International US Foreign Currency Exchange Rates Predictor

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## Blog Post Inspiration and Objectives

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

## Data Preprocessing - Cleaning and Analytics

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

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

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

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

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

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

(5217, 24)

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

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

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

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

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

0

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

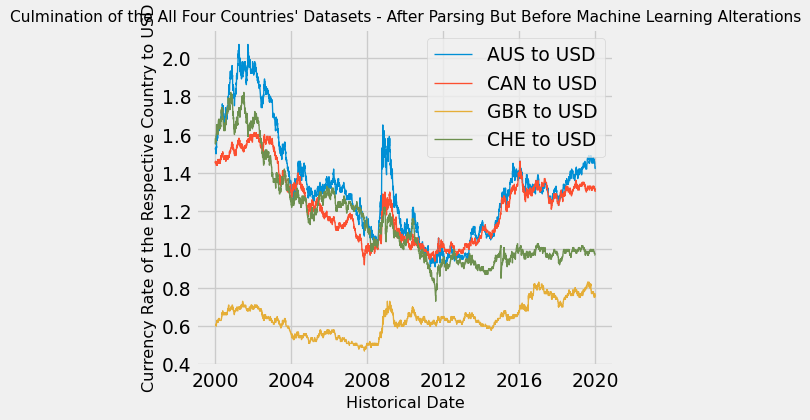
```{python}  
def windowed\_df\_to\_date\_X\_y(windowed\_dataframe: pd.DataFrame):  
 df\_as\_np = windowed\_dataframe.to\_numpy()  
   
 dates = df\_as\_np[:, 0]  
   
 middle\_matrix = df\_as\_np[:, 1:-1]  
 X = middle\_matrix.reshape((len(dates), middle\_matrix.shape[1], 1))  
 Y = df\_as\_np[:, -1]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

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

(5016, 5016, 5016, 5016)

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

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



## Machine Learning - Model Training and Evaluation

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

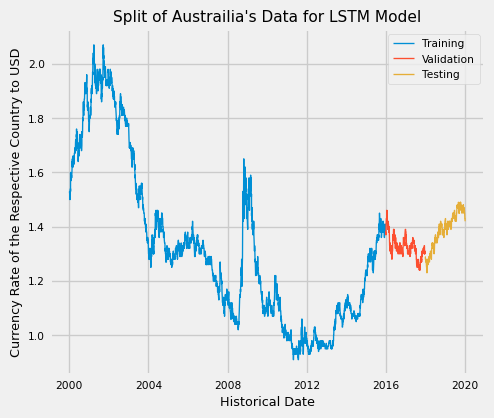
For this blog post, I worked to create Machine Learning models for each country’s dataset separately. I started with Austrailia’s data first (as shown below):

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

(4012, 4514)

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

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



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

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

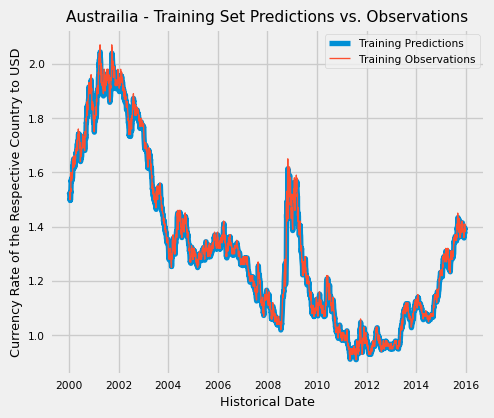
Epoch 1/100  
 1/126 [..............................] - ETA: 3:39 - loss: 1.8787 - mean\_absolute\_error: 1.3275 19/126 [===>..........................] - ETA: 0s - loss: 1.2379 - mean\_absolute\_error: 1.0669 41/126 [========>.....................] - ETA: 0s - loss: 0.6428 - mean\_absolute\_error: 0.6536 63/126 [==============>...............] - ETA: 0s - loss: 0.4231 - mean\_absolute\_error: 0.4574 88/126 [===================>..........] - ETA: 0s - loss: 0.3043 - mean\_absolute\_error: 0.3444112/126 [=========================>....] - ETA: 0s - loss: 0.2399 - mean\_absolute\_error: 0.2811126/126 [==============================] - 2s 6ms/step - loss: 0.2146 - mean\_absolute\_error: 0.2561 - val\_loss: 2.1495e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0027 - mean\_absolute\_error: 0.0434 21/126 [====>.........................] - ETA: 0s - loss: 0.0026 - mean\_absolute\_error: 0.0427 44/126 [=========>....................] - ETA: 0s - loss: 0.0024 - mean\_absolute\_error: 0.0404 68/126 [===============>..............] - ETA: 0s - loss: 0.0020 - mean\_absolute\_error: 0.0370 91/126 [====================>.........] - ETA: 0s - loss: 0.0018 - mean\_absolute\_error: 0.0346115/126 [==========================>...] - ETA: 0s - loss: 0.0016 - mean\_absolute\_error: 0.0324126/126 [==============================] - 0s 3ms/step - loss: 0.0015 - mean\_absolute\_error: 0.0314 - val\_loss: 1.5589e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9278e-04 - mean\_absolute\_error: 0.0170 20/126 [===>..........................] - ETA: 0s - loss: 5.9594e-04 - mean\_absolute\_error: 0.0197 45/126 [=========>....................] - ETA: 0s - loss: 5.3831e-04 - mean\_absolute\_error: 0.0181 67/126 [==============>...............] - ETA: 0s - loss: 4.8663e-04 - mean\_absolute\_error: 0.0173 93/126 [=====================>........] - ETA: 0s - loss: 4.3710e-04 - mean\_absolute\_error: 0.0163118/126 [===========================>..] - ETA: 0s - loss: 4.0331e-04 - mean\_absolute\_error: 0.0156126/126 [==============================] - 0s 3ms/step - loss: 3.9609e-04 - mean\_absolute\_error: 0.0154 - val\_loss: 1.2218e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 4.2972e-04 - mean\_absolute\_error: 0.0159 23/126 [====>.........................] - ETA: 0s - loss: 2.8058e-04 - mean\_absolute\_error: 0.0128 46/126 [=========>....................] - ETA: 0s - loss: 2.6076e-04 - mean\_absolute\_error: 0.0119 69/126 [===============>..............] - ETA: 0s - loss: 2.5440e-04 - mean\_absolute\_error: 0.0119 92/126 [====================>.........] - ETA: 0s - loss: 2.6352e-04 - mean\_absolute\_error: 0.0118115/126 [==========================>...] - ETA: 0s - loss: 2.6619e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6263e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.3173e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1938e-04 - mean\_absolute\_error: 0.0085 24/126 [====>.........................] - ETA: 0s - loss: 2.5618e-04 - mean\_absolute\_error: 0.0116 47/126 [==========>...................] - ETA: 0s - loss: 2.6574e-04 - mean\_absolute\_error: 0.0119 70/126 [===============>..............] - ETA: 0s - loss: 2.7176e-04 - mean\_absolute\_error: 0.0118 94/126 [=====================>........] - ETA: 0s - loss: 2.6097e-04 - mean\_absolute\_error: 0.0116119/126 [===========================>..] - ETA: 0s - loss: 2.4984e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 2ms/step - loss: 2.5275e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.3131e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8558e-04 - mean\_absolute\_error: 0.0125 22/126 [====>.........................] - ETA: 0s - loss: 2.2663e-04 - mean\_absolute\_error: 0.0113 44/126 [=========>....................] - ETA: 0s - loss: 2.6825e-04 - mean\_absolute\_error: 0.0117 66/126 [==============>...............] - ETA: 0s - loss: 2.5459e-04 - mean\_absolute\_error: 0.0116 90/126 [====================>.........] - ETA: 0s - loss: 2.5170e-04 - mean\_absolute\_error: 0.0115115/126 [==========================>...] - ETA: 0s - loss: 2.5594e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5223e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.3999e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1974e-04 - mean\_absolute\_error: 0.0097 21/126 [====>.........................] - ETA: 0s - loss: 2.9098e-04 - mean\_absolute\_error: 0.0120 46/126 [=========>....................] - ETA: 0s - loss: 2.6907e-04 - mean\_absolute\_error: 0.0118 70/126 [===============>..............] - ETA: 0s - loss: 2.6791e-04 - mean\_absolute\_error: 0.0118 96/126 [=====================>........] - ETA: 0s - loss: 2.6464e-04 - mean\_absolute\_error: 0.0117120/126 [===========================>..] - ETA: 0s - loss: 2.6102e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.6054e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.4780e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6237e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 2.2413e-04 - mean\_absolute\_error: 0.0111 48/126 [==========>...................] - ETA: 0s - loss: 2.3927e-04 - mean\_absolute\_error: 0.0113 71/126 [===============>..............] - ETA: 0s - loss: 2.5752e-04 - mean\_absolute\_error: 0.0116 95/126 [=====================>........] - ETA: 0s - loss: 2.4384e-04 - mean\_absolute\_error: 0.0113120/126 [===========================>..] - ETA: 0s - loss: 2.4856e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.5245e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.3158e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3600e-04 - mean\_absolute\_error: 0.0133 20/126 [===>..........................] - ETA: 0s - loss: 3.0680e-04 - mean\_absolute\_error: 0.0118 39/126 [========>.....................] - ETA: 0s - loss: 2.9230e-04 - mean\_absolute\_error: 0.0120 61/126 [=============>................] - ETA: 0s - loss: 2.8037e-04 - mean\_absolute\_error: 0.0118 84/126 [===================>..........] - ETA: 0s - loss: 2.6981e-04 - mean\_absolute\_error: 0.0115109/126 [========================>.....] - ETA: 0s - loss: 2.6058e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5467e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.5264e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5808e-04 - mean\_absolute\_error: 0.0128 22/126 [====>.........................] - ETA: 0s - loss: 2.4070e-04 - mean\_absolute\_error: 0.0118 45/126 [=========>....................] - ETA: 0s - loss: 2.4294e-04 - mean\_absolute\_error: 0.0116 70/126 [===============>..............] - ETA: 0s - loss: 2.4920e-04 - mean\_absolute\_error: 0.0115 94/126 [=====================>........] - ETA: 0s - loss: 2.4958e-04 - mean\_absolute\_error: 0.0116118/126 [===========================>..] - ETA: 0s - loss: 2.5156e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5717e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2327e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1469e-04 - mean\_absolute\_error: 0.0107 20/126 [===>..........................] - ETA: 0s - loss: 2.4362e-04 - mean\_absolute\_error: 0.0111 45/126 [=========>....................] - ETA: 0s - loss: 2.7076e-04 - mean\_absolute\_error: 0.0114 70/126 [===============>..............] - ETA: 0s - loss: 2.5110e-04 - mean\_absolute\_error: 0.0112 95/126 [=====================>........] - ETA: 0s - loss: 2.5421e-04 - mean\_absolute\_error: 0.0114118/126 [===========================>..] - ETA: 0s - loss: 2.5526e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5490e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 2.0065e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8632e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 2.6957e-04 - mean\_absolute\_error: 0.0121 44/126 [=========>....................] - ETA: 0s - loss: 2.6487e-04 - mean\_absolute\_error: 0.0118 67/126 [==============>...............] - ETA: 0s - loss: 2.6580e-04 - mean\_absolute\_error: 0.0118 91/126 [====================>.........] - ETA: 0s - loss: 2.6885e-04 - mean\_absolute\_error: 0.0118115/126 [==========================>...] - ETA: 0s - loss: 2.5777e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5566e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.3686e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4622e-04 - mean\_absolute\_error: 0.0097 19/126 [===>..........................] - ETA: 0s - loss: 2.8598e-04 - mean\_absolute\_error: 0.0112 41/126 [========>.....................] - ETA: 0s - loss: 2.6776e-04 - mean\_absolute\_error: 0.0114 66/126 [==============>...............] - ETA: 0s - loss: 2.7032e-04 - mean\_absolute\_error: 0.0114 91/126 [====================>.........] - ETA: 0s - loss: 2.5153e-04 - mean\_absolute\_error: 0.0113117/126 [==========================>...] - ETA: 0s - loss: 2.5553e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5195e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.9653e-04 - val\_mean\_absolute\_error: 0.0111  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4393e-04 - mean\_absolute\_error: 0.0099 20/126 [===>..........................] - ETA: 0s - loss: 2.4392e-04 - mean\_absolute\_error: 0.0115 45/126 [=========>....................] - ETA: 0s - loss: 2.8955e-04 - mean\_absolute\_error: 0.0119 71/126 [===============>..............] - ETA: 0s - loss: 2.6854e-04 - mean\_absolute\_error: 0.0117 95/126 [=====================>........] - ETA: 0s - loss: 2.7178e-04 - mean\_absolute\_error: 0.0118120/126 [===========================>..] - ETA: 0s - loss: 2.6086e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.6021e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2223e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6983e-04 - mean\_absolute\_error: 0.0092 16/126 [==>...........................] - ETA: 0s - loss: 2.5737e-04 - mean\_absolute\_error: 0.0112 32/126 [======>.......................] - ETA: 0s - loss: 2.3900e-04 - mean\_absolute\_error: 0.0112 53/126 [===========>..................] - ETA: 0s - loss: 2.3620e-04 - mean\_absolute\_error: 0.0112 78/126 [=================>............] - ETA: 0s - loss: 2.4838e-04 - mean\_absolute\_error: 0.0113102/126 [=======================>......] - ETA: 0s - loss: 2.5129e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4853e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.4070e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9535e-04 - mean\_absolute\_error: 0.0098 22/126 [====>.........................] - ETA: 0s - loss: 2.2776e-04 - mean\_absolute\_error: 0.0114 47/126 [==========>...................] - ETA: 0s - loss: 2.4295e-04 - mean\_absolute\_error: 0.0115 73/126 [================>.............] - ETA: 0s - loss: 2.5256e-04 - mean\_absolute\_error: 0.0117 96/126 [=====================>........] - ETA: 0s - loss: 2.7432e-04 - mean\_absolute\_error: 0.0119120/126 [===========================>..] - ETA: 0s - loss: 2.6210e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 2ms/step - loss: 2.6101e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.4548e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0601e-04 - mean\_absolute\_error: 0.0114 20/126 [===>..........................] - ETA: 0s - loss: 2.4498e-04 - mean\_absolute\_error: 0.0115 35/126 [=======>......................] - ETA: 0s - loss: 2.3862e-04 - mean\_absolute\_error: 0.0114 53/126 [===========>..................] - ETA: 0s - loss: 2.5218e-04 - mean\_absolute\_error: 0.0117 77/126 [=================>............] - ETA: 0s - loss: 2.5371e-04 - mean\_absolute\_error: 0.0117102/126 [=======================>......] - ETA: 0s - loss: 2.5890e-04 - mean\_absolute\_error: 0.0117125/126 [============================>.] - ETA: 0s - loss: 2.6118e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6121e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.4562e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5507e-04 - mean\_absolute\_error: 0.0149 23/126 [====>.........................] - ETA: 0s - loss: 2.1703e-04 - mean\_absolute\_error: 0.0110 44/126 [=========>....................] - ETA: 0s - loss: 2.2203e-04 - mean\_absolute\_error: 0.0111 65/126 [==============>...............] - ETA: 0s - loss: 2.3513e-04 - mean\_absolute\_error: 0.0112 89/126 [====================>.........] - ETA: 0s - loss: 2.4826e-04 - mean\_absolute\_error: 0.0114114/126 [==========================>...] - ETA: 0s - loss: 2.5197e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5648e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 2.0248e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6308e-04 - mean\_absolute\_error: 0.0155 17/126 [===>..........................] - ETA: 0s - loss: 2.4819e-04 - mean\_absolute\_error: 0.0119 29/126 [=====>........................] - ETA: 0s - loss: 2.8336e-04 - mean\_absolute\_error: 0.0122 50/126 [==========>...................] - ETA: 0s - loss: 2.8770e-04 - mean\_absolute\_error: 0.0122 73/126 [================>.............] - ETA: 0s - loss: 2.7158e-04 - mean\_absolute\_error: 0.0121 98/126 [======================>.......] - ETA: 0s - loss: 2.6234e-04 - mean\_absolute\_error: 0.0119123/126 [============================>.] - ETA: 0s - loss: 2.5938e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6227e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.9076e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2778e-04 - mean\_absolute\_error: 0.0089 20/126 [===>..........................] - ETA: 0s - loss: 2.9286e-04 - mean\_absolute\_error: 0.0115 42/126 [=========>....................] - ETA: 0s - loss: 2.6695e-04 - mean\_absolute\_error: 0.0114 67/126 [==============>...............] - ETA: 0s - loss: 2.5711e-04 - mean\_absolute\_error: 0.0113 91/126 [====================>.........] - ETA: 0s - loss: 2.5588e-04 - mean\_absolute\_error: 0.0115115/126 [==========================>...] - ETA: 0s - loss: 2.6875e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6923e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.6349e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0361e-04 - mean\_absolute\_error: 0.0084 21/126 [====>.........................] - ETA: 0s - loss: 2.1993e-04 - mean\_absolute\_error: 0.0111 41/126 [========>.....................] - ETA: 0s - loss: 2.5040e-04 - mean\_absolute\_error: 0.0115 66/126 [==============>...............] - ETA: 0s - loss: 2.4088e-04 - mean\_absolute\_error: 0.0113 91/126 [====================>.........] - ETA: 0s - loss: 2.4559e-04 - mean\_absolute\_error: 0.0113115/126 [==========================>...] - ETA: 0s - loss: 2.5271e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.5678e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.4644e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4983e-04 - mean\_absolute\_error: 0.0091 19/126 [===>..........................] - ETA: 0s - loss: 2.6486e-04 - mean\_absolute\_error: 0.0117 40/126 [========>.....................] - ETA: 0s - loss: 2.3563e-04 - mean\_absolute\_error: 0.0112 64/126 [==============>...............] - ETA: 0s - loss: 2.5826e-04 - mean\_absolute\_error: 0.0116 89/126 [====================>.........] - ETA: 0s - loss: 2.5813e-04 - mean\_absolute\_error: 0.0117114/126 [==========================>...] - ETA: 0s - loss: 2.4720e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5219e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.3980e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3774e-04 - mean\_absolute\_error: 0.0095 21/126 [====>.........................] - ETA: 0s - loss: 3.3356e-04 - mean\_absolute\_error: 0.0127 43/126 [=========>....................] - ETA: 0s - loss: 3.6948e-04 - mean\_absolute\_error: 0.0139 66/126 [==============>...............] - ETA: 0s - loss: 3.2464e-04 - mean\_absolute\_error: 0.0130 91/126 [====================>.........] - ETA: 0s - loss: 3.0934e-04 - mean\_absolute\_error: 0.0127116/126 [==========================>...] - ETA: 0s - loss: 2.9272e-04 - mean\_absolute\_error: 0.0124126/126 [==============================] - 0s 3ms/step - loss: 2.8525e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 1.2666e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4135e-04 - mean\_absolute\_error: 0.0113 24/126 [====>.........................] - ETA: 0s - loss: 2.5762e-04 - mean\_absolute\_error: 0.0120 44/126 [=========>....................] - ETA: 0s - loss: 2.8636e-04 - mean\_absolute\_error: 0.0120 66/126 [==============>...............] - ETA: 0s - loss: 2.8502e-04 - mean\_absolute\_error: 0.0119 90/126 [====================>.........] - ETA: 0s - loss: 2.6561e-04 - mean\_absolute\_error: 0.0117115/126 [==========================>...] - ETA: 0s - loss: 2.5857e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5412e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.2457e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0397e-04 - mean\_absolute\_error: 0.0085 20/126 [===>..........................] - ETA: 0s - loss: 2.0627e-04 - mean\_absolute\_error: 0.0107 43/126 [=========>....................] - ETA: 0s - loss: 2.4206e-04 - mean\_absolute\_error: 0.0112 67/126 [==============>...............] - ETA: 0s - loss: 2.9003e-04 - mean\_absolute\_error: 0.0120 92/126 [====================>.........] - ETA: 0s - loss: 2.8156e-04 - mean\_absolute\_error: 0.0120115/126 [==========================>...] - ETA: 0s - loss: 2.7817e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.7898e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 2.3864e-04 - val\_mean\_absolute\_error: 0.0129  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2659e-04 - mean\_absolute\_error: 0.0119 23/126 [====>.........................] - ETA: 0s - loss: 3.0327e-04 - mean\_absolute\_error: 0.0123 46/126 [=========>....................] - ETA: 0s - loss: 2.7759e-04 - mean\_absolute\_error: 0.0117 70/126 [===============>..............] - ETA: 0s - loss: 2.6970e-04 - mean\_absolute\_error: 0.0116 94/126 [=====================>........] - ETA: 0s - loss: 2.7069e-04 - mean\_absolute\_error: 0.0117116/126 [==========================>...] - ETA: 0s - loss: 2.5771e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5664e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.4245e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1469e-04 - mean\_absolute\_error: 0.0140 24/126 [====>.........................] - ETA: 0s - loss: 3.4164e-04 - mean\_absolute\_error: 0.0139 46/126 [=========>....................] - ETA: 0s - loss: 2.8699e-04 - mean\_absolute\_error: 0.0127 68/126 [===============>..............] - ETA: 0s - loss: 2.6142e-04 - mean\_absolute\_error: 0.0120 93/126 [=====================>........] - ETA: 0s - loss: 2.6347e-04 - mean\_absolute\_error: 0.0119117/126 [==========================>...] - ETA: 0s - loss: 