_error: 0.0045 84/126 [===================>..........] - ETA: 0s - loss: 3.6066e-05 - mean\_absolute\_error: 0.0045106/126 [========================>.....] - ETA: 0s - loss: 3.5427e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.4960e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.8302e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8585e-05 - mean\_absolute\_error: 0.0063 23/126 [====>.........................] - ETA: 0s - loss: 3.5833e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.5756e-05 - mean\_absolute\_error: 0.0045 62/126 [=============>................] - ETA: 0s - loss: 4.1345e-05 - mean\_absolute\_error: 0.0049 85/126 [===================>..........] - ETA: 0s - loss: 3.8235e-05 - mean\_absolute\_error: 0.0047107/126 [========================>.....] - ETA: 0s - loss: 3.8391e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9038e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 9.4200e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0020e-05 - mean\_absolute\_error: 0.0049 23/126 [====>.........................] - ETA: 0s - loss: 5.1053e-05 - mean\_absolute\_error: 0.0056 42/126 [=========>....................] - ETA: 0s - loss: 4.8383e-05 - mean\_absolute\_error: 0.0054 63/126 [==============>...............] - ETA: 0s - loss: 5.0181e-05 - mean\_absolute\_error: 0.0056 85/126 [===================>..........] - ETA: 0s - loss: 4.6574e-05 - mean\_absolute\_error: 0.0053106/126 [========================>.....] - ETA: 0s - loss: 4.3457e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.1480e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 5.8429e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5097e-05 - mean\_absolute\_error: 0.0038 24/126 [====>.........................] - ETA: 0s - loss: 3.4230e-05 - mean\_absolute\_error: 0.0043 48/126 [==========>...................] - ETA: 0s - loss: 3.1823e-05 - mean\_absolute\_error: 0.0041 70/126 [===============>..............] - ETA: 0s - loss: 3.1367e-05 - mean\_absolute\_error: 0.0041 93/126 [=====================>........] - ETA: 0s - loss: 3.3717e-05 - mean\_absolute\_error: 0.0042114/126 [==========================>...] - ETA: 0s - loss: 3.3010e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.3954e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 1.0957e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4606e-05 - mean\_absolute\_error: 0.0058 25/126 [====>.........................] - ETA: 0s - loss: 5.3854e-05 - mean\_absolute\_error: 0.0058 48/126 [==========>...................] - ETA: 0s - loss: 4.5705e-05 - mean\_absolute\_error: 0.0052 72/126 [================>.............] - ETA: 0s - loss: 4.0767e-05 - mean\_absolute\_error: 0.0048 97/126 [======================>.......] - ETA: 0s - loss: 3.8528e-05 - mean\_absolute\_error: 0.0046120/126 [===========================>..] - ETA: 0s - loss: 3.7554e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.7440e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 5.7283e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2998e-05 - mean\_absolute\_error: 0.0042 22/126 [====>.........................] - ETA: 0s - loss: 4.6440e-05 - mean\_absolute\_error: 0.0051 44/126 [=========>....................] - ETA: 0s - loss: 4.1615e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 4.1770e-05 - mean\_absolute\_error: 0.0049 90/126 [====================>.........] - ETA: 0s - loss: 4.3727e-05 - mean\_absolute\_error: 0.0050112/126 [=========================>....] - ETA: 0s - loss: 4.2978e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.3840e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 9.9307e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8413e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 3.7183e-05 - mean\_absolute\_error: 0.0045 47/126 [==========>...................] - ETA: 0s - loss: 3.3912e-05 - mean\_absolute\_error: 0.0042 70/126 [===============>..............] - ETA: 0s - loss: 3.3223e-05 - mean\_absolute\_error: 0.0042 92/126 [====================>.........] - ETA: 0s - loss: 3.5202e-05 - mean\_absolute\_error: 0.0044115/126 [==========================>...] - ETA: 0s - loss: 3.4982e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5209e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.1359e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3190e-05 - mean\_absolute\_error: 0.0057 23/126 [====>.........................] - ETA: 0s - loss: 3.8200e-05 - mean\_absolute\_error: 0.0048 44/126 [=========>....................] - ETA: 0s - loss: 3.9884e-05 - mean\_absolute\_error: 0.0050 55/126 [============>.................] - ETA: 0s - loss: 3.8181e-05 - mean\_absolute\_error: 0.0048 66/126 [==============>...............] - ETA: 0s - loss: 3.6710e-05 - mean\_absolute\_error: 0.0046 80/126 [==================>...........] - ETA: 0s - loss: 3.5643e-05 - mean\_absolute\_error: 0.0045 95/126 [=====================>........] - ETA: 0s - loss: 3.5330e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.5239e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 4ms/step - loss: 3.6331e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.3073e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5158e-05 - mean\_absolute\_error: 0.0056 21/126 [====>.........................] - ETA: 0s - loss: 5.8979e-05 - mean\_absolute\_error: 0.0063 38/126 [========>.....................] - ETA: 0s - loss: 4.9812e-05 - mean\_absolute\_error: 0.0056 54/126 [===========>..................] - ETA: 0s - loss: 4.6295e-05 - mean\_absolute\_error: 0.0053 71/126 [===============>..............] - ETA: 0s - loss: 4.3822e-05 - mean\_absolute\_error: 0.0051 88/126 [===================>..........] - ETA: 0s - loss: 4.2036e-05 - mean\_absolute\_error: 0.0049106/126 [========================>.....] - ETA: 0s - loss: 4.2288e-05 - mean\_absolute\_error: 0.0050119/126 [===========================>..] - ETA: 0s - loss: 4.1202e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 4ms/step - loss: 4.0994e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.9045e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5409e-05 - mean\_absolute\_error: 0.0049 15/126 [==>...........................] - ETA: 0s - loss: 3.3395e-05 - mean\_absolute\_error: 0.0043 29/126 [=====>........................] - ETA: 0s - loss: 3.7780e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 3.7813e-05 - mean\_absolute\_error: 0.0048 62/126 [=============>................] - ETA: 0s - loss: 3.7637e-05 - mean\_absolute\_error: 0.0047 77/126 [=================>............] - ETA: 0s - loss: 3.7053e-05 - mean\_absolute\_error: 0.0047 94/126 [=====================>........] - ETA: 0s - loss: 3.7403e-05 - mean\_absolute\_error: 0.0047111/126 [=========================>....] - ETA: 0s - loss: 3.8558e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 4ms/step - loss: 3.8184e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.6875e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3493e-05 - mean\_absolute\_error: 0.0062 21/126 [====>.........................] - ETA: 0s - loss: 5.0147e-05 - mean\_absolute\_error: 0.0056 37/126 [=======>......................] - ETA: 0s - loss: 5.4496e-05 - mean\_absolute\_error: 0.0059 57/126 [============>.................] - ETA: 0s - loss: 4.9272e-05 - mean\_absolute\_error: 0.0056 80/126 [==================>...........] - ETA: 0s - loss: 4.6788e-05 - mean\_absolute\_error: 0.0054 99/126 [======================>.......] - ETA: 0s - loss: 4.4147e-05 - mean\_absolute\_error: 0.0052122/126 [============================>.] - ETA: 0s - loss: 4.4829e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.4494e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 1.3608e-04 - val\_mean\_absolute\_error: 0.0096

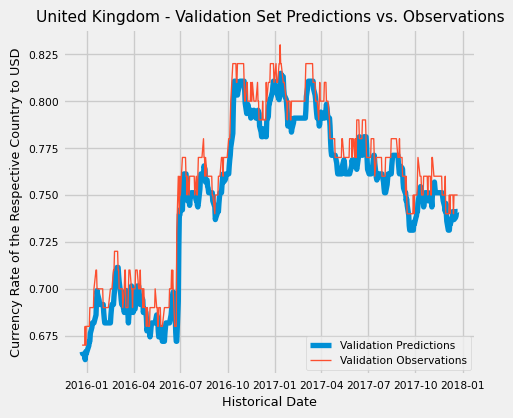
<keras.src.callbacks.History at 0x253bacec710>

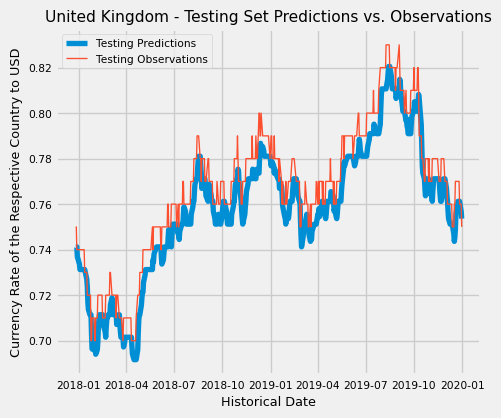
After the training and fitting of the Machine Learning model for the United Kingdom, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and 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: 41s 34/126 [=======>......................] - ETA: 0s 73/126 [================>.............] - ETA: 0s114/126 [==========================>...] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step

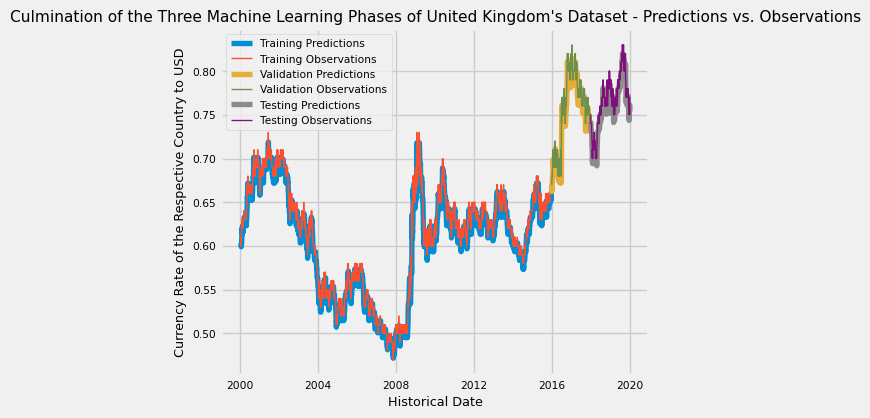






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

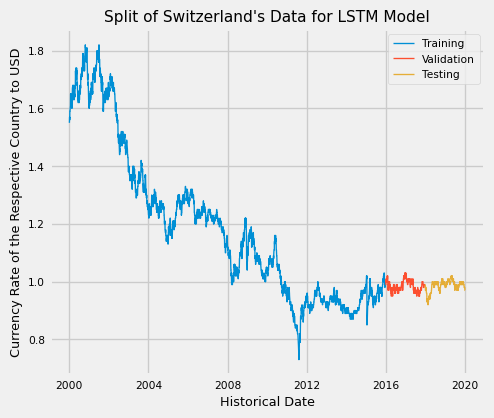
```{python}  
# Plotting United Kingdom's observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model)   
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_train, 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)  
```

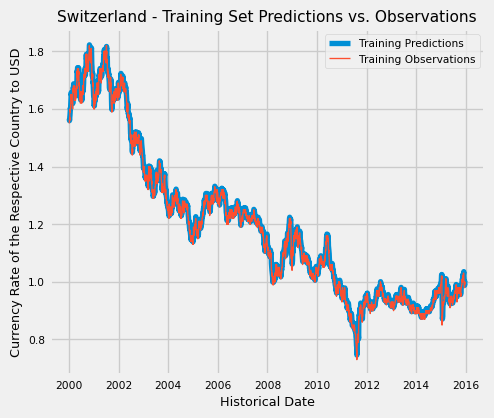
Epoch 1/100  