2.6119e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6155e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.5331e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3479e-04 - mean\_absolute\_error: 0.0133 23/126 [====>.........................] - ETA: 0s - loss: 2.3894e-04 - mean\_absolute\_error: 0.0115 48/126 [==========>...................] - ETA: 0s - loss: 2.5207e-04 - mean\_absolute\_error: 0.0115 71/126 [===============>..............] - ETA: 0s - loss: 2.5033e-04 - mean\_absolute\_error: 0.0114 93/126 [=====================>........] - ETA: 0s - loss: 2.5114e-04 - mean\_absolute\_error: 0.0114117/126 [==========================>...] - ETA: 0s - loss: 2.4807e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4861e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.5327e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5558e-04 - mean\_absolute\_error: 0.0118 22/126 [====>.........................] - ETA: 0s - loss: 2.3111e-04 - mean\_absolute\_error: 0.0115 47/126 [==========>...................] - ETA: 0s - loss: 2.4386e-04 - mean\_absolute\_error: 0.0114 70/126 [===============>..............] - ETA: 0s - loss: 2.6200e-04 - mean\_absolute\_error: 0.0116 96/126 [=====================>........] - ETA: 0s - loss: 2.5919e-04 - mean\_absolute\_error: 0.0116121/126 [===========================>..] - ETA: 0s - loss: 2.6006e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 2ms/step - loss: 2.5883e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.5838e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4945e-04 - mean\_absolute\_error: 0.0099 19/126 [===>..........................] - ETA: 0s - loss: 2.9461e-04 - mean\_absolute\_error: 0.0120 42/126 [=========>....................] - ETA: 0s - loss: 3.0007e-04 - mean\_absolute\_error: 0.0124 61/126 [=============>................] - ETA: 0s - loss: 2.8497e-04 - mean\_absolute\_error: 0.0122 83/126 [==================>...........] - ETA: 0s - loss: 2.7702e-04 - mean\_absolute\_error: 0.0121105/126 [========================>.....] - ETA: 0s - loss: 2.6407e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6787e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 2.3161e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7473e-04 - mean\_absolute\_error: 0.0146 24/126 [====>.........................] - ETA: 0s - loss: 2.8773e-04 - mean\_absolute\_error: 0.0116 49/126 [==========>...................] - ETA: 0s - loss: 2.6222e-04 - mean\_absolute\_error: 0.0115 72/126 [================>.............] - ETA: 0s - loss: 2.6479e-04 - mean\_absolute\_error: 0.0115 96/126 [=====================>........] - ETA: 0s - loss: 2.6001e-04 - mean\_absolute\_error: 0.0116121/126 [===========================>..] - ETA: 0s - loss: 2.7103e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 2ms/step - loss: 2.6847e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.7747e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5094e-04 - mean\_absolute\_error: 0.0096 23/126 [====>.........................] - ETA: 0s - loss: 2.5815e-04 - mean\_absolute\_error: 0.0117 48/126 [==========>...................] - ETA: 0s - loss: 2.5292e-04 - mean\_absolute\_error: 0.0118 73/126 [================>.............] - ETA: 0s - loss: 2.6011e-04 - mean\_absolute\_error: 0.0117 97/126 [======================>.......] - ETA: 0s - loss: 2.6603e-04 - mean\_absolute\_error: 0.0118121/126 [===========================>..] - ETA: 0s - loss: 2.7105e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 2ms/step - loss: 2.6935e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.2425e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1628e-04 - mean\_absolute\_error: 0.0123 19/126 [===>..........................] - ETA: 0s - loss: 2.8764e-04 - mean\_absolute\_error: 0.0116 42/126 [=========>....................] - ETA: 0s - loss: 2.9011e-04 - mean\_absolute\_error: 0.0120 66/126 [==============>...............] - ETA: 0s - loss: 2.8768e-04 - mean\_absolute\_error: 0.0122 88/126 [===================>..........] - ETA: 0s - loss: 2.9523e-04 - mean\_absolute\_error: 0.0125114/126 [==========================>...] - ETA: 0s - loss: 2.9196e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.9144e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.2805e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6952e-04 - mean\_absolute\_error: 0.0088 22/126 [====>.........................] - ETA: 0s - loss: 2.3244e-04 - mean\_absolute\_error: 0.0113 45/126 [=========>....................] - ETA: 0s - loss: 2.3210e-04 - mean\_absolute\_error: 0.0114 67/126 [==============>...............] - ETA: 0s - loss: 2.6458e-04 - mean\_absolute\_error: 0.0120 91/126 [====================>.........] - ETA: 0s - loss: 2.6814e-04 - mean\_absolute\_error: 0.0119115/126 [==========================>...] - ETA: 0s - loss: 2.5627e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5704e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2903e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4956e-04 - mean\_absolute\_error: 0.0092 23/126 [====>.........................] - ETA: 0s - loss: 2.7763e-04 - mean\_absolute\_error: 0.0120 49/126 [==========>...................] - ETA: 0s - loss: 2.5622e-04 - mean\_absolute\_error: 0.0118 74/126 [================>.............] - ETA: 0s - loss: 2.5746e-04 - mean\_absolute\_error: 0.0117 97/126 [======================>.......] - ETA: 0s - loss: 2.7449e-04 - mean\_absolute\_error: 0.0119119/126 [===========================>..] - ETA: 0s - loss: 2.6418e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 2ms/step - loss: 2.6935e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.1900e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2930e-04 - mean\_absolute\_error: 0.0141 24/126 [====>.........................] - ETA: 0s - loss: 2.1687e-04 - mean\_absolute\_error: 0.0107 47/126 [==========>...................] - ETA: 0s - loss: 2.2879e-04 - mean\_absolute\_error: 0.0108 72/126 [================>.............] - ETA: 0s - loss: 2.6154e-04 - mean\_absolute\_error: 0.0117 93/126 [=====================>........] - ETA: 0s - loss: 2.6861e-04 - mean\_absolute\_error: 0.0120117/126 [==========================>...] - ETA: 0s - loss: 2.7436e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.7388e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 2.5700e-04 - val\_mean\_absolute\_error: 0.0132  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8156e-04 - mean\_absolute\_error: 0.0171 22/126 [====>.........................] - ETA: 0s - loss: 3.6425e-04 - mean\_absolute\_error: 0.0134 45/126 [=========>....................] - ETA: 0s - loss: 2.8733e-04 - mean\_absolute\_error: 0.0120 70/126 [===============>..............] - ETA: 0s - loss: 2.6975e-04 - mean\_absolute\_error: 0.0117 95/126 [=====================>........] - ETA: 0s - loss: 2.6171e-04 - mean\_absolute\_error: 0.0116118/126 [===========================>..] - ETA: 0s - loss: 2.5004e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5435e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 4.2941e-04 - val\_mean\_absolute\_error: 0.0183  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9511e-04 - mean\_absolute\_error: 0.0193 25/126 [====>.........................] - ETA: 0s - loss: 3.9269e-04 - mean\_absolute\_error: 0.0146 50/126 [==========>...................] - ETA: 0s - loss: 3.5587e-04 - mean\_absolute\_error: 0.0143 73/126 [================>.............] - ETA: 0s - loss: 3.4945e-04 - mean\_absolute\_error: 0.0139 97/126 [======================>.......] - ETA: 0s - loss: 3.2388e-04 - mean\_absolute\_error: 0.0133115/126 [==========================>...] - ETA: 0s - loss: 3.1429e-04 - mean\_absolute\_error: 0.0131126/126 [==============================] - 0s 3ms/step - loss: 3.0549e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 1.2159e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4789e-04 - mean\_absolute\_error: 0.0102 22/126 [====>.........................] - ETA: 0s - loss: 2.1297e-04 - mean\_absolute\_error: 0.0108 45/126 [=========>....................] - ETA: 0s - loss: 2.8311e-04 - mean\_absolute\_error: 0.0122 68/126 [===============>..............] - ETA: 0s - loss: 2.7274e-04 - mean\_absolute\_error: 0.0120 91/126 [====================>.........] - ETA: 0s - loss: 2.7931e-04 - mean\_absolute\_error: 0.0124112/126 [=========================>....] - ETA: 0s - loss: 2.9364e-04 - mean\_absolute\_error: 0.0124126/126 [==============================] - 0s 3ms/step - loss: 3.0037e-04 - mean\_absolute\_error: 0.0127 - val\_loss: 1.5916e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3521e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 2.4551e-04 - mean\_absolute\_error: 0.0116 44/126 [=========>....................] - ETA: 0s - loss: 2.5593e-04 - mean\_absolute\_error: 0.0115 69/126 [===============>..............] - ETA: 0s - loss: 2.7223e-04 - mean\_absolute\_error: 0.0119 95/126 [=====================>........] - ETA: 0s - loss: 2.7362e-04 - mean\_absolute\_error: 0.0119119/126 [===========================>..] - ETA: 0s - loss: 2.6315e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6314e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 2.8786e-04 - val\_mean\_absolute\_error: 0.0144  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8444e-04 - mean\_absolute\_error: 0.0165 24/126 [====>.........................] - ETA: 0s - loss: 2.7377e-04 - mean\_absolute\_error: 0.0121 49/126 [==========>...................] - ETA: 0s - loss: 2.4415e-04 - mean\_absolute\_error: 0.0115 73/126 [================>.............] - ETA: 0s - loss: 2.3221e-04 - mean\_absolute\_error: 0.0113 96/126 [=====================>........] - ETA: 0s - loss: 2.4530e-04 - mean\_absolute\_error: 0.0116120/126 [===========================>..] - ETA: 0s - loss: 2.9652e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 2ms/step - loss: 2.9960e-04 - mean\_absolute\_error: 0.0127 - val\_loss: 2.8505e-04 - val\_mean\_absolute\_error: 0.0140  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0925e-04 - mean\_absolute\_error: 0.0108 24/126 [====>.........................] - ETA: 0s - loss: 2.7205e-04 - mean\_absolute\_error: 0.0121 49/126 [==========>...................] - ETA: 0s - loss: 2.8638e-04 - mean\_absolute\_error: 0.0128 73/126 [================>.............] - ETA: 0s - loss: 3.1385e-04 - mean\_absolute\_error: 0.0134 97/126 [======================>.......] - ETA: 0s - loss: 2.9286e-04 - mean\_absolute\_error: 0.0129117/126 [==========================>...] - ETA: 0s - loss: 3.0874e-04 - mean\_absolute\_error: 0.0130126/126 [==============================] - 0s 3ms/step - loss: 3.0280e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 2.0785e-04 - val\_mean\_absolute\_error: 0.0116  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7647e-04 - mean\_absolute\_error: 0.0143 24/126 [====>.........................] - ETA: 0s - loss: 3.0551e-04 - mean\_absolute\_error: 0.0124 46/126 [=========>....................] - ETA: 0s - loss: 2.7300e-04 - mean\_absolute\_error: 0.0117 69/126 [===============>..............] - ETA: 0s - loss: 2.5794e-04 - mean\_absolute\_error: 0.0114 93/126 [=====================>........] - ETA: 0s - loss: 2.5265e-04 - mean\_absolute\_error: 0.0114117/126 [==========================>...] - ETA: 0s - loss: 2.4792e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4253e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.8475e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3547e-04 - mean\_absolute\_error: 0.0116 25/126 [====>.........................] - ETA: 0s - loss: 2.2390e-04 - mean\_absolute\_error: 0.0114 49/126 [==========>...................] - ETA: 0s - loss: 2.3360e-04 - mean\_absolute\_error: 0.0112 73/126 [================>.............] - ETA: 0s - loss: 2.5048e-04 - mean\_absolute\_error: 0.0117 99/126 [======================>.......] - ETA: 0s - loss: 2.5724e-04 - mean\_absolute\_error: 0.0119125/126 [============================>.] - ETA: 0s - loss: 2.6474e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 2ms/step - loss: 2.6428e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.2939e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0586e-04 - mean\_absolute\_error: 0.0110 21/126 [====>.........................] - ETA: 0s - loss: 2.5224e-04 - mean\_absolute\_error: 0.0114 45/126 [=========>....................] - ETA: 0s - loss: 2.6793e-04 - mean\_absolute\_error: 0.0117 69/126 [===============>..............] - ETA: 0s - loss: 2.6938e-04 - mean\_absolute\_error: 0.0118 92/126 [====================>.........] - ETA: 0s - loss: 2.7534e-04 - mean\_absolute\_error: 0.0119116/126 [==========================>...] - ETA: 0s - loss: 2.6017e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5906e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2066e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8746e-04 - mean\_absolute\_error: 0.0099 23/126 [====>.........................] - ETA: 0s - loss: 3.1789e-04 - mean\_absolute\_error: 0.0121 46/126 [=========>....................] - ETA: 0s - loss: 2.6116e-04 - mean\_absolute\_error: 0.0115 71/126 [===============>..............] - ETA: 0s - loss: 2.4470e-04 - mean\_absolute\_error: 0.0113 94/126 [=====================>........] - ETA: 0s - loss: 2.4798e-04 - mean\_absolute\_error: 0.0114118/126 [===========================>..] - ETA: 0s - loss: 2.4328e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.4764e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1731e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0829e-04 - mean\_absolute\_error: 0.0167 24/126 [====>.........................] - ETA: 0s - loss: 2.8007e-04 - mean\_absolute\_error: 0.0121 48/126 [==========>...................] - ETA: 0s - loss: 2.4631e-04 - mean\_absolute\_error: 0.0113 72/126 [================>.............] - ETA: 0s - loss: 2.2538e-04 - mean\_absolute\_error: 0.0109 96/126 [=====================>........] - ETA: 0s - loss: 2.4559e-04 - mean\_absolute\_error: 0.0114119/126 [===========================>..] - ETA: 0s - loss: 2.6501e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 2ms/step - loss: 2.6349e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.7302e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4442e-04 - mean\_absolute\_error: 0.0127 23/126 [====>.........................] - ETA: 0s - loss: 2.5069e-04 - mean\_absolute\_error: 0.0118 45/126 [=========>....................] - ETA: 0s - loss: 2.6854e-04 - mean\_absolute\_error: 0.0120 70/126 [===============>..............] - ETA: 0s - loss: 2.9159e-04 - mean\_absolute\_error: 0.0124 94/126 [=====================>........] - ETA: 0s - loss: 2.7959e-04 - mean\_absolute\_error: 0.0122118/126 [===========================>..] - ETA: 0s - loss: 2.8322e-04 - mean\_absolute\_error: 0.0125126/126 [==============================] - 0s 3ms/step - loss: 2.8890e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.1369e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0161e-04 - mean\_absolute\_error: 0.0113 21/126 [====>.........................] - ETA: 0s - loss: 2.3221e-04 - mean\_absolute\_error: 0.0117 41/126 [========>.....................] - ETA: 0s - loss: 2.3158e-04 - mean\_absolute\_error: 0.0116 64/126 [==============>...............] - ETA: 0s - loss: 2.4458e-04 - mean\_absolute\_error: 0.0117 90/126 [====================>.........] - ETA: 0s - loss: 2.4795e-04 - mean\_absolute\_error: 0.0115115/126 [==========================>...] - ETA: 0s - loss: 2.5514e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.6023e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 3.1952e-04 - val\_mean\_absolute\_error: 0.0152  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4470e-04 - mean\_absolute\_error: 0.0174 26/126 [=====>........................] - ETA: 0s - loss: 3.1792e-04 - mean\_absolute\_error: 0.0126 52/126 [===========>..................] - ETA: 0s - loss: 3.2447e-04 - mean\_absolute\_error: 0.0129 76/126 [=================>............] - ETA: 0s - loss: 2.9475e-04 - mean\_absolute\_error: 0.0123100/126 [======================>.......] - ETA: 0s - loss: 2.8069e-04 - mean\_absolute\_error: 0.0122123/126 [============================>.] - ETA: 0s - loss: 2.6762e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 2ms/step - loss: 2.6608e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.2254e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1094e-04 - mean\_absolute\_error: 0.0145 25/126 [====>.........................] - ETA: 0s - loss: 2.8026e-04 - mean\_absolute\_error: 0.0123 49/126 [==========>...................] - ETA: 0s - loss: 2.5257e-04 - mean\_absolute\_error: 0.0116 73/126 [================>.............] - ETA: 0s - loss: 2.3812e-04 - mean\_absolute\_error: 0.0113 98/126 [======================>.......] - ETA: 0s - loss: 2.4536e-04 - mean\_absolute\_error: 0.0114122/126 [============================>.] - ETA: 0s - loss: 2.5242e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 2ms/step - loss: 2.5018e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.2263e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0611e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 2.1854e-04 - mean\_absolute\_error: 0.0106 47/126 [==========>...................] - ETA: 0s - loss: 2.2984e-04 - mean\_absolute\_error: 0.0110 71/126 [===============>..............] - ETA: 0s - loss: 2.8022e-04 - mean\_absolute\_error: 0.0121 95/126 [=====================>........] - ETA: 0s - loss: 2.6735e-04 - mean\_absolute\_error: 0.0119119/126 [===========================>..] - ETA: 0s - loss: 2.6855e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 2ms/step - loss: 2.6907e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 3.0726e-04 - val\_mean\_absolute\_error: 0.0151  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6369e-04 - mean\_absolute\_error: 0.0159 24/126 [====>.........................] - ETA: 0s - loss: 3.7279e-04 - mean\_absolute\_error: 0.0147 47/126 [==========>...................] - ETA: 0s - loss: 3.3240e-04 - mean\_absolute\_error: 0.0137 72/126 [================>.............] - ETA: 0s - loss: 3.1778e-04 - mean\_absolute\_error: 0.0132 97/126 [======================>.......] - ETA: 0s - loss: 3.1065e-04 - mean\_absolute\_error: 0.0130121/126 [===========================>..] - ETA: 0s - loss: 2.9198e-04 - mean\_absolute\_error: 0.0127126/126 [==============================] - 0s 2ms/step - loss: 2.8919e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.3045e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2024e-04 - mean\_absolute\_error: 0.0118 25/126 [====>.........................] - ETA: 0s - loss: 2.0536e-04 - mean\_absolute\_error: 0.0107 50/126 [==========>...................] - ETA: 0s - loss: 2.3321e-04 - mean\_absolute\_error: 0.0109 75/126 [================>.............] - ETA: 0s - loss: 2.3883e-04 - mean\_absolute\_error: 0.0109 98/126 [======================>.......] - ETA: 0s - loss: 2.3833e-04 - mean\_absolute\_error: 0.0110122/126 [============================>.] - ETA: 0s - loss: 2.5576e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 2ms/step - loss: 2.5435e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.1844e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3907e-04 - mean\_absolute\_error: 0.0098 24/126 [====>.........................] - ETA: 0s - loss: 2.0845e-04 - mean\_absolute\_error: 0.0104 48/126 [==========>...................] - ETA: 0s - loss: 2.3161e-04 - mean\_absolute\_error: 0.0112 70/126 [===============>..............] - ETA: 0s - loss: 2.4501e-04 - mean\_absolute\_error: 0.0114 93/126 [=====================>........] - ETA: 0s - loss: 2.4574e-04 - mean\_absolute\_error: 0.0113116/126 [==========================>...] - ETA: 0s - loss: 2.3075e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3736e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 2.2657e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5187e-04 - mean\_absolute\_error: 0.0131 25/126 [====>.........................] - ETA: 0s - loss: 2.7817e-04 - mean\_absolute\_error: 0.0122 49/126 [==========>...................] - ETA: 0s - loss: 2.3709e-04 - mean\_absolute\_error: 0.0113 73/126 [================>.............] - ETA: 0s - loss: 2.4852e-04 - mean\_absolute\_error: 0.0115 97/126 [======================>.......] - ETA: 0s - loss: 2.4402e-04 - mean\_absolute\_error: 0.0114121/126 [===========================>..] - ETA: 0s - loss: 2.4967e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 2ms/step - loss: 2.4748e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.2589e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5032e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 2.7748e-04 - mean\_absolute\_error: 0.0117 48/126 [==========>...................] - ETA: 0s - loss: 2.8720e-04 - mean\_absolute\_error: 0.0119 72/126 [================>.............] - ETA: 0s - loss: 2.6925e-04 - mean\_absolute\_error: 0.0116 96/126 [=====================>........] - ETA: 0s - loss: 2.5932e-04 - mean\_absolute\_error: 0.0115120/126 [===========================>..] - ETA: 0s - loss: 2.4823e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.4874e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1889e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8425e-04 - mean\_absolute\_error: 0.0126 25/126 [====>.........................] - ETA: 0s - loss: 3.2227e-04 - mean\_absolute\_error: 0.0127 49/126 [==========>...................] - ETA: 0s - loss: 2.8317e-04 - mean\_absolute\_error: 0.0120 73/126 [================>.............] - ETA: 0s - loss: 2.8553e-04 - mean\_absolute\_error: 0.0122 95/126 [=====================>........] - ETA: 0s - loss: 2.9492e-04 - mean\_absolute\_error: 0.0125120/126 [===========================>..] - ETA: 0s - loss: 2.7527e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 2ms/step - loss: 2.7227e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.4209e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7920e-04 - mean\_absolute\_error: 0.0151 24/126 [====>.........................] - ETA: 0s - loss: 2.3498e-04 - mean\_absolute\_error: 0.0113 48/126 [==========>...................] - ETA: 0s - loss: 2.3671e-04 - mean\_absolute\_error: 0.0112 72/126 [================>.............] - ETA: 0s - loss: 2.3870e-04 - mean\_absolute\_error: 0.0111 95/126 [=====================>........] - ETA: 0s - loss: 2.3725e-04 - mean\_absolute\_error: 0.0110119/126 [===========================>..] - ETA: 0s - loss: 2.3273e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.3240e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 2.1666e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9118e-04 - mean\_absolute\_error: 0.0127 24/126 [====>.........................] - ETA: 0s - loss: 2.6235e-04 - mean\_absolute\_error: 0.0116 49/126 [==========>...................] - ETA: 0s - loss: 2.3785e-04 - mean\_absolute\_error: 0.0112 74/126 [================>.............] - ETA: 0s - loss: 2.3473e-04 - mean\_absolute\_error: 0.0113 98/126 [======================>.......] - ETA: 0s - loss: 2.6143e-04 - mean\_absolute\_error: 0.0118120/126 [===========================>..] - ETA: 0s - loss: 2.7919e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 2ms/step - loss: 2.7831e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 2.2678e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6456e-04 - mean\_absolute\_error: 0.0120 24/126 [====>.........................] - ETA: 0s - loss: 2.0646e-04 - mean\_absolute\_error: 0.0110 49/126 [==========>...................] - ETA: 0s - loss: 2.3100e-04 - mean\_absolute\_error: 0.0113 74/126 [================>.............] - ETA: 0s - loss: 2.4988e-04 - mean\_absolute\_error: 0.0116 98/126 [======================>.......] - ETA: 0s - loss: 2.5719e-04 - mean\_absolute\_error: 0.0117119/126 [===========================>..] - ETA: 0s - loss: 2.4872e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4559e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.5257e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6474e-04 - mean\_absolute\_error: 0.0147 25/126 [====>.........................] - ETA: 0s - loss: 3.5922e-04 - mean\_absolute\_error: 0.0144 50/126 [==========>...................] - ETA: 0s - loss: 3.1338e-04 - mean\_absolute\_error: 0.0131 74/126 [================>.............] - ETA: 0s - loss: 2.9420e-04 - mean\_absolute\_error: 0.0127 98/126 [======================>.......] - ETA: 0s - loss: 2.7636e-04 - mean\_absolute\_error: 0.0124121/126 [===========================>..] - ETA: 0s - loss: 2.6839e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 2ms/step - loss: 2.6919e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.1086e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7151e-04 - mean\_absolute\_error: 0.0090 25/126 [====>.........................] - ETA: 0s - loss: 2.5049e-04 - mean\_absolute\_error: 0.0113 47/126 [==========>...................] - ETA: 0s - loss: 2.4814e-04 - mean\_absolute\_error: 0.0114 66/126 [==============>...............] - ETA: 0s - loss: 2.4928e-04 - mean\_absolute\_error: 0.0114 86/126 [===================>..........] - ETA: 0s - loss: 2.6475e-04 - mean\_absolute\_error: 0.0119106/126 [========================>.....] - ETA: 0s - loss: 2.7797e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 3ms/step - loss: 2.9920e-04 - mean\_absolute\_error: 0.0128 - val\_loss: 1.2674e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8837e-04 - mean\_absolute\_error: 0.0111 19/126 [===>..........................] - ETA: 0s - loss: 2.5398e-04 - mean\_absolute\_error: 0.0116 40/126 [========>.....................] - ETA: 0s - loss: 2.2570e-04 - mean\_absolute\_error: 0.0110 63/126 [==============>...............] - ETA: 0s - loss: 2.3872e-04 - mean\_absolute\_error: 0.0111 87/126 [===================>..........] - ETA: 0s - loss: 2.2501e-04 - mean\_absolute\_error: 0.0109108/126 [========================>.....] - ETA: 0s - loss: 2.2659e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.3088e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 2.2972e-04 - val\_mean\_absolute\_error: 0.0125  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2906e-04 - mean\_absolute\_error: 0.0140 25/126 [====>.........................] - ETA: 0s - loss: 2.9187e-04 - mean\_absolute\_error: 0.0127 50/126 [==========>...................] - ETA: 0s - loss: 2.4261e-04 - mean\_absolute\_error: 0.0115 74/126 [================>.............] - ETA: 0s - loss: 2.4888e-04 - mean\_absolute\_error: 0.0116 99/126 [======================>.......] - ETA: 0s - loss: 2.5732e-04 - mean\_absolute\_error: 0.0118123/126 [============================>.] - ETA: 0s - loss: 2.5490e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 2ms/step - loss: 2.5511e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.0825e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3870e-04 - mean\_absolute\_error: 0.0118 25/126 [====>.........................] - ETA: 0s - loss: 2.2378e-04 - mean\_absolute\_error: 0.0105 49/126 [==========>...................] - ETA: 0s - loss: 2.1741e-04 - mean\_absolute\_error: 0.0106 73/126 [================>.............] - ETA: 0s - loss: 2.2523e-04 - mean\_absolute\_error: 0.0108 97/126 [======================>.......] - ETA: 0s - loss: 2.1696e-04 - mean\_absolute\_error: 0.0107121/126 [===========================>..] - ETA: 0s - loss: 2.3370e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 2ms/step - loss: 2.3651e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 4.2484e-04 - val\_mean\_absolute\_error: 0.0182  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2147e-04 - mean\_absolute\_error: 0.0237 24/126 [====>.........................] - ETA: 0s - loss: 3.7165e-04 - mean\_absolute\_error: 0.0146 47/126 [==========>...................] - ETA: 0s - loss: 3.4035e-04 - mean\_absolute\_error: 0.0139 71/126 [===============>..............] - ETA: 0s - loss: 3.4694e-04 - mean\_absolute\_error: 0.0141 94/126 [=====================>........] - ETA: 0s - loss: 3.1980e-04 - mean\_absolute\_error: 0.0134117/126 [==========================>...] - ETA: 0s - loss: 3.0339e-04 - mean\_absolute\_error: 0.0130126/126 [==============================] - 0s 3ms/step - loss: 2.9916e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 1.5367e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0402e-04 - mean\_absolute\_error: 0.0106 24/126 [====>.........................] - ETA: 0s - loss: 2.3572e-04 - mean\_absolute\_error: 0.0112 49/126 [==========>...................] - ETA: 0s - loss: 2.4739e-04 - mean\_absolute\_error: 0.0114 73/126 [================>.............] - ETA: 0s - loss: 2.7346e-04 - mean\_absolute\_error: 0.0121 97/126 [======================>.......] - ETA: 0s - loss: 2.5323e-04 - mean\_absolute\_error: 0.0116121/126 [===========================>..] - ETA: 0s - loss: 2.4449e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.4568e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1390e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5439e-04 - mean\_absolute\_error: 0.0118 25/126 [====>.........................] - ETA: 0s - loss: 2.9016e-04 - mean\_absolute\_error: 0.0128 50/126 [==========>...................] - ETA: 0s - loss: 2.4589e-04 - mean\_absolute\_error: 0.0118 74/126 [================>.............] - ETA: 0s - loss: 2.5014e-04 - mean\_absolute\_error: 0.0116 99/126 [======================>.......] - ETA: 0s - loss: 2.7483e-04 - mean\_absolute\_error: 0.0122123/126 [============================>.] - ETA: 0s - loss: 2.7459e-04 - mean\_absolute\_error: 0.0122126/126 [==============================] - 0s 2ms/step - loss: 2.7362e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 1.4291e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6984e-04 - mean\_absolute\_error: 0.0097 25/126 [====>.........................] - ETA: 0s - loss: 2.1115e-04 - mean\_absolute\_error: 0.0105 50/126 [==========>...................] - ETA: 0s - loss: 1.9965e-04 - mean\_absolute\_error: 0.0103 74/126 [================>.............] - ETA: 0s - loss: 2.1508e-04 - mean\_absolute\_error: 0.0108 98/126 [======================>.......] - ETA: 0s - loss: 2.5497e-04 - mean\_absolute\_error: 0.0114121/126 [===========================>..] - ETA: 0s - loss: 2.5565e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 2ms/step - loss: 2.5348e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 3.1268e-04 - val\_mean\_absolute\_error: 0.0153  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4823e-04 - mean\_absolute\_error: 0.0189 23/126 [====>.........................] - ETA: 0s - loss: 2.4051e-04 - mean\_absolute\_error: 0.0118 47/126 [==========>...................] - ETA: 0s - loss: 2.4368e-04 - mean\_absolute\_error: 0.0116 70/126 [===============>..............] - ETA: 0s - loss: 2.5161e-04 - mean\_absolute\_error: 0.0116 93/126 [=====================>........] - ETA: 0s - loss: 2.4478e-04 - mean\_absolute\_error: 0.0114116/126 [==========================>...] - ETA: 0s - loss: 2.3859e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3786e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1330e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4085e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 2.2133e-04 - mean\_absolute\_error: 0.0106 48/126 [==========>...................] - ETA: 0s - loss: 2.4290e-04 - mean\_absolute\_error: 0.0110 72/126 [================>.............] - ETA: 0s - loss: 2.3830e-04 - mean\_absolute\_error: 0.0112 96/126 [=====================>........] - ETA: 0s - loss: 2.2846e-04 - mean\_absolute\_error: 0.0110120/126 [===========================>..] - ETA: 0s - loss: 2.3794e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.3801e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.2199e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1498e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 2.6727e-04 - mean\_absolute\_error: 0.0112 48/126 [==========>...................] - ETA: 0s - loss: 2.3002e-04 - mean\_absolute\_error: 0.0107 72/126 [================>.............] - ETA: 0s - loss: 2.2231e-04 - mean\_absolute\_error: 0.0106 95/126 [=====================>........] - ETA: 0s - loss: 2.0801e-04 - mean\_absolute\_error: 0.0103118/126 [===========================>..] - ETA: 0s - loss: 2.2084e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1678e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 1.0578e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5257e-04 - mean\_absolute\_error: 0.0097 23/126 [====>.........................] - ETA: 0s - loss: 2.0628e-04 - mean\_absolute\_error: 0.0107 46/126 [=========>....................] - ETA: 0s - loss: 2.5132e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.5205e-04 - mean\_absolute\_error: 0.0114 92/126 [====================>.........] - ETA: 0s - loss: 2.3226e-04 - mean\_absolute\_error: 0.0110116/126 [==========================>...] - ETA: 0s - loss: 2.2176e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2552e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.2659e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9820e-04 - mean\_absolute\_error: 0.0117 25/126 [====>.........................] - ETA: 0s - loss: 2.7327e-04 - mean\_absolute\_error: 0.0121 49/126 [==========>...................] - ETA: 0s - loss: 2.5419e-04 - mean\_absolute\_error: 0.0119 72/126 [================>.............] - ETA: 0s - loss: 2.6866e-04 - mean\_absolute\_error: 0.0120 96/126 [=====================>........] - ETA: 0s - loss: 2.6298e-04 - mean\_absolute\_error: 0.0119119/126 [===========================>..] - ETA: 0s - loss: 2.5022e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 2ms/step - loss: 2.4650e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.0435e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3820e-04 - mean\_absolute\_error: 0.0107 25/126 [====>.........................] - ETA: 0s - loss: 2.0905e-04 - mean\_absolute\_error: 0.0106 49/126 [==========>...................] - ETA: 0s - loss: 2.0077e-04 - mean\_absolute\_error: 0.0105 73/126 [================>.............] - ETA: 0s - loss: 2.0418e-04 - mean\_absolute\_error: 0.0105 96/126 [=====================>........] - ETA: 0s - loss: 2.0721e-04 - mean\_absolute\_error: 0.0106119/126 [===========================>..] - ETA: 0s - loss: 2.1154e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1509e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 1.4447e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4925e-04 - mean\_absolute\_error: 0.0092 19/126 [===>..........................] - ETA: 0s - loss: 2.0757e-04 - mean\_absolute\_error: 0.0101 34/126 [=======>......................] - ETA: 0s - loss: 1.9867e-04 - mean\_absolute\_error: 0.0102 53/126 [===========>..................] - ETA: 0s - loss: 2.2017e-04 - mean\_absolute\_error: 0.0108 71/126 [===============>..............] - ETA: 0s - loss: 2.1762e-04 - mean\_absolute\_error: 0.0108 87/126 [===================>..........] - ETA: 0s - loss: 2.2606e-04 - mean\_absolute\_error: 0.0109105/126 [========================>.....] - ETA: 0s - loss: 2.3326e-04 - mean\_absolute\_error: 0.0112125/126 [============================>.] - ETA: 0s - loss: 2.3710e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3671e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.7250e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0292e-04 - mean\_absolute\_error: 0.0114 24/126 [====>.........................] - ETA: 0s - loss: 1.9652e-04 - mean\_absolute\_error: 0.0103 45/126 [=========>....................] - ETA: 0s - loss: 2.2035e-04 - mean\_absolute\_error: 0.0106 69/126 [===============>..............] - ETA: 0s - loss: 2.2503e-04 - mean\_absolute\_error: 0.0108 92/126 [====================>.........] - ETA: 0s - loss: 2.4196e-04 - mean\_absolute\_error: 0.0113116/126 [==========================>...] - ETA: 0s - loss: 2.4664e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4225e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.0181e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2582e-04 - mean\_absolute\_error: 0.0088 25/126 [====>.........................] - ETA: 0s - loss: 1.8700e-04 - mean\_absolute\_error: 0.0101 49/126 [==========>...................] - ETA: 0s - loss: 2.1394e-04 - mean\_absolute\_error: 0.0109 72/126 [================>.............] - ETA: 0s - loss: 2.2457e-04 - mean\_absolute\_error: 0.0113 95/126 [=====================>........] - ETA: 0s - loss: 2.3329e-04 - mean\_absolute\_error: 0.0112118/126 [===========================>..] - ETA: 0s - loss: 2.2943e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.2795e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.6489e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4459e-04 - mean\_absolute\_error: 0.0100 22/126 [====>.........................] - ETA: 0s - loss: 2.0218e-04 - mean\_absolute\_error: 0.0107 44/126 [=========>....................] - ETA: 0s - loss: 2.2361e-04 - mean\_absolute\_error: 0.0109 67/126 [==============>...............] - ETA: 0s - loss: 2.0910e-04 - mean\_absolute\_error: 0.0106 91/126 [====================>.........] - ETA: 0s - loss: 2.1031e-04 - mean\_absolute\_error: 0.0107115/126 [==========================>...] - ETA: 0s - loss: 2.2140e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2392e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.2718e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8975e-04 - mean\_absolute\_error: 0.0126 25/126 [====>.........................] - ETA: 0s - loss: 1.8496e-04 - mean\_absolute\_error: 0.0100 49/126 [==========>...................] - ETA: 0s - loss: 1.9439e-04 - mean\_absolute\_error: 0.0104 73/126 [================>.............] - ETA: 0s - loss: 2.0695e-04 - mean\_absolute\_error: 0.0105 97/126 [======================>.......] - ETA: 0s - loss: 2.3737e-04 - mean\_absolute\_error: 0.0112121/126 [===========================>..] - ETA: 0s - loss: 2.3226e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 2ms/step - loss: 2.2955e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.2123e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7989e-04 - mean\_absolute\_error: 0.0130 25/126 [====>.........................] - ETA: 0s - loss: 2.8096e-04 - mean\_absolute\_error: 0.0123 49/126 [==========>...................] - ETA: 0s - loss: 2.5766e-04 - mean\_absolute\_error: 0.0117 73/126 [================>.............] - ETA: 0s - loss: 2.3684e-04 - mean\_absolute\_error: 0.0114 97/126 [======================>.......] - ETA: 0s - loss: 2.3571e-04 - mean\_absolute\_error: 0.0112120/126 [===========================>..] - ETA: 0s - loss: 2.3236e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 2ms/step - loss: 2.3019e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.1828e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2815e-04 - mean\_absolute\_error: 0.0082 25/126 [====>.........................] - ETA: 0s - loss: 2.3612e-04 - mean\_absolute\_error: 0.0112 47/126 [==========>...................] - ETA: 0s - loss: 2.0305e-04 - mean\_absolute\_error: 0.0104 70/126 [===============>..............] - ETA: 0s - loss: 2.1977e-04 - mean\_absolute\_error: 0.0106 93/126 [=====================>........] - ETA: 0s - loss: 2.1274e-04 - mean\_absolute\_error: 0.0105117/126 [==========================>...] - ETA: 0s - loss: 2.2596e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2460e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.0376e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2185e-04 - mean\_absolute\_error: 0.0085 25/126 [====>.........................] - ETA: 0s - loss: 1.9355e-04 - mean\_absolute\_error: 0.0099 49/126 [==========>...................] - ETA: 0s - loss: 2.5318e-04 - mean\_absolute\_error: 0.0117 71/126 [===============>..............] - ETA: 0s - loss: 2.4041e-04 - mean\_absolute\_error: 0.0115 95/126 [=====================>........] - ETA: 0s - loss: 2.3719e-04 - mean\_absolute\_error: 0.0113119/126 [===========================>..] - ETA: 0s - loss: 2.3917e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3794e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.1628e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4743e-04 - mean\_absolute\_error: 0.0091 25/126 [====>.........................] - ETA: 0s - loss: 1.8287e-04 - mean\_absolute\_error: 0.0101 49/126 [==========>...................] - ETA: 0s - loss: 1.8995e-04 - mean\_absolute\_error: 0.0104 73/126 [================>.............] - ETA: 0s - loss: 2.0294e-04 - mean\_absolute\_error: 0.0105 98/126 [======================>.......] - ETA: 0s - loss: 2.2409e-04 - mean\_absolute\_error: 0.0108122/126 [============================>.] - ETA: 0s - loss: 2.2512e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 2ms/step - loss: 2.2496e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 2.9771e-04 - val\_mean\_absolute\_error: 0.0148  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4905e-04 - mean\_absolute\_error: 0.0200 24/126 [====>.........................] - ETA: 0s - loss: 3.2902e-04 - mean\_absolute\_error: 0.0134 48/126 [==========>...................] - ETA: 0s - loss: 2.5896e-04 - mean\_absolute\_error: 0.0118 71/126 [===============>..............] - ETA: 0s - loss: 2.5332e-04 - mean\_absolute\_error: 0.0115 92/126 [====================>.........] - ETA: 0s - loss: 2.4045e-04 - mean\_absolute\_error: 0.0112115/126 [==========================>...] - ETA: 0s - loss: 2.4658e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.3818e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1418e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8606e-04 - mean\_absolute\_error: 0.0118 25/126 [====>.........................] - ETA: 0s - loss: 2.6383e-04 - mean\_absolute\_error: 0.0111 49/126 [==========>...................] - ETA: 0s - loss: 2.3316e-04 - mean\_absolute\_error: 0.0109 73/126 [================>.............] - ETA: 0s - loss: 2.5253e-04 - mean\_absolute\_error: 0.0116 97/126 [======================>.......] - ETA: 0s - loss: 2.5050e-04 - mean\_absolute\_error: 0.0115121/126 [===========================>..] - ETA: 0s - loss: 2.4028e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.4194e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1445e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4525e-04 - mean\_absolute\_error: 0.0092 25/126 [====>.........................] - ETA: 0s - loss: 2.0958e-04 - mean\_absolute\_error: 0.0102 49/126 [==========>...................] - ETA: 0s - loss: 2.1094e-04 - mean\_absolute\_error: 0.0105 73/126 [================>.............] - ETA: 0s - loss: 2.0036e-04 - mean\_absolute\_error: 0.0101 97/126 [======================>.......] - ETA: 0s - loss: 1.9229e-04 - mean\_absolute\_error: 0.0100121/126 [===========================>..] - ETA: 0s - loss: 1.9966e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 2ms/step - loss: 1.9937e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 1.3047e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7211e-04 - mean\_absolute\_error: 0.0094 25/126 [====>.........................] - ETA: 0s - loss: 2.0615e-04 - mean\_absolute\_error: 0.0104 49/126 [==========>...................] - ETA: 0s - loss: 2.3859e-04 - mean\_absolute\_error: 0.0116 72/126 [================>.............] - ETA: 0s - loss: 2.4833e-04 - mean\_absolute\_error: 0.0120 94/126 [=====================>........] - ETA: 0s - loss: 2.4202e-04 - mean\_absolute\_error: 0.0116117/126 [==========================>...] - ETA: 0s - loss: 2.5340e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.5525e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.3094e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0807e-04 - mean\_absolute\_error: 0.0109 26/126 [=====>........................] - ETA: 0s - loss: 2.5105e-04 - mean\_absolute\_error: 0.0120 50/126 [==========>...................] - ETA: 0s - loss: 2.5142e-04 - mean\_absolute\_error: 0.0119 74/126 [================>.............] - ETA: 0s - loss: 2.3916e-04 - mean\_absolute\_error: 0.0115 98/126 [======================>.......] - ETA: 0s - loss: 2.3826e-04 - mean\_absolute\_error: 0.0116121/126 [===========================>..] - ETA: 0s - loss: 2.2674e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 2ms/step - loss: 2.3180e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 9.8344e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0943e-05 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 2.4593e-04 - mean\_absolute\_error: 0.0114 48/126 [==========>...................] - ETA: 0s - loss: 2.4006e-04 - mean\_absolute\_error: 0.0109 72/126 [================>.............] - ETA: 0s - loss: 2.3334e-04 - mean\_absolute\_error: 0.0110 96/126 [=====================>........] - ETA: 0s - loss: 2.3965e-04 - mean\_absolute\_error: 0.0113120/126 [===========================>..] - ETA: 0s - loss: 2.3283e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 2ms/step - loss: 2.2993e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 9.8703e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2133e-04 - mean\_absolute\_error: 0.0087 25/126 [====>.........................] - ETA: 0s - loss: 2.0507e-04 - mean\_absolute\_error: 0.0109 48/126 [==========>...................] - ETA: 0s - loss: 2.1039e-04 - mean\_absolute\_error: 0.0109 71/126 [===============>..............] - ETA: 0s - loss: 2.1168e-04 - mean\_absolute\_error: 0.0107 94/126 [=====================>........] - ETA: 0s - loss: 2.1004e-04 - mean\_absolute\_error: 0.0106116/126 [==========================>...] - ETA: 0s - loss: 2.1840e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1705e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 2.1335e-04 - val\_mean\_absolute\_error: 0.0121  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9516e-04 - mean\_absolute\_error: 0.0154 24/126 [====>.........................] - ETA: 0s - loss: 2.2719e-04 - mean\_absolute\_error: 0.0109 49/126 [==========>...................] - ETA: 0s - loss: 2.1184e-04 - mean\_absolute\_error: 0.0107 73/126 [================>.............] - ETA: 0s - loss: 2.0158e-04 - mean\_absolute\_error: 0.0104 97/126 [======================>.......] - ETA: 0s - loss: 1.9413e-04 - mean\_absolute\_error: 0.0102121/126 [===========================>..] - ETA: 0s - loss: 1.9496e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 2ms/step - loss: 1.9835e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 1.6012e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4292e-04 - mean\_absolute\_error: 0.0129 25/126 [====>.........................] - ETA: 0s - loss: 2.1592e-04 - mean\_absolute\_error: 0.0106 49/126 [==========>...................] - ETA: 0s - loss: 1.9796e-04 - mean\_absolute\_error: 0.0102 73/126 [================>.............] - ETA: 0s - loss: 2.1591e-04 - mean\_absolute\_error: 0.0106 97/126 [======================>.......] - ETA: 0s - loss: 2.0922e-04 - mean\_absolute\_error: 0.0106121/126 [===========================>..] - ETA: 0s - loss: 2.1082e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 2ms/step - loss: 2.0922e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 9.8434e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2502e-04 - mean\_absolute\_error: 0.0089 25/126 [====>.........................] - ETA: 0s - loss: 1.6003e-04 - mean\_absolute\_error: 0.0090 50/126 [==========>...................] - ETA: 0s - loss: 1.7499e-04 - mean\_absolute\_error: 0.0095 75/126 [================>.............] - ETA: 0s - loss: 2.2154e-04 - mean\_absolute\_error: 0.0106 98/126 [======================>.......] - ETA: 0s - loss: 2.2603e-04 - mean\_absolute\_error: 0.0110121/126 [===========================>..] - ETA: 0s - loss: 2.2166e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.2084e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 2.1391e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5345e-04 - mean\_absolute\_error: 0.0127 24/126 [====>.........................] - ETA: 0s - loss: 1.8761e-04 - mean\_absolute\_error: 0.0102 48/126 [==========>...................] - ETA: 0s - loss: 1.9277e-04 - mean\_absolute\_error: 0.0101 72/126 [================>.............] - ETA: 0s - loss: 1.8585e-04 - mean\_absolute\_error: 0.0100 97/126 [======================>.......] - ETA: 0s - loss: 2.3583e-04 - mean\_absolute\_error: 0.0112121/126 [===========================>..] - ETA: 0s - loss: 2.3898e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 2ms/step - loss: 2.3607e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.5064e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3883e-04 - mean\_absolute\_error: 0.0136 25/126 [====>.........................] - ETA: 0s - loss: 2.3423e-04 - mean\_absolute\_error: 0.0108 48/126 [==========>...................] - ETA: 0s - loss: 2.1319e-04 - mean\_absolute\_error: 0.0104 72/126 [================>.............] - ETA: 0s - loss: 2.0583e-04 - mean\_absolute\_error: 0.0104 97/126 [======================>.......] - ETA: 0s - loss: 2.0445e-04 - mean\_absolute\_error: 0.0103121/126 [===========================>..] - ETA: 0s - loss: 2.0107e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 2ms/step - loss: 2.0053e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 9.3761e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8540e-05 - mean\_absolute\_error: 0.0076 25/126 [====>.........................] - ETA: 0s - loss: 2.4009e-04 - mean\_absolute\_error: 0.0109 49/126 [==========>...................] - ETA: 0s - loss: 2.2877e-04 - mean\_absolute\_error: 0.0110 73/126 [================>.............] - ETA: 0s - loss: 2.3631e-04 - mean\_absolute\_error: 0.0113 97/126 [======================>.......] - ETA: 0s - loss: 2.2430e-04 - mean\_absolute\_error: 0.0110119/126 [===========================>..] - ETA: 0s - loss: 2.2457e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 2ms/step - loss: 2.3023e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.5773e-04 - val\_mean\_absolute\_error: 0.0101  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0793e-04 - mean\_absolute\_error: 0.0138 24/126 [====>.........................] - ETA: 0s - loss: 2.6388e-04 - mean\_absolute\_error: 0.0119 46/126 [=========>....................] - ETA: 0s - loss: 2.3284e-04 - mean\_absolute\_error: 0.0109 70/126 [===============>..............] - ETA: 0s - loss: 2.3969e-04 - mean\_absolute\_error: 0.0113 94/126 [=====================>........] - ETA: 0s - loss: 2.3673e-04 - mean\_absolute\_error: 0.0112118/126 [===========================>..] - ETA: 0s - loss: 2.2075e-04 - mean\_absolute\_error: 0.0108126/126 [==============================] - 0s 3ms/step - loss: 2.1878e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.9687e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8475e-04 - mean\_absolute\_error: 0.0138 25/126 [====>.........................] - ETA: 0s - loss: 2.1403e-04 - mean\_absolute\_error: 0.0106 49/126 [==========>...................] - ETA: 0s - loss: 2.1013e-04 - mean\_absolute\_error: 0.0104 73/126 [================>.............] - ETA: 0s - loss: 2.1104e-04 - mean\_absolute\_error: 0.0104 97/126 [======================>.......] - ETA: 0s - loss: 2.0051e-04 - mean\_absolute\_error: 0.0102121/126 [===========================>..] - ETA: 0s - loss: 2.0330e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - 0s 2ms/step - loss: 2.0236e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.1655e-04 - val\_mean\_absolute\_error: 0.0085

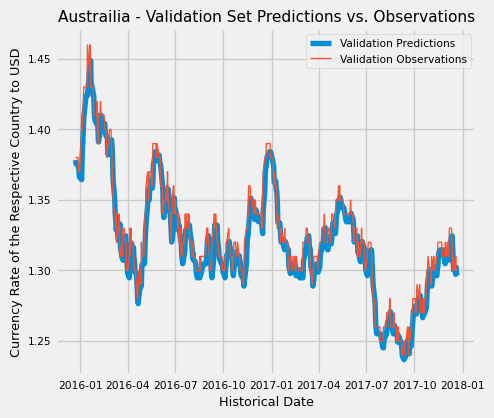
<keras.src.callbacks.History at 0x2115bbcead0>

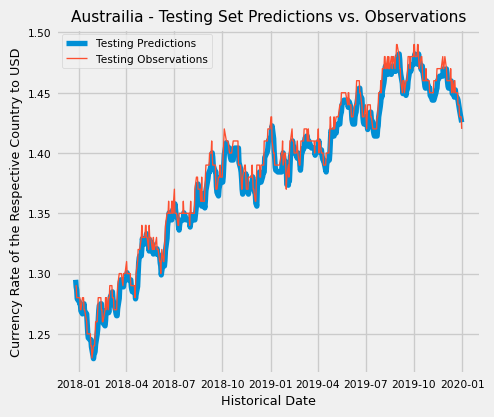
After the training and fitting of the Machine Learning model for Austrailia, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 42s 35/126 [=======>......................] - ETA: 0s 79/126 [=================>............] - ETA: 0s122/126 [============================>.] - ETA: 0s126/126 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step

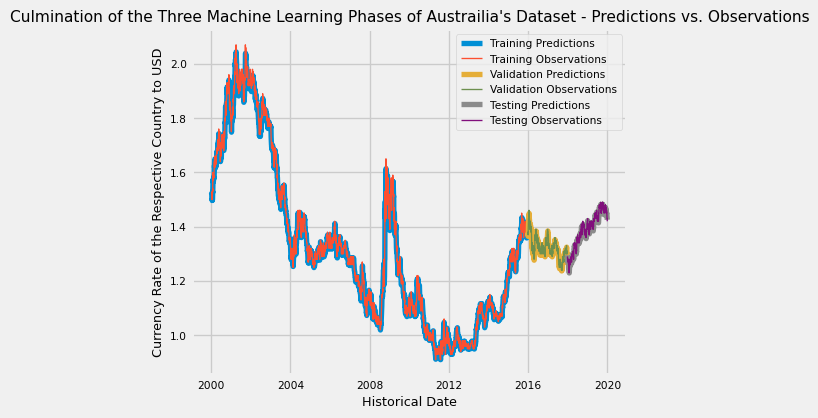






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

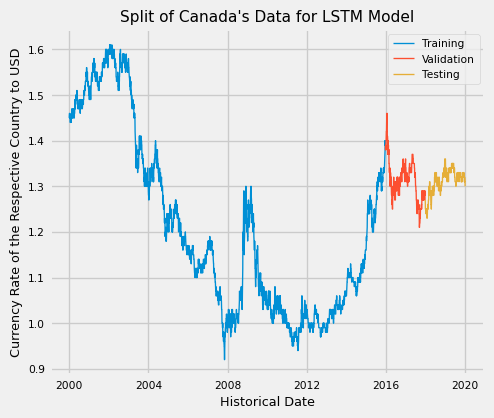
```{python}  
# Plotting Austrailia's observational (reference) data with the predictions of   
# its Machine Learning Model (as a way to visually inspect the effectiveness of   
# the model)   
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_train,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

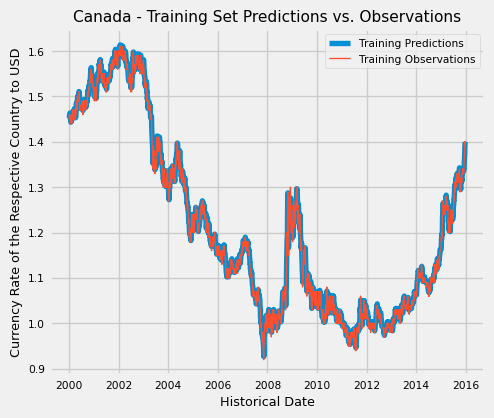
Epoch 1/100  
 1/126 [..............................] - ETA: 3:35 - loss: 1.1762 - mean\_absolute\_error: 1.0753 19/126 [===>..........................] - ETA: 0s - loss: 0.8513 - mean\_absolute\_error: 0.8950 44/126 [=========>....................] - ETA: 0s - loss: 0.4074 - mean\_absolute\_error: 0.5116 69/126 [===============>..............] - ETA: 0s - loss: 0.2621 - mean\_absolute\_error: 0.3484 93/126 [=====================>........] - ETA: 0s - loss: 0.1953 - mean\_absolute\_error: 0.2710118/126 [===========================>..] - ETA: 0s - loss: 0.1545 - mean\_absolute\_error: 0.2235126/126 [==============================] - 2s 6ms/step - loss: 0.1455 - mean\_absolute\_error: 0.2129 - val\_loss: 6.0407e-04 - val\_mean\_absolute\_error: 0.0209  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0020 - mean\_absolute\_error: 0.0389 23/126 [====>.........................] - ETA: 0s - loss: 0.0024 - mean\_absolute\_error: 0.0431 49/126 [==========>...................] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0401 73/126 [================>.............] - ETA: 0s - loss: 0.0020 - mean\_absolute\_error: 0.0388 96/126 [=====================>........] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0377120/126 [===========================>..] - ETA: 0s - loss: 0.0018 - mean\_absolute\_error: 0.0363126/126 [==============================] - 0s 2ms/step - loss: 0.0017 - mean\_absolute\_error: 0.0359 - val\_loss: 1.7718e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0012 - mean\_absolute\_error: 0.0317 26/126 [=====>........................] - ETA: 0s - loss: 9.6394e-04 - mean\_absolute\_error: 0.0273 52/126 [===========>..................] - ETA: 0s - loss: 8.8029e-04 - mean\_absolute\_error: 0.0259 77/126 [=================>............] - ETA: 0s - loss: 7.9081e-04 - mean\_absolute\_error: 0.0243103/126 [=======================>......] - ETA: 0s - loss: 7.1226e-04 - mean\_absolute\_error: 0.0229126/126 [==============================] - 0s 2ms/step - loss: 6.5741e-04 - mean\_absolute\_error: 0.0218 - val\_loss: 1.4815e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9978e-04 - mean\_absolute\_error: 0.0171 22/126 [====>.........................] - ETA: 0s - loss: 3.1379e-04 - mean\_absolute\_error: 0.0151 48/126 [==========>...................] - ETA: 0s - loss: 2.7329e-04 - mean\_absolute\_error: 0.0139 74/126 [================>.............] - ETA: 0s - loss: 2.4860e-04 - mean\_absolute\_error: 0.0132 99/126 [======================>.......] - ETA: 0s - loss: 2.2395e-04 - mean\_absolute\_error: 0.0124125/126 [============================>.] - ETA: 0s - loss: 2.0969e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 2ms/step - loss: 2.0929e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.0550e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5259e-04 - mean\_absolute\_error: 0.0108 19/126 [===>..........................] - ETA: 0s - loss: 1.3254e-04 - mean\_absolute\_error: 0.0092 42/126 [=========>....................] - ETA: 0s - loss: 1.2367e-04 - mean\_absolute\_error: 0.0087 67/126 [==============>...............] - ETA: 0s - loss: 1.1658e-04 - mean\_absolute\_error: 0.0084 91/126 [====================>.........] - ETA: 0s - loss: 1.1170e-04 - mean\_absolute\_error: 0.0082117/126 [==========================>...] - ETA: 0s - loss: 1.0773e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0705e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1052e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8911e-05 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 7.9795e-05 - mean\_absolute\_error: 0.0069 47/126 [==========>...................] - ETA: 0s - loss: 9.4590e-05 - mean\_absolute\_error: 0.0073 72/126 [================>.............] - ETA: 0s - loss: 9.4301e-05 - mean\_absolute\_error: 0.0073 96/126 [=====================>........] - ETA: 0s - loss: 9.2245e-05 - mean\_absolute\_error: 0.0073122/126 [============================>.] - ETA: 0s - loss: 9.3359e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.4068e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0477e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1638e-04 - mean\_absolute\_error: 0.0082 19/126 [===>..........................] - ETA: 0s - loss: 8.7002e-05 - mean\_absolute\_error: 0.0070 43/126 [=========>....................] - ETA: 0s - loss: 8.7681e-05 - mean\_absolute\_error: 0.0070 68/126 [===============>..............] - ETA: 0s - loss: 8.7324e-05 - mean\_absolute\_error: 0.0070 91/126 [====================>.........] - ETA: 0s - loss: 9.4285e-05 - mean\_absolute\_error: 0.0073108/126 [========================>.....] - ETA: 0s - loss: 9.3906e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.4310e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0867e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7895e-05 - mean\_absolute\_error: 0.0077 20/126 [===>..........................] - ETA: 0s - loss: 1.0788e-04 - mean\_absolute\_error: 0.0078 45/126 [=========>....................] - ETA: 0s - loss: 9.7523e-05 - mean\_absolute\_error: 0.0073 70/126 [===============>..............] - ETA: 0s - loss: 9.9386e-05 - mean\_absolute\_error: 0.0074 95/126 [=====================>........] - ETA: 0s - loss: 9.4974e-05 - mean\_absolute\_error: 0.0073119/126 [===========================>..] - ETA: 0s - loss: 9.5707e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.5551e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0970e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3624e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 9.6068e-05 - mean\_absolute\_error: 0.0072 46/126 [=========>....................] - ETA: 0s - loss: 9.7315e-05 - mean\_absolute\_error: 0.0073 69/126 [===============>..............] - ETA: 0s - loss: 9.1417e-05 - mean\_absolute\_error: 0.0071 91/126 [====================>.........] - ETA: 0s - loss: 9.0043e-05 - mean\_absolute\_error: 0.0072109/126 [========================>.....] - ETA: 0s - loss: 9.1187e-05 - mean\_absolute\_error: 0.0072126/126 [==============================] - 0s 3ms/step - loss: 9.3168e-05 - mean\_absolute\_error: 0.0072 - val\_loss: 1.1248e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0857e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 8.7196e-05 - mean\_absolute\_error: 0.0071 44/126 [=========>....................] - ETA: 0s - loss: 9.0486e-05 - mean\_absolute\_error: 0.0072 67/126 [==============>...............] - ETA: 0s - loss: 9.1487e-05 - mean\_absolute\_error: 0.0072 92/126 [====================>.........] - ETA: 0s - loss: 9.2553e-05 - mean\_absolute\_error: 0.0072117/126 [==========================>...] - ETA: 0s - loss: 9.2889e-05 - mean\_absolute\_error: 0.0072126/126 [==============================] - 0s 3ms/step - loss: 9.2785e-05 - mean\_absolute\_error: 0.0072 - val\_loss: 1.0641e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6285e-05 - mean\_absolute\_error: 0.0067 23/126 [====>.........................] - ETA: 0s - loss: 8.8046e-05 - mean\_absolute\_error: 0.0072 46/126 [=========>....................] - ETA: 0s - loss: 9.0086e-05 - mean\_absolute\_error: 0.0072 69/126 [===============>..............] - ETA: 0s - loss: 9.4864e-05 - mean\_absolute\_error: 0.0073 91/126 [====================>.........] - ETA: 0s - loss: 9.3928e-05 - mean\_absolute\_error: 0.0073110/126 [=========================>....] - ETA: 0s - loss: 9.4948e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.3960e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0654e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6263e-05 - mean\_absolute\_error: 0.0076 23/126 [====>.........................] - ETA