 1/126 [..............................] - ETA: 3:46 - loss: 1.6575 - mean\_absolute\_error: 1.2603 19/126 [===>..........................] - ETA: 0s - loss: 0.9890 - mean\_absolute\_error: 0.9566 43/126 [=========>....................] - ETA: 0s - loss: 0.5074 - mean\_absolute\_error: 0.5832 66/126 [==============>...............] - ETA: 0s - loss: 0.3345 - mean\_absolute\_error: 0.4088 90/126 [====================>.........] - ETA: 0s - loss: 0.2466 - mean\_absolute\_error: 0.3155115/126 [==========================>...] - ETA: 0s - loss: 0.1938 - mean\_absolute\_error: 0.2580126/126 [==============================] - 2s 5ms/step - loss: 0.1780 - mean\_absolute\_error: 0.2404 - val\_loss: 0.0021 - val\_mean\_absolute\_error: 0.0456  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0032 - mean\_absolute\_error: 0.0468 21/126 [====>.........................] - ETA: 0s - loss: 0.0027 - mean\_absolute\_error: 0.0440 46/126 [=========>....................] - ETA: 0s - loss: 0.0023 - mean\_absolute\_error: 0.0402 70/126 [===============>..............] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0381 92/126 [====================>.........] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0356117/126 [==========================>...] - ETA: 0s - loss: 0.0017 - mean\_absolute\_error: 0.0331126/126 [==============================] - 0s 3ms/step - loss: 0.0016 - mean\_absolute\_error: 0.0322 - val\_loss: 5.9728e-04 - val\_mean\_absolute\_error: 0.0234  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7484e-04 - mean\_absolute\_error: 0.0233 23/126 [====>.........................] - ETA: 0s - loss: 5.4342e-04 - mean\_absolute\_error: 0.0187 46/126 [=========>....................] - ETA: 0s - loss: 4.5411e-04 - mean\_absolute\_error: 0.0171 71/126 [===============>..............] - ETA: 0s - loss: 4.0026e-04 - mean\_absolute\_error: 0.0158 95/126 [=====================>........] - ETA: 0s - loss: 3.5506e-04 - mean\_absolute\_error: 0.0148120/126 [===========================>..] - ETA: 0s - loss: 3.1554e-04 - mean\_absolute\_error: 0.0139126/126 [==============================] - 0s 2ms/step - loss: 3.0836e-04 - mean\_absolute\_error: 0.0137 - val\_loss: 7.6020e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2640e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 1.4961e-04 - mean\_absolute\_error: 0.0096 48/126 [==========>...................] - ETA: 0s - loss: 1.4333e-04 - mean\_absolute\_error: 0.0094 71/126 [===============>..............] - ETA: 0s - loss: 1.3945e-04 - mean\_absolute\_error: 0.0092 95/126 [=====================>........] - ETA: 0s - loss: 1.4695e-04 - mean\_absolute\_error: 0.0091120/126 [===========================>..] - ETA: 0s - loss: 1.4882e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4852e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.1255e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7192e-05 - mean\_absolute\_error: 0.0072 19/126 [===>..........................] - ETA: 0s - loss: 1.2578e-04 - mean\_absolute\_error: 0.0087 41/126 [========>.....................] - ETA: 0s - loss: 1.5993e-04 - mean\_absolute\_error: 0.0090 67/126 [==============>...............] - ETA: 0s - loss: 1.4881e-04 - mean\_absolute\_error: 0.0089 91/126 [====================>.........] - ETA: 0s - loss: 1.4455e-04 - mean\_absolute\_error: 0.0089116/126 [==========================>...] - ETA: 0s - loss: 1.4461e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4336e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.6919e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 6.9313e-04 - mean\_absolute\_error: 0.0126 23/126 [====>.........................] - ETA: 0s - loss: 1.6514e-04 - mean\_absolute\_error: 0.0092 47/126 [==========>...................] - ETA: 0s - loss: 1.4505e-04 - mean\_absolute\_error: 0.0089 71/126 [===============>..............] - ETA: 0s - loss: 1.4768e-04 - mean\_absolute\_error: 0.0091 95/126 [=====================>........] - ETA: 0s - loss: 1.4826e-04 - mean\_absolute\_error: 0.0090119/126 [===========================>..] - ETA: 0s - loss: 1.4502e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4429e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.1311e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8606e-04 - mean\_absolute\_error: 0.0107 23/126 [====>.........................] - ETA: 0s - loss: 1.8568e-04 - mean\_absolute\_error: 0.0102 48/126 [==========>...................] - ETA: 0s - loss: 1.6502e-04 - mean\_absolute\_error: 0.0097 72/126 [================>.............] - ETA: 0s - loss: 1.6056e-04 - mean\_absolute\_error: 0.0094 97/126 [======================>.......] - ETA: 0s - loss: 1.5500e-04 - mean\_absolute\_error: 0.0093122/126 [============================>.] - ETA: 0s - loss: 1.4928e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4876e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9169e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5322e-05 - mean\_absolute\_error: 0.0064 20/126 [===>..........................] - ETA: 0s - loss: 1.3150e-04 - mean\_absolute\_error: 0.0088 44/126 [=========>....................] - ETA: 0s - loss: 1.3844e-04 - mean\_absolute\_error: 0.0091 68/126 [===============>..............] - ETA: 0s - loss: 1.5856e-04 - mean\_absolute\_error: 0.0095 94/126 [=====================>........] - ETA: 0s - loss: 1.5138e-04 - mean\_absolute\_error: 0.0093117/126 [==========================>...] - ETA: 0s - loss: 1.5635e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5543e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.1562e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 9.2995e-05 - mean\_absolute\_error: 0.0078 25/126 [====>.........................] - ETA: 0s - loss: 1.3113e-04 - mean\_absolute\_error: 0.0088 49/126 [==========>...................] - ETA: 0s - loss: 1.3553e-04 - mean\_absolute\_error: 0.0088 73/126 [================>.............] - ETA: 0s - loss: 1.4315e-04 - mean\_absolute\_error: 0.0089 98/126 [======================>.......] - ETA: 0s - loss: 1.5262e-04 - mean\_absolute\_error: 0.0091124/126 [============================>.] - ETA: 0s - loss: 1.4658e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4618e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.0185e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4228e-04 - mean\_absolute\_error: 0.0082 22/126 [====>.........................] - ETA: 0s - loss: 1.4630e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.3399e-04 - mean\_absolute\_error: 0.0087 68/126 [===============>..............] - ETA: 0s - loss: 1.4668e-04 - mean\_absolute\_error: 0.0089 94/126 [=====================>........] - ETA: 0s - loss: 1.4536e-04 - mean\_absolute\_error: 0.0090119/126 [===========================>..] - ETA: 0s - loss: 1.4951e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4867e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.7567e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7527e-04 - mean\_absolute\_error: 0.0129 18/126 [===>..........................] - ETA: 0s - loss: 1.4952e-04 - mean\_absolute\_error: 0.0096 36/126 [=======>......................] - ETA: 0s - loss: 1.5953e-04 - mean\_absolute\_error: 0.0095 59/126 [=============>................] - ETA: 0s - loss: 1.4717e-04 - mean\_absolute\_error: 0.0091 84/126 [===================>..........] - ETA: 0s - loss: 1.4233e-04 - mean\_absolute\_error: 0.0090109/126 [========================>.....] - ETA: 0s - loss: 1.4738e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4730e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.3876e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3836e-04 - mean\_absolute\_error: 0.0113 22/126 [====>.........................] - ETA: 0s - loss: 1.3695e-04 - mean\_absolute\_error: 0.0086 45/126 [=========>....................] - ETA: 0s - loss: 1.4174e-04 - mean\_absolute\_error: 0.0087 67/126 [==============>...............] - ETA: 0s - loss: 1.4924e-04 - mean\_absolute\_error: 0.0089 89/126 [====================>.........] - ETA: 0s - loss: 1.4856e-04 - mean\_absolute\_error: 0.0090105/126 [========================>.....] - ETA: 0s - loss: 1.4709e-04 - mean\_absolute\_error: 0.0090120/126 [===========================>..] - ETA: 0s - loss: 1.4527e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4540e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.1407e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7218e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 1.5285e-04 - mean\_absolute\_error: 0.0088 45/126 [=========>....................] - ETA: 0s - loss: 1.5410e-04 - mean\_absolute\_error: 0.0089 68/126 [===============>..............] - ETA: 0s - loss: 1.4822e-04 - mean\_absolute\_error: 0.0090 91/126 [====================>.........] - ETA: 0s - loss: 1.4714e-04 - mean\_absolute\_error: 0.0091115/126 [==========================>...] - ETA: 0s - loss: 1.4396e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4687e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9814e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0058e-04 - mean\_absolute\_error: 0.0076 25/126 [====>.........................] - ETA: 0s - loss: 1.5088e-04 - mean\_absolute\_error: 0.0093 44/126 [=========>....................] - ETA: 0s - loss: 1.4109e-04 - mean\_absolute\_error: 0.0089 67/126 [==============>...............] - ETA: 0s - loss: 1.4412e-04 - mean\_absolute\_error: 0.0090 90/126 [====================>.........] - ETA: 0s - loss: 1.3860e-04 - mean\_absolute\_error: 0.0089110/126 [=========================>....] - ETA: 0s - loss: 1.3929e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4448e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 6.2497e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8834e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 1.2693e-04 - mean\_absolute\_error: 0.0085 49/126 [==========>...................] - ETA: 0s - loss: 1.3510e-04 - mean\_absolute\_error: 0.0088 74/126 [================>.............] - ETA: 0s - loss: 1.3532e-04 - mean\_absolute\_error: 0.0089 98/126 [======================>.......] - ETA: 0s - loss: 1.4311e-04 - mean\_absolute\_error: 0.0090123/126 [============================>.] - ETA: 0s - loss: 1.4963e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.4926e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9264e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2878e-04 - mean\_absolute\_error: 0.0090 21/126 [====>.........................] - ETA: 0s - loss: 1.3853e-04 - mean\_absolute\_error: 0.0089 43/126 [=========>....................] - ETA: 0s - loss: 1.4258e-04 - mean\_absolute\_error: 0.0090 66/126 [==============>...............] - ETA: 0s - loss: 1.5035e-04 - mean\_absolute\_error: 0.0092 82/126 [==================>...........] - ETA: 0s - loss: 1.4854e-04 - mean\_absolute\_error: 0.0090 98/126 [======================>.......] - ETA: 0s - loss: 1.4489e-04 - mean\_absolute\_error: 0.0089114/126 [==========================>...] - ETA: 0s - loss: 1.4450e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4333e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 5.2535e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3901e-05 - mean\_absolute\_error: 0.0079 17/126 [===>..........................] - ETA: 0s - loss: 1.2150e-04 - mean\_absolute\_error: 0.0084 33/126 [======>.......................] - ETA: 0s - loss: 1.2267e-04 - mean\_absolute\_error: 0.0085 49/126 [==========>...................] - ETA: 0s - loss: 1.5843e-04 - mean\_absolute\_error: 0.0091 64/126 [==============>...............] - ETA: 0s - loss: 1.5767e-04 - mean\_absolute\_error: 0.0092 80/126 [==================>...........] - ETA: 0s - loss: 1.5744e-04 - mean\_absolute\_error: 0.0092 94/126 [=====================>........] - ETA: 0s - loss: 1.5689e-04 - mean\_absolute\_error: 0.0092107/126 [========================>.....] - ETA: 0s - loss: 1.5675e-04 - mean\_absolute\_error: 0.0093122/126 [============================>.] - ETA: 0s - loss: 1.5383e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 4ms/step - loss: 1.5276e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.0322e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0940e-04 - mean\_absolute\_error: 0.0080 22/126 [====>.........................] - ETA: 0s - loss: 1.5129e-04 - mean\_absolute\_error: 0.0087 40/126 [========>.....................] - ETA: 0s - loss: 1.3828e-04 - mean\_absolute\_error: 0.0086 62/126 [=============>................] - ETA: 0s - loss: 1.4481e-04 - mean\_absolute\_error: 0.0088 84/126 [===================>..........] - ETA: 0s - loss: 1.3974e-04 - mean\_absolute\_error: 0.0087107/126 [========================>.....] - ETA: 0s - loss: 1.3999e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3985e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 6.2269e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1654e-04 - mean\_absolute\_error: 0.0096 23/126 [====>.........................] - ETA: 0s - loss: 1.5695e-04 - mean\_absolute\_error: 0.0089 45/126 [=========>....................] - ETA: 0s - loss: 1.4320e-04 - mean\_absolute\_error: 0.0088 60/126 [=============>................] - ETA: 0s - loss: 1.3842e-04 - mean\_absolute\_error: 0.0088 81/126 [==================>...........] - ETA: 0s - loss: 1.3710e-04 - mean\_absolute\_error: 0.0088102/126 [=======================>......] - ETA: 0s - loss: 1.3729e-04 - mean\_absolute\_error: 0.0088123/126 [============================>.] - ETA: 0s - loss: 1.3786e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.4170e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 5.0382e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4841e-04 - mean\_absolute\_error: 0.0091 17/126 [===>..........................] - ETA: 0s - loss: 1.2802e-04 - mean\_absolute\_error: 0.0086 37/126 [=======>......................] - ETA: 0s - loss: 1.4407e-04 - mean\_absolute\_error: 0.0088 59/126 [=============>................] - ETA: 0s - loss: 1.4141e-04 - mean\_absolute\_error: 0.0088 80/126 [==================>...........] - ETA: 0s - loss: 1.4415e-04 - mean\_absolute\_error: 0.0088101/126 [=======================>......] - ETA: 0s - loss: 1.4611e-04 - mean\_absolute\_error: 0.0090122/126 [============================>.] - ETA: 0s - loss: 1.4686e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4760e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.6147e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0168e-04 - mean\_absolute\_error: 0.0080 18/126 [===>..........................] - ETA: 0s - loss: 1.2699e-04 - mean\_absolute\_error: 0.0085 39/126 [========>.....................] - ETA: 0s - loss: 1.2463e-04 - mean\_absolute\_error: 0.0085 61/126 [=============>................] - ETA: 0s - loss: 1.3649e-04 - mean\_absolute\_error: 0.0087 80/126 [==================>...........] - ETA: 0s - loss: 1.4210e-04 - mean\_absolute\_error: 0.0087102/126 [=======================>......] - ETA: 0s - loss: 1.4100e-04 - mean\_absolute\_error: 0.0087125/126 [============================>.] - ETA: 0s - loss: 1.4295e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4292e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 9.4806e-05 - val\_mean\_absolute\_error: 0.0080  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4936e-04 - mean\_absolute\_error: 0.0125 24/126 [====>.........................] - ETA: 0s - loss: 1.4495e-04 - mean\_absolute\_error: 0.0092 47/126 [==========>...................] - ETA: 0s - loss: 1.5737e-04 - mean\_absolute\_error: 0.0093 72/126 [================>.............] - ETA: 0s - loss: 1.5049e-04 - mean\_absolute\_error: 0.0092 97/126 [======================>.......] - ETA: 0s - loss: 1.5027e-04 - mean\_absolute\_error: 0.0092119/126 [===========================>..] - ETA: 0s - loss: 1.4991e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4900e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9348e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1563e-04 - mean\_absolute\_error: 0.0065 20/126 [===>..........................] - ETA: 0s - loss: 1.3363e-04 - mean\_absolute\_error: 0.0088 43/126 [=========>....................] - ETA: 0s - loss: 1.3199e-04 - mean\_absolute\_error: 0.0088 66/126 [==============>...............] - ETA: 0s - loss: 1.3138e-04 - mean\_absolute\_error: 0.0087 90/126 [====================>.........] - ETA: 0s - loss: 1.4012e-04 - mean\_absolute\_error: 0.0089113/126 [=========================>....] - ETA: 0s - loss: 1.4416e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4767e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.8262e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4451e-04 - mean\_absolute\_error: 0.0110 21/126 [====>.........................] - ETA: 0s - loss: 1.5536e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.5281e-04 - mean\_absolute\_error: 0.0090 71/126 [===============>..............] - ETA: 0s - loss: 1.5513e-04 - mean\_absolute\_error: 0.0090 96/126 [=====================>........] - ETA: 0s - loss: 1.6064e-04 - mean\_absolute\_error: 0.0093121/126 [===========================>..] - ETA: 0s - loss: 1.5917e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5721e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.9692e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1661e-04 - mean\_absolute\_error: 0.0084 22/126 [====>.........................] - ETA: 0s - loss: 1.2512e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.5098e-04 - mean\_absolute\_error: 0.0091 71/126 [===============>..............] - ETA: 0s - loss: 1.4793e-04 - mean\_absolute\_error: 0.0089 95/126 [=====================>........] - ETA: 0s - loss: 1.4383e-04 - mean\_absolute\_error: 0.0089121/126 [===========================>..] - ETA: 0s - loss: 1.4527e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4544e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.5668e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7223e-04 - mean\_absolute\_error: 0.0089 21/126 [====>.........................] - ETA: 0s - loss: 1.8516e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 1.8051e-04 - mean\_absolute\_error: 0.0101 67/126 [==============>...............] - ETA: 0s - loss: 1.6638e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.6208e-04 - mean\_absolute\_error: 0.0097110/126 [=========================>....] - ETA: 0s - loss: 1.6277e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6654e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 4.9595e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6798e-05 - mean\_absolute\_error: 0.0073 21/126 [====>.........................] - ETA: 0s - loss: 1.3126e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.4919e-04 - mean\_absolute\_error: 0.0091 70/126 [===============>..............] - ETA: 0s - loss: 1.4688e-04 - mean\_absolute\_error: 0.0091 94/126 [=====================>........] - ETA: 0s - loss: 1.4674e-04 - mean\_absolute\_error: 0.0091116/126 [==========================>...] - ETA: 0s - loss: 1.4659e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4403e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.5069e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5446e-04 - mean\_absolute\_error: 0.0100 20/126 [===>..........................] - ETA: 0s - loss: 1.3895e-04 - mean\_absolute\_error: 0.0089 42/126 [=========>....................] - ETA: 0s - loss: 1.3561e-04 - mean\_absolute\_error: 0.0090 67/126 [==============>...............] - ETA: 0s - loss: 1.5818e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.8475e-04 - mean\_absolute\_error: 0.0102116/126 [==========================>...] - ETA: 0s - loss: 1.7470e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7651e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 8.2895e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1480e-04 - mean\_absolute\_error: 0.0089 20/126 [===>..........................] - ETA: 0s - loss: 1.4426e-04 - mean\_absolute\_error: 0.0092 44/126 [=========>....................] - ETA: 0s - loss: 1.7078e-04 - mean\_absolute\_error: 0.0097 67/126 [==============>...............] - ETA: 0s - loss: 1.9019e-04 - mean\_absolute\_error: 0.0105 88/126 [===================>..........] - ETA: 0s - loss: 1.9085e-04 - mean\_absolute\_error: 0.0105111/126 [=========================>....] - ETA: 0s - loss: 1.8323e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 3ms/step - loss: 1.7651e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 4.9045e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8779e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 1.5373e-04 - mean\_absolute\_error: 0.0094 45/126 [=========>....................] - ETA: 0s - loss: 1.4105e-04 - mean\_absolute\_error: 0.0091 70/126 [===============>..............] - ETA: 0s - loss: 1.4998e-04 - mean\_absolute\_error: 0.0092 94/126 [=====================>........] - ETA: 0s - loss: 1.5007e-04 - mean\_absolute\_error: 0.0091118/126 [===========================>..] - ETA: 0s - loss: 1.5165e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5242e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 7.4397e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6059e-04 - mean\_absolute\_error: 0.0126 18/126 [===>..........................] - ETA: 0s - loss: 1.4939e-04 - mean\_absolute\_error: 0.0089 42/126 [=========>....................] - ETA: 0s - loss: 1.6670e-04 - mean\_absolute\_error: 0.0093 66/126 [==============>...............] - ETA: 0s - loss: 1.6975e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.6603e-04 - mean\_absolute\_error: 0.0095115/126 [==========================>...] - ETA: 0s - loss: 1.5556e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5340e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 8.5015e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2256e-04 - mean\_absolute\_error: 0.0091 19/126 [===>..........................] - ETA: 0s - loss: 1.3368e-04 - mean\_absolute\_error: 0.0090 44/126 [=========>....................] - ETA: 0s - loss: 1.3261e-04 - mean\_absolute\_error: 0.0089 70/126 [===============>..............] - ETA: 0s - loss: 1.3941e-04 - mean\_absolute\_error: 0.0089 95/126 [=====================>........] - ETA: 0s - loss: 1.3875e-04 - mean\_absolute\_error: 0.0089120/126 [===========================>..] - ETA: 0s - loss: 1.4725e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4633e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.1488e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5572e-04 - mean\_absolute\_error: 0.0101 18/126 [===>..........................] - ETA: 0s - loss: 1.3577e-04 - mean\_absolute\_error: 0.0087 41/126 [========>.....................] - ETA: 0s - loss: 1.3853e-04 - mean\_absolute\_error: 0.0086 66/126 [==============>...............] - ETA: 0s - loss: 1.3890e-04 - mean\_absolute\_error: 0.0087 90/126 [====================>.........] - ETA: 0s - loss: 1.3722e-04 - mean\_absolute\_error: 0.0088114/126 [==========================>...] - ETA: 0s - loss: 1.4372e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4491e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 7.2273e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0271e-04 - mean\_absolute\_error: 0.0117 24/126 [====>.........................] - ETA: 0s - loss: 1.5710e-04 - mean\_absolute\_error: 0.0097 49/126 [==========>...................] - ETA: 0s - loss: 1.5643e-04 - mean\_absolute\_error: 0.0094 74/126 [================>.............] - ETA: 0s - loss: 1.4574e-04 - mean\_absolute\_error: 0.0091 99/126 [======================>.......] - ETA: 0s - loss: 1.4715e-04 - mean\_absolute\_error: 0.0090123/126 [============================>.] - ETA: 0s - loss: 1.5050e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4910e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 6.2660e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2460e-04 - mean\_absolute\_error: 0.0091 17/126 [===>..........................] - ETA: 0s - loss: 1.3070e-04 - mean\_absolute\_error: 0.0086 36/126 [=======>......................] - ETA: 0s - loss: 1.4283e-04 - mean\_absolute\_error: 0.0091 59/126 [=============>................] - ETA: 0s - loss: 1.4050e-04 - mean\_absolute\_error: 0.0091 83/126 [==================>...........] - ETA: 0s - loss: 1.3742e-04 - mean\_absolute\_error: 0.0090105/126 [========================>.....] - ETA: 0s - loss: 1.4893e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4960e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.3707e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7746e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 1.5518e-04 - mean\_absolute\_error: 0.0091 47/126 [==========>...................] - ETA: 0s - loss: 1.5967e-04 - mean\_absolute\_error: 0.0092 70/126 [===============>..............] - ETA: 0s - loss: 1.5592e-04 - mean\_absolute\_error: 0.0092 93/126 [=====================>........] - ETA: 0s - loss: 1.5265e-04 - mean\_absolute\_error: 0.0092111/126 [=========================>....] - ETA: 0s - loss: 1.5443e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5162e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 7.1606e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0640e-04 - mean\_absolute\_error: 0.0107 24/126 [====>.........................] - ETA: 0s - loss: 1.3070e-04 - mean\_absolute\_error: 0.0088 49/126 [==========>...................] - ETA: 0s - loss: 1.5215e-04 - mean\_absolute\_error: 0.0092 74/126 [================>.............] - ETA: 0s - loss: 1.5317e-04 - mean\_absolute\_error: 0.0094 99/126 [======================>.......] - ETA: 0s - loss: 1.4794e-04 - mean\_absolute\_error: 0.0092122/126 [============================>.] - ETA: 0s - loss: 1.5189e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5119e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 2.1800e-04 - val\_mean\_absolute\_error: 0.0133  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6985e-04 - mean\_absolute\_error: 0.0139 22/126 [====>.........................] - ETA: 0s - loss: 1.8257e-04 - mean\_absolute\_error: 0.0104 47/126 [==========>...................] - ETA: 0s - loss: 1.6558e-04 - mean\_absolute\_error: 0.0098 71/126 [===============>..............] - ETA: 0s - loss: 1.5300e-04 - mean\_absolute\_error: 0.0094 96/126 [=====================>........] - ETA: 0s - loss: 1.5935e-04 - mean\_absolute\_error: 0.0095121/126 [===========================>..] - ETA: 0s - loss: 1.6592e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 2ms/step - loss: 1.6976e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 8.5087e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2822e-04 - mean\_absolute\_error: 0.0087 18/126 [===>..........................] - ETA: 0s - loss: 1.6682e-04 - mean\_absolute\_error: 0.0099 41/126 [========>.....................] - ETA: 0s - loss: 1.5167e-04 - mean\_absolute\_error: 0.0093 64/126 [==============>...............] - ETA: 0s - loss: 1.4240e-04 - mean\_absolute\_error: 0.0091 82/126 [==================>...........] - ETA: 0s - loss: 1.5383e-04 - mean\_absolute\_error: 0.0093 99/126 [======================>.......] - ETA: 0s - loss: 1.5434e-04 - mean\_absolute\_error: 0.0092117/126 [==========================>...] - ETA: 0s - loss: 1.4850e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4738e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.8164e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8947e-05 - mean\_absolute\_error: 0.0064 17/126 [===>..........................] - ETA: 0s - loss: 1.7351e-04 - mean\_absolute\_error: 0.0091 32/126 [======>.......................] - ETA: 0s - loss: 1.3710e-04 - mean\_absolute\_error: 0.0083 49/126 [==========>...................] - ETA: 0s - loss: 1.5425e-04 - mean\_absolute\_error: 0.0090 68/126 [===============>..............] - ETA: 0s - loss: 1.6811e-04 - mean\_absolute\_error: 0.0097 87/126 [===================>..........] - ETA: 0s - loss: 1.6715e-04 - mean\_absolute\_error: 0.0095104/126 [=======================>......] - ETA: 0s - loss: 1.6132e-04 - mean\_absolute\_error: 0.0094122/126 [============================>.] - ETA: 0s - loss: 1.5991e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5974e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.4504e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5384e-04 - mean\_absolute\_error: 0.0152 24/126 [====>.........................] - ETA: 0s - loss: 1.6526e-04 - mean\_absolute\_error: 0.0100 49/126 [==========>...................] - ETA: 0s - loss: 1.8002e-04 - mean\_absolute\_error: 0.0102 73/126 [================>.............] - ETA: 0s - loss: 1.9077e-04 - mean\_absolute\_error: 0.0106 98/126 [======================>.......] - ETA: 0s - loss: 1.8369e-04 - mean\_absolute\_error: 0.0104121/126 [===========================>..] - ETA: 0s - loss: 1.8198e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.7980e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 4.8946e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0545e-04 - mean\_absolute\_error: 0.0076 16/126 [==>...........................] - ETA: 0s - loss: 1.3730e-04 - mean\_absolute\_error: 0.0090 34/126 [=======>......................] - ETA: 0s - loss: 1.5580e-04 - mean\_absolute\_error: 0.0095 53/126 [===========>..................] - ETA: 0s - loss: 1.8300e-04 - mean\_absolute\_error: 0.0100 71/126 [===============>..............] - ETA: 0s - loss: 1.6719e-04 - mean\_absolute\_error: 0.0096 91/126 [====================>.........] - ETA: 0s - loss: 1.5746e-04 - mean\_absolute\_error: 0.0093111/126 [=========================>....] - ETA: 0s - loss: 1.5512e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5891e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.8012e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4470e-04 - mean\_absolute\_error: 0.0086 21/126 [====>.........................] - ETA: 0s - loss: 1.4376e-04 - mean\_absolute\_error: 0.0091 43/126 [=========>....................] - ETA: 0s - loss: 1.5739e-04 - mean\_absolute\_error: 0.0096 62/126 [=============>................] - ETA: 0s - loss: 1.6880e-04 - mean\_absolute\_error: 0.0098 77/126 [=================>............] - ETA: 0s - loss: 1.7599e-04 - mean\_absolute\_error: 0.0101 98/126 [======================>.......] - ETA: 0s - loss: 1.6825e-04 - mean\_absolute\_error: 0.0099121/126 [===========================>..] - ETA: 0s - loss: 1.7768e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.8010e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.2206e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5855e-04 - mean\_absolute\_error: 0.0142 15/126 [==>...........................] - ETA: 0s - loss: 1.6090e-04 - mean\_absolute\_error: 0.0103 34/126 [=======>......................] - ETA: 0s - loss: 1.5122e-04 - mean\_absolute\_error: 0.0096 58/126 [============>.................] - ETA: 0s - loss: 1.5950e-04 - mean\_absolute\_error: 0.0097 82/126 [==================>...........] - ETA: 0s - loss: 1.6003e-04 - mean\_absolute\_error: 0.0097106/126 [========================>.....] - ETA: 0s - loss: 1.6435e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.5902e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 7.9460e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8171e-04 - mean\_absolute\_error: 0.0108 20/126 [===>..........................] - ETA: 0s - loss: 1.7170e-04 - mean\_absolute\_error: 0.0097 43/126 [=========>....................] - ETA: 0s - loss: 1.5493e-04 - mean\_absolute\_error: 0.0093 64/126 [==============>...............] - ETA: 0s - loss: 1.4549e-04 - mean\_absolute\_error: 0.0091 88/126 [===================>..........] - ETA: 0s - loss: 1.4150e-04 - mean\_absolute\_error: 0.0090113/126 [=========================>....] - ETA: 0s - loss: 1.4731e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4932e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 1.2184e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0083e-04 - mean\_absolute\_error: 0.0116 23/126 [====>.........................] - ETA: 0s - loss: 1.6749e-04 - mean\_absolute\_error: 0.0100 46/126 [=========>....................] - ETA: 0s - loss: 1.7687e-04 - mean\_absolute\_error: 0.0099 71/126 [===============>..............] - ETA: 0s - loss: 1.7536e-04 - mean\_absolute\_error: 0.0099 96/126 [=====================>........] - ETA: 0s - loss: 1.6657e-04 - mean\_absolute\_error: 0.0097120/126 [===========================>..] - ETA: 0s - loss: 1.6157e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.5916e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.7435e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9288e-04 - mean\_absolute\_error: 0.0108 20/126 [===>..........................] - ETA: 0s - loss: 1.5983e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.5117e-04 - mean\_absolute\_error: 0.0090 70/126 [===============>..............] - ETA: 0s - loss: 1.5539e-04 - mean\_absolute\_error: 0.0093 95/126 [=====================>........] - ETA: 0s - loss: 1.4789e-04 - mean\_absolute\_error: 0.0091120/126 [===========================>..] - ETA: 0s - loss: 1.4882e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5033e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.7702e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1978e-04 - mean\_absolute\_error: 0.0096 19/126 [===>..........................] - ETA: 0s - loss: 1.4276e-04 - mean\_absolute\_error: 0.0093 42/126 [=========>....................] - ETA: 0s - loss: 1.3695e-04 - mean\_absolute\_error: 0.0088 66/126 [==============>...............] - ETA: 0s - loss: 1.4269e-04 - mean\_absolute\_error: 0.0091 91/126 [====================>.........] - ETA: 0s - loss: 1.4608e-04 - mean\_absolute\_error: 0.0093116/126 [==========================>...] - ETA: 0s - loss: 1.4978e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4945e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.6529e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9021e-04 - mean\_absolute\_error: 0.0131 22/126 [====>.........................] - ETA: 0s - loss: 1.4758e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.3655e-04 - mean\_absolute\_error: 0.0088 68/126 [===============>..............] - ETA: 0s - loss: 1.3458e-04 - mean\_absolute\_error: 0.0087 94/126 [=====================>........] - ETA: 0s - loss: 1.4527e-04 - mean\_absolute\_error: 0.0090119/126 [===========================>..] - ETA: 0s - loss: 1.5541e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5560e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 6.9610e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3825e-04 - mean\_absolute\_error: 0.0101 20/126 [===>..........................] - ETA: 0s - loss: 1.9544e-04 - mean\_absolute\_error: 0.0095 45/126 [=========>....................] - ETA: 0s - loss: 1.6581e-04 - mean\_absolute\_error: 0.0093 70/126 [===============>..............] - ETA: 0s - loss: 1.5599e-04 - mean\_absolute\_error: 0.0093 95/126 [=====================>........] - ETA: 0s - loss: 1.4883e-04 - mean\_absolute\_error: 0.0091120/126 [===========================>..] - ETA: 0s - loss: 1.4818e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5131e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.5691e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1750e-04 - mean\_absolute\_error: 0.0083 20/126 [===>..........................] - ETA: 0s - loss: 1.4497e-04 - mean\_absolute\_error: 0.0094 45/126 [=========>....................] - ETA: 0s - loss: 1.6261e-04 - mean\_absolute\_error: 0.0097 69/126 [===============>..............] - ETA: 0s - loss: 1.5542e-04 - mean\_absolute\_error: 0.0092 94/126 [=====================>........] - ETA: 0s - loss: 1.4627e-04 - mean\_absolute\_error: 0.0090119/126 [===========================>..] - ETA: 0s - loss: 1.4728e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4980e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9978e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0391e-04 - mean\_absolute\_error: 0.0102 18/126 [===>..........................] - ETA: 0s - loss: 1.6626e-04 - mean\_absolute\_error: 0.0092 41/126 [========>.....................] - ETA: 0s - loss: 1.4309e-04 - mean\_absolute\_error: 0.0088 66/126 [==============>...............] - ETA: 0s - loss: 1.3471e-04 - mean\_absolute\_error: 0.0087 91/126 [====================>.........] - ETA: 0s - loss: 1.3334e-04 - mean\_absolute\_error: 0.0088116/126 [==========================>...] - ETA: 0s - loss: 1.5300e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.6094e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.7415e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0907e-04 - mean\_absolute\_error: 0.0090 21/126 [====>.........................] - ETA: 0s - loss: 1.2576e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.2685e-04 - mean\_absolute\_error: 0.0087 69/126 [===============>..............] - ETA: 0s - loss: 1.2363e-04 - mean\_absolute\_error: 0.0085 94/126 [=====================>........] - ETA: 0s - loss: 1.5399e-04 - mean\_absolute\_error: 0.0092120/126 [===========================>..] - ETA: 0s - loss: 1.8664e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.8546e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 8.8918e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2957e-04 - mean\_absolute\_error: 0.0098 22/126 [====>.........................] - ETA: 0s - loss: 1.8837e-04 - mean\_absolute\_error: 0.0103 45/126 [=========>....................] - ETA: 0s - loss: 1.7527e-04 - mean\_absolute\_error: 0.0101 70/126 [===============>..............] - ETA: 0s - loss: 1.7597e-04 - mean\_absolute\_error: 0.0100 96/126 [=====================>........] - ETA: 0s - loss: 1.6965e-04 - mean\_absolute\_error: 0.0099121/126 [===========================>..] - ETA: 0s - loss: 1.5903e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 2ms/step - loss: 1.5897e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 6.7177e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1156e-04 - mean\_absolute\_error: 0.0091 20/126 [===>..........................] - ETA: 0s - loss: 1.3296e-04 - mean\_absolute\_error: 0.0088 45/126 [=========>....................] - ETA: 0s - loss: 1.5196e-04 - mean\_absolute\_error: 0.0092 71/126 [===============>..............] - ETA: 0s - loss: 1.5167e-04 - mean\_absolute\_error: 0.0093 96/126 [=====================>........] - ETA: 0s - loss: 1.8074e-04 - mean\_absolute\_error: 0.0101118/126 [===========================>..] - ETA: 0s - loss: 1.7471e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7316e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 4.8027e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2310e-04 - mean\_absolute\_error: 0.0083 23/126 [====>.........................] - ETA: 0s - loss: 1.5338e-04 - mean\_absolute\_error: 0.0088 46/126 [=========>....................] - ETA: 0s - loss: 1.3813e-04 - mean\_absolute\_error: 0.0087 71/126 [===============>..............] - ETA: 0s - loss: 1.5053e-04 - mean\_absolute\_error: 0.0092 96/126 [=====================>........] - ETA: 0s - loss: 1.4252e-04 - mean\_absolute\_error: 0.0090122/126 [============================>.] - ETA: 0s - loss: 1.4447e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4651e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 6.2437e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3791e-05 - mean\_absolute\_error: 0.0076 18/126 [===>..........................] - ETA: 0s - loss: 1.1591e-04 - mean\_absolute\_error: 0.0083 40/126 [========>.....................] - ETA: 0s - loss: 1.2850e-04 - mean\_absolute\_error: 0.0086 65/126 [==============>...............] - ETA: 0s - loss: 1.3789e-04 - mean\_absolute\_error: 0.0089 89/126 [====================>.........] - ETA: 0s - loss: 1.3872e-04 - mean\_absolute\_error: 0.0090112/126 [=========================>....] - ETA: 0s - loss: 1.3753e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4846e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.6334e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0701e-05 - mean\_absolute\_error: 0.0057 24/126 [====>.........................] - ETA: 0s - loss: 1.3594e-04 - mean\_absolute\_error: 0.0084 48/126 [==========>...................] - ETA: 0s - loss: 1.3260e-04 - mean\_absolute\_error: 0.0085 72/126 [================>.............] - ETA: 0s - loss: 1.3248e-04 - mean\_absolute\_error: 0.0086 96/126 [=====================>........] - ETA: 0s - loss: 1.4427e-04 - mean\_absolute\_error: 0.0089119/126 [===========================>..] - ETA: 0s - loss: 1.4231e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4155e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 8.2188e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7904e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.9032e-04 - mean\_absolute\_error: 0.0108 49/126 [==========>...................] - ETA: 0s - loss: 1.6959e-04 - mean\_absolute\_error: 0.0099 75/126 [================>.............] - ETA: 0s - loss: 1.5359e-04 - mean\_absolute\_error: 0.0095101/126 [=======================>......] - ETA: 0s - loss: 1.5193e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - ETA: 0s - loss: 1.5551e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5551e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.6309e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3471e-04 - mean\_absolute\_error: 0.0085 22/126 [====>.........................] - ETA: 0s - loss: 1.3110e-04 - mean\_absolute\_error: 0.0084 45/126 [=========>....................] - ETA: 0s - loss: 1.5157e-04 - mean\_absolute\_error: 0.0088 67/126 [==============>...............] - ETA: 0s - loss: 1.4933e-04 - mean\_absolute\_error: 0.0090 90/126 [====================>.........] - ETA: 0s - loss: 1.4540e-04 - mean\_absolute\_error: 0.0089114/126 [==========================>...] - ETA: 0s - loss: 1.3818e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3635e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 7.6003e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3992e-04 - mean\_absolute\_error: 0.0112 18/126 [===>..........................] - ETA: 0s - loss: 1.3360e-04 - mean\_absolute\_error: 0.0088 36/126 [=======>......................] - ETA: 0s - loss: 1.5101e-04 - mean\_absolute\_error: 0.0094 59/126 [=============>................] - ETA: 0s - loss: 1.8021e-04 - mean\_absolute\_error: 0.0100 84/126 [===================>..........] - ETA: 0s - loss: 1.6792e-04 - mean\_absolute\_error: 0.0096110/126 [=========================>....] - ETA: 0s - loss: 1.6101e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5844e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 1.1718e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9174e-04 - mean\_absolute\_error: 0.0117 20/126 [===>..........................] - ETA: 0s - loss: 1.3657e-04 - mean\_absolute\_error: 0.0091 45/126 [=========>....................] - ETA: 0s - loss: 1.3696e-04 - mean\_absolute\_error: 0.0089 71/126 [===============>..............] - ETA: 0s - loss: 1.4096e-04 - mean\_absolute\_error: 0.0091 97/126 [======================>.......] - ETA: 0s - loss: 1.5759e-04 - mean\_absolute\_error: 0.0094122/126 [============================>.] - ETA: 0s - loss: 1.5118e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5139e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.7491e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6926e-04 - mean\_absolute\_error: 0.0103 22/126 [====>.........................] - ETA: 0s - loss: 1.6506e-04 - mean\_absolute\_error: 0.0098 48/126 [==========>...................] - ETA: 0s - loss: 1.7578e-04 - mean\_absolute\_error: 0.0101 74/126 [================>.............] - ETA: 0s - loss: 1.6596e-04 - mean\_absolute\_error: 0.0097 99/126 [======================>.......] - ETA: 0s - loss: 1.5840e-04 - mean\_absolute\_error: 0.0094123/126 [============================>.] - ETA: 0s - loss: 1.5374e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5261e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 9.1194e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1934e-04 - mean\_absolute\_error: 0.0096 25/126 [====>.........................] - ETA: 0s - loss: 1.5262e-04 - mean\_absolute\_error: 0.0095 51/126 [===========>..................] - ETA: 0s - loss: 1.3871e-04 - mean\_absolute\_error: 0.0090 77/126 [=================>............] - ETA: 0s - loss: 1.5392e-04 - mean\_absolute\_error: 0.0095103/126 [=======================>......] - ETA: 0s - loss: 1.5415e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5026e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.9279e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5574e-04 - mean\_absolute\_error: 0.0095 20/126 [===>..........................] - ETA: 0s - loss: 1.5521e-04 - mean\_absolute\_error: 0.0097 44/126 [=========>....................] - ETA: 0s - loss: 1.4081e-04 - mean\_absolute\_error: 0.0093 69/126 [===============>..............] - ETA: 0s - loss: 1.5419e-04 - mean\_absolute\_error: 0.0097 91/126 [====================>.........] - ETA: 0s - loss: 1.5760e-04 - mean\_absolute\_error: 0.0096110/126 [=========================>....] - ETA: 0s - loss: 1.5843e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.5240e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 8.6989e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5556e-04 - mean\_absolute\_error: 0.0100 18/126 [===>..........................] - ETA: 0s - loss: 1.3495e-04 - mean\_absolute\_error: 0.0088 36/126 [=======>......................] - ETA: 0s - loss: 1.4559e-04 - mean\_absolute\_error: 0.0088 56/126 [============>.................] - ETA: 0s - loss: 1.5329e-04 - mean\_absolute\_error: 0.0090 74/126 [================>.............] - ETA: 0s - loss: 1.7468e-04 - mean\_absolute\_error: 0.0098 91/126 [====================>.........] - ETA: 0s - loss: 1.9137e-04 - mean\_absolute\_error: 0.0104110/126 [=========================>....] - ETA: 0s - loss: 1.9776e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 1.8793e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 8.8508e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3745e-04 - mean\_absolute\_error: 0.0099 18/126 [===>..........................] - ETA: 0s - loss: 1.6588e-04 - mean\_absolute\_error: 0.0102 37/126 [=======>......................] - ETA: 0s - loss: 1.4838e-04 - mean\_absolute\_error: 0.0094 55/126 [============>.................] - ETA: 0s - loss: 1.4589e-04 - mean\_absolute\_error: 0.0093 72/126 [================>.............] - ETA: 0s - loss: 1.5068e-04 - mean\_absolute\_error: 0.0093 90/126 [====================>.........] - ETA: 0s - loss: 1.5346e-04 - mean\_absolute\_error: 0.0093108/126 [========================>.....] - ETA: 0s - loss: 1.4790e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4704e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.5439e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0351e-04 - mean\_absolute\_error: 0.0078 18/126 [===>..........................] - ETA: 0s - loss: 1.5915e-04 - mean\_absolute\_error: 0.0097 34/126 [=======>......................] - ETA: 0s - loss: 1.6033e-04 - mean\_absolute\_error: 0.0096 51/126 [===========>..................] - ETA: 0s - loss: 1.5524e-04 - mean\_absolute\_error: 0.0096 73/126 [================>.............] - ETA: 0s - loss: 1.6861e-04 - mean\_absolute\_error: 0.0098 92/126 [====================>.........] - ETA: 0s - loss: 1.7160e-04 - mean\_absolute\_error: 0.0100113/126 [=========================>....] - ETA: 0s - loss: 1.7528e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.7297e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 4.5447e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4056e-05 - mean\_absolute\_error: 0.0072 17/126 [===>..........................] - ETA: 0s - loss: 1.5284e-04 - mean\_absolute\_error: 0.0087 35/126 [=======>......................] - ETA: 0s - loss: 1.3897e-04 - mean\_absolute\_error: 0.0088 56/126 [============>.................] - ETA: 0s - loss: 1.4101e-04 - mean\_absolute\_error: 0.0087 73/126 [================>.............] - ETA: 0s - loss: 1.3646e-04 - mean\_absolute\_error: 0.0086 91/126 [====================>.........] - ETA: 0s - loss: 1.3334e-04 - mean\_absolute\_error: 0.0085110/126 [=========================>....] - ETA: 0s - loss: 1.3079e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.3544e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 6.4567e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5604e-04 - mean\_absolute\_error: 0.0104 19/126 [===>..........................] - ETA: 0s - loss: 1.2105e-04 - mean\_absolute\_error: 0.0083 35/126 [=======>......................] - ETA: 0s - loss: 1.4143e-04 - mean\_absolute\_error: 0.0091 54/126 [===========>..................] - ETA: 0s - loss: 1.6717e-04 - mean\_absolute\_error: 0.0095 76/126 [=================>............] - ETA: 0s - loss: 1.5744e-04 - mean\_absolute\_error: 0.0093100/126 [======================>.......] - ETA: 0s - loss: 1.5372e-04 - mean\_absolute\_error: 0.0092120/126 [===========================>..] - ETA: 0s - loss: 1.4777e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5142e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.6664e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5369e-04 - mean\_absolute\_error: 0.0100 17/126 [===>..........................] - ETA: 0s - loss: 1.7782e-04 - mean\_absolute\_error: 0.0105 39/126 [========>.....................] - ETA: 0s - loss: 2.0650e-04 - mean\_absolute\_error: 0.0111 64/126 [==============>...............] - ETA: 0s - loss: 1.8776e-04 - mean\_absolute\_error: 0.0105 88/126 [===================>..........] - ETA: 0s - loss: 1.7405e-04 - mean\_absolute\_error: 0.0100112/126 [=========================>....] - ETA: 0s - loss: 1.5985e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.5989e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 4.4831e-05 - val\_mean\_absolute\_error: 0.0050  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3686e-05 - mean\_absolute\_error: 0.0064 23/126 [====>.........................] - ETA: 0s - loss: 1.3593e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 1.3378e-04 - mean\_absolute\_error: 0.0087 71/126 [===============>..............] - ETA: 0s - loss: 1.4058e-04 - mean\_absolute\_error: 0.0089 97/126 [======================>.......] - ETA: 0s - loss: 1.6389e-04 - mean\_absolute\_error: 0.0096120/126 [===========================>..] - ETA: 0s - loss: 1.5641e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5478e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.4860e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1611e-04 - mean\_absolute\_error: 0.0087 16/126 [==>...........................] - ETA: 0s - loss: 1.1915e-04 - mean\_absolute\_error: 0.0086 31/126 [======>.......................] - ETA: 0s - loss: 1.4198e-04 - mean\_absolute\_error: 0.0087 49/126 [==========>...................] - ETA: 0s - loss: 1.3263e-04 - mean\_absolute\_error: 0.0085 69/126 [===============>..............] - ETA: 0s - loss: 1.2871e-04 - mean\_absolute\_error: 0.0085 92/126 [====================>.........] - ETA: 0s - loss: 1.3155e-04 - mean\_absolute\_error: 0.0085116/126 [==========================>...] - ETA: 0s - loss: 1.3113e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.3695e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 5.9563e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8176e-05 - mean\_absolute\_error: 0.0058 24/126 [====>.........................] - ETA: 0s - loss: 1.5662e-04 - mean\_absolute\_error: 0.0096 49/126 [==========>...................] - ETA: 0s - loss: 1.5699e-04 - mean\_absolute\_error: 0.0096 73/126 [================>.............] - ETA: 0s - loss: 1.4192e-04 - mean\_absolute\_error: 0.0091 97/126 [======================>.......] - ETA: 0s - loss: 1.3647e-04 - mean\_absolute\_error: 0.0089118/126 [===========================>..] - ETA: 0s - loss: 1.5612e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.6004e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 2.6807e-04 - val\_mean\_absolute\_error: 0.0150  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2618e-04 - mean\_absolute\_error: 0.0206 25/126 [====>.........................] - ETA: 0s - loss: 1.8380e-04 - mean\_absolute\_error: 0.0099 50/126 [==========>...................] - ETA: 0s - loss: 1.4536e-04 - mean\_absolute\_error: 0.0090 75/126 [================>.............] - ETA: 0s - loss: 1.3878e-04 - mean\_absolute\_error: 0.0088 94/126 [=====================>........] - ETA: 0s - loss: 1.3665e-04 - mean\_absolute\_error: 0.0088108/126 [========================>.....] - ETA: 0s - loss: 1.3502e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3617e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 8.3267e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8373e-05 - mean\_absolute\_error: 0.0073 19/126 [===>..........................] - ETA: 0s - loss: 1.8891e-04 - mean\_absolute\_error: 0.0101 44/126 [=========>....................] - ETA: 0s - loss: 1.5135e-04 - mean\_absolute\_error: 0.0092 66/126 [==============>...............] - ETA: 0s - loss: 1.4451e-04 - mean\_absolute\_error: 0.0090 87/126 [===================>..........] - ETA: 0s - loss: 1.3908e-04 - mean\_absolute\_error: 0.0089106/126 [========================>.....] - ETA: 0s - loss: 1.4873e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4865e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 8.1946e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5528e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 2.0175e-04 - mean\_absolute\_error: 0.0109 46/126 [=========>....................] - ETA: 0s - loss: 1.8075e-04 - mean\_absolute\_error: 0.0101 66/126 [==============>...............] - ETA: 0s - loss: 1.6234e-04 - mean\_absolute\_error: 0.0096 91/126 [====================>.........] - ETA: 0s - loss: 1.5036e-04 - mean\_absolute\_error: 0.0092115/126 [==========================>...] - ETA: 0s - loss: 1.4508e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4389e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 7.9713e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7742e-04 - mean\_absolute\_error: 0.0108 19/126 [===>..........................] - ETA: 0s - loss: 1.4040e-04 - mean\_absolute\_error: 0.0090 43/126 [=========>....................] - ETA: 0s - loss: 1.7091e-04 - mean\_absolute\_error: 0.0102 68/126 [===============>..............] - ETA: 0s - loss: 1.5879e-04 - mean\_absolute\_error: 0.0098 91/126 [====================>.........] - ETA: 0s - loss: 1.5354e-04 - mean\_absolute\_error: 0.0095116/126 [==========================>...] - ETA: 0s - loss: 1.6071e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6256e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.0076e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 7.4633e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 1.3638e-04 - mean\_absolute\_error: 0.0084 45/126 [=========>....................] - ETA: 0s - loss: 1.2588e-04 - mean\_absolute\_error: 0.0082 66/126 [==============>...............] - ETA: 0s - loss: 1.2782e-04 - mean\_absolute\_error: 0.0083 87/126 [===================>..........] - ETA: 0s - loss: 1.2845e-04 - mean\_absolute\_error: 0.0084110/126 [=========================>....] - ETA: 0s - loss: 1.2653e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.3000e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 5.0325e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2780e-04 - mean\_absolute\_error: 0.0097 22/126 [====>.........................] - ETA: 0s - loss: 1.2020e-04 - mean\_absolute\_error: 0.0083 46/126 [=========>....................] - ETA: 0s - loss: 1.1767e-04 - mean\_absolute\_error: 0.0082 70/126 [===============>..............] - ETA: 0s - loss: 1.2759e-04 - mean\_absolute\_error: 0.0085 93/126 [=====================>........] - ETA: 0s - loss: 1.3281e-04 - mean\_absolute\_error: 0.0088116/126 [==========================>...] - ETA: 0s - loss: 1.3861e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3638e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 5.3228e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0621e-04 - mean\_absolute\_error: 0.0087 24/126 [====>.........................] - ETA: 0s - loss: 1.4164e-04 - mean\_absolute\_error: 0.0093 49/126 [==========>...................] - ETA: 0s - loss: 1.3991e-04 - mean\_absolute\_error: 0.0092 73/126 [================>.............] - ETA: 0s - loss: 1.4282e-04 - mean\_absolute\_error: 0.0090 98/126 [======================>.......] - ETA: 0s - loss: 1.3867e-04 - mean\_absolute\_error: 0.0088123/126 [============================>.] - ETA: 0s - loss: 1.4435e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4450e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.1710e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7563e-04 - mean\_absolute\_error: 0.0112 18/126 [===>..........................] - ETA: 0s - loss: 1.6356e-04 - mean\_absolute\_error: 0.0102 43/126 [=========>....................] - ETA: 0s - loss: 1.4721e-04 - mean\_absolute\_error: 0.0095 68/126 [===============>..............] - ETA: 0s - loss: 1.5197e-04 - mean\_absolute\_error: 0.0093 93/126 [=====================>........] - ETA: 0s - loss: 1.4847e-04 - mean\_absolute\_error: 0.0092119/126 [===========================>..] - ETA: 0s - loss: 1.4182e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.3995e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.3251e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6309e-04 - mean\_absolute\_error: 0.0109 19/126 [===>..........................] - ETA: 0s - loss: 1.3007e-04 - mean\_absolute\_error: 0.0084 44/126 [=========>....................] - ETA: 0s - loss: 1.2843e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.3024e-04 - mean\_absolute\_error: 0.0087 93/126 [=====================>........] - ETA: 0s - loss: 1.2947e-04 - mean\_absolute\_error: 0.0087117/126 [==========================>...] - ETA: 0s - loss: 1.3733e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3896e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 4.5976e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3270e-04 - mean\_absolute\_error: 0.0087 19/126 [===>..........................] - ETA: 0s - loss: 1.2472e-04 - mean\_absolute\_error: 0.0084 42/126 [=========>....................] - ETA: 0s - loss: 1.3405e-04 - mean\_absolute\_error: 0.0086 64/126 [==============>...............] - ETA: 0s - loss: 1.3131e-04 - mean\_absolute\_error: 0.0086 89/126 [====================>.........] - ETA: 0s - loss: 1.4204e-04 - mean\_absolute\_error: 0.0090113/126 [=========================>....] - ETA: 0s - loss: 1.4517e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4277e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.8634e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9958e-05 - mean\_absolute\_error: 0.0058 22/126 [====>.........................] - ETA: 0s - loss: 1.2527e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.4256e-04 - mean\_absolute\_error: 0.0092 71/126 [===============>..............] - ETA: 0s - loss: 1.4032e-04 - mean\_absolute\_error: 0.0091 95/126 [=====================>........] - ETA: 0s - loss: 1.4271e-04 - mean\_absolute\_error: 0.0090121/126 [===========================>..] - ETA: 0s - loss: 1.4707e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4799e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 1.0083e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2152e-04 - mean\_absolute\_error: 0.0121 21/126 [====>.........................] - ETA: 0s - loss: 1.5365e-04 - mean\_absolute\_error: 0.0096 45/126 [=========>....................] - ETA: 0s - loss: 1.4895e-04 - mean\_absolute\_error: 0.0092 70/126 [===============>..............] - ETA: 0s - loss: 1.4204e-04 - mean\_absolute\_error: 0.0090 93/126 [=====================>........] - ETA: 0s - loss: 1.5181e-04 - mean\_absolute\_error: 0.0094118/126 [===========================>..] - ETA: 0s - loss: 1.4794e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4684e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.6005e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2297e-05 - mean\_absolute\_error: 0.0064 21/126 [====>.........................] - ETA: 0s - loss: 1.5359e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.3292e-04 - mean\_absolute\_error: 0.0085 67/126 [==============>...............] - ETA: 0s - loss: 1.2948e-04 - mean\_absolute\_error: 0.0084 90/126 [====================>.........] - ETA: 0s - loss: 1.2579e-04 - mean\_absolute\_error: 0.0084114/126 [==========================>...] - ETA: 0s - loss: 1.2758e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.3125e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 7.1821e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4097e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 1.3517e-04 - mean\_absolute\_error: 0.0091 48/126 [==========>...................] - ETA: 0s - loss: 1.2480e-04 - mean\_absolute\_error: 0.0086 73/126 [================>.............] - ETA: 0s - loss: 1.2577e-04 - mean\_absolute\_error: 0.0085 97/126 [======================>.......] - ETA: 0s - loss: 1.4041e-04 - mean\_absolute\_error: 0.0089121/126 [===========================>..] - ETA: 0s - loss: 1.3528e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3494e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.4014e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4664e-04 - mean\_absolute\_error: 0.0099 20/126 [===>..........................] - ETA: 0s - loss: 1.5189e-04 - mean\_absolute\_error: 0.0097 45/126 [=========>....................] - ETA: 0s - loss: 1.4332e-04 - mean\_absolute\_error: 0.0093 70/126 [===============>..............] - ETA: 0s - loss: 1.5233e-04 - mean\_absolute\_error: 0.0094 94/126 [=====================>........] - ETA: 0s - loss: 1.4597e-04 - mean\_absolute\_error: 0.0091118/126 [===========================>..] - ETA: 0s - loss: 1.5289e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5162e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.5493e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 9.2021e-05 - mean\_absolute\_error: 0.0079 20/126 [===>..........................] - ETA: 0s - loss: 1.2686e-04 - mean\_absolute\_error: 0.0084 42/126 [=========>....................] - ETA: 0s - loss: 1.2814e-04 - mean\_absolute\_error: 0.0086 67/126 [==============>...............] - ETA: 0s - loss: 1.2541e-04 - mean\_absolute\_error: 0.0086 92/126 [====================>.........] - ETA: 0s - loss: 1.2502e-04 - mean\_absolute\_error: 0.0084118/126 [===========================>..] - ETA: 0s - loss: 1.2939e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2825e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 5.2689e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2862e-04 - mean\_absolute\_error: 0.0094 20/126 [===>..........................] - ETA: 0s - loss: 1.5133e-04 - mean\_absolute\_error: 0.0096 40/126 [========>.....................] - ETA: 0s - loss: 1.2844e-04 - mean\_absolute\_error: 0.0087 62/126 [=============>................] - ETA: 0s - loss: 1.2418e-04 - mean\_absolute\_error: 0.0085 87/126 [===================>..........] - ETA: 0s - loss: 1.3521e-04 - mean\_absolute\_error: 0.0087111/126 [=========================>....] - ETA: 0s - loss: 1.3527e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.4017e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 9.8598e-05 - val\_mean\_absolute\_error: 0.0084  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6431e-04 - mean\_absolute\_error: 0.0105 22/126 [====>.........................] - ETA: 0s - loss: 1.1279e-04 - mean\_absolute\_error: 0.0082 46/126 [=========>....................] - ETA: 0s - loss: 1.3640e-04 - mean\_absolute\_error: 0.0089 71/126 [===============>..............] - ETA: 0s - loss: 1.4849e-04 - mean\_absolute\_error: 0.0092 96/126 [=====================>........] - ETA: 0s - loss: 1.5126e-04 - mean\_absolute\_error: 0.0093121/126 [===========================>..] - ETA: 0s - loss: 1.4582e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4441e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.2565e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0797e-04 - mean\_absolute\_error: 0.0081 17/126 [===>..........................] - ETA: 0s - loss: 1.4822e-04 - mean\_absolute\_error: 0.0084 38/126 [========>.....................] - ETA: 0s - loss: 1.4065e-04 - mean\_absolute\_error: 0.0084 63/126 [==============>...............] - ETA: 0s - loss: 1.2830e-04 - mean\_absolute\_error: 0.0083 88/126 [===================>..........] - ETA: 0s - loss: 1.2635e-04 - mean\_absolute\_error: 0.0084113/126 [=========================>....] - ETA: 0s - loss: 1.2172e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.2166e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 9.3808e-05 - val\_mean\_absolute\_error: 0.0082  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3062e-04 - mean\_absolute\_error: 0.0127 19/126 [===>..........................] - ETA: 0s - loss: 1.5143e-04 - mean\_absolute\_error: 0.0090 44/126 [=========>....................] - ETA: 0s - loss: 1.5373e-04 - mean\_absolute\_error: 0.0089 69/126 [===============>..............] - ETA: 0s - loss: 1.3874e-04 - mean\_absolute\_error: 0.0087 93/126 [=====================>........] - ETA: 0s - loss: 1.4546e-04 - mean\_absolute\_error: 0.0091117/126 [==========================>...] - ETA: 0s - loss: 1.4095e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4043e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 9.2746e-05 - val\_mean\_absolute\_error: 0.0081  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1696e-04 - mean\_absolute\_error: 0.0122 21/126 [====>.........................] - ETA: 0s - loss: 2.4954e-04 - mean\_absolute\_error: 0.0124 45/126 [=========>....................] - ETA: 0s - loss: 2.0406e-04 - mean\_absolute\_error: 0.0111 70/126 [===============>..............] - ETA: 0s - loss: 1.6958e-04 - mean\_absolute\_error: 0.0100 95/126 [=====================>........] - ETA: 0s - loss: 1.5723e-04 - mean\_absolute\_error: 0.0095119/126 [===========================>..] - ETA: 0s - loss: 1.5325e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5070e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.9243e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6866e-04 - mean\_absolute\_error: 0.0112 20/126 [===>..........................] - ETA: 0s - loss: 1.9535e-04 - mean\_absolute\_error: 0.0111 42/126 [=========>....................] - ETA: 0s - loss: 1.7756e-04 - mean\_absolute\_error: 0.0103 66/126 [==============>...............] - ETA: 0s - loss: 1.6345e-04 - mean\_absolute\_error: 0.0096 89/126 [====================>.........] - ETA: 0s - loss: 1.5630e-04 - mean\_absolute\_error: 0.0094114/126 [==========================>...] - ETA: 0s - loss: 1.4580e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4153e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.7059e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7906e-05 - mean\_absolute\_error: 0.0073 23/126 [====>.........................] - ETA: 0s - loss: 1.3729e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.3657e-04 - mean\_absolute\_error: 0.0090 70/126 [===============>..............] - ETA: 0s - loss: 1.3048e-04 - mean\_absolute\_error: 0.0088 94/126 [=====================>........] - ETA: 0s - loss: 1.2801e-04 - mean\_absolute\_error: 0.0086118/126 [===========================>..] - ETA: 0s - loss: 1.2917e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2887e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 5.7150e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3846e-04 - mean\_absolute\_error: 0.0093 23/126 [====>.........................] - ETA: 0s - loss: 1.1932e-04 - mean\_absolute\_error: 0.0084 48/126 [==========>...................] - ETA: 0s - loss: 1.2231e-04 - mean\_absolute\_error: 0.0087 72/126 [================>.............] - ETA: 0s - loss: 1.3636e-04 - mean\_absolute\_error: 0.0089 95/126 [=====================>........] - ETA: 0s - loss: 1.3859e-04 - mean\_absolute\_error: 0.0090119/126 [===========================>..] - ETA: 0s - loss: 1.3880e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4176e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 8.6987e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0140e-04 - mean\_absolute\_error: 0.0111 24/126 [====>.........................] - ETA: 0s - loss: 1.4804e-04 - mean\_absolute\_error: 0.0093 49/126 [==========>...................] - ETA: 0s - loss: 1.3504e-04 - mean\_absolute\_error: 0.0087 72/126 [================>.............] - ETA: 0s - loss: 1.4802e-04 - mean\_absolute\_error: 0.0091 97/126 [======================>.......] - ETA: 0s - loss: 1.4945e-04 - mean\_absolute\_error: 0.0093122/126 [============================>.] - ETA: 0s - loss: 1.4659e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4509e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.1111e-05 - val\_mean\_absolute\_error: 0.0048  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2257e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 1.2246e-04 - mean\_absolute\_error: 0.0086 48/126 [==========>...................] - ETA: 0s - loss: 1.2830e-04 - mean\_absolute\_error: 0.0088 72/126 [================>.............] - ETA: 0s - loss: 1.3813e-04 - mean\_absolute\_error: 0.0090 97/126 [======================>.......] - ETA: 0s - loss: 1.3008e-04 - mean\_absolute\_error: 0.0087122/126 [============================>.] - ETA: 0s - loss: 1.2827e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3115e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 7.3433e-05 - val\_mean\_absolute\_error: 0.0071

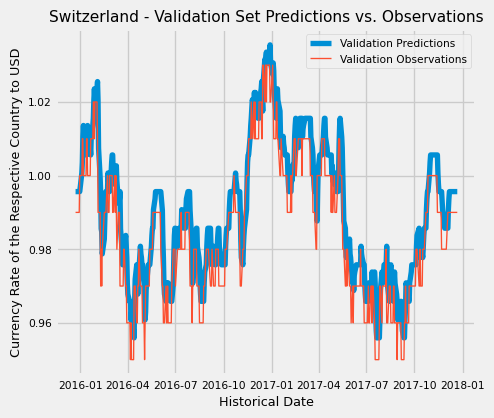
<keras.src.callbacks.History at 0x253c8381ad0>

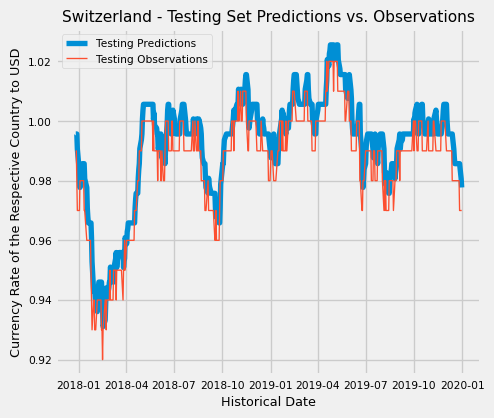
After the training and fitting of the Machine Learning model for Switzerland, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 40s 39/126 [========>.....................] - ETA: 0s 80/126 [==================>...........] - ETA: 0s121/126 [===========================>..] - ETA: 0s126/126 [==============================] - 0s 1ms/step  
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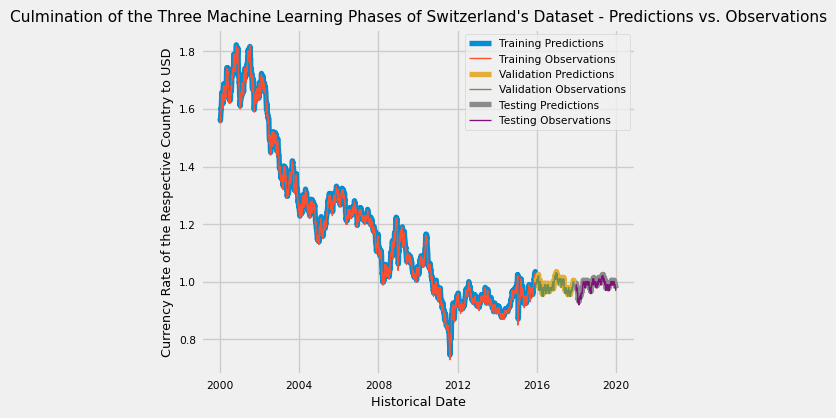






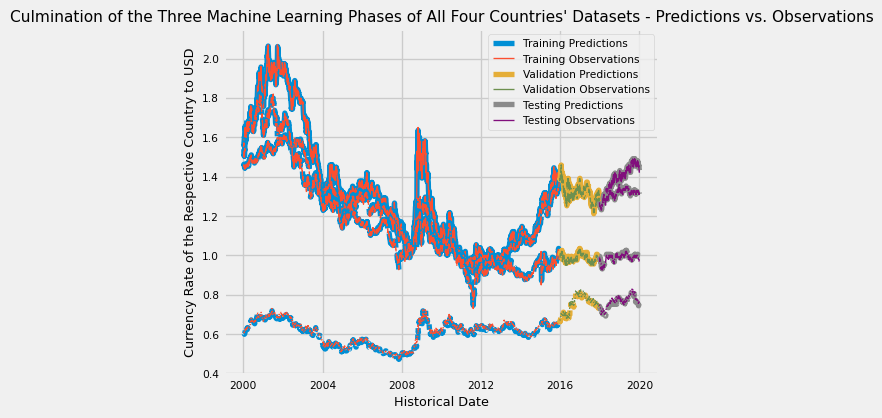
Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and 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()  
```



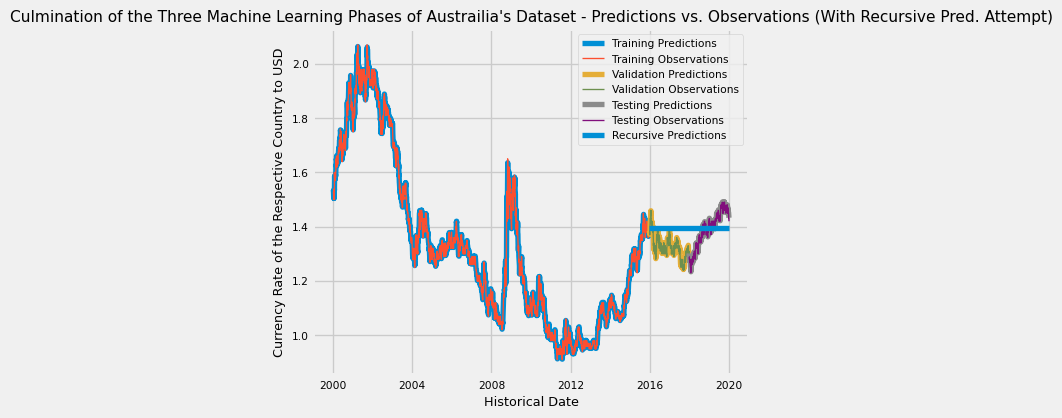
Ultimately, here is the moment of truth: I tried to recursively predict Austrailia’s future expected projection on its international currency rate between the United States through using my LSTM prediction model as shown below. By using the data from the training dataset for Austrailia, I tried to contrast 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:

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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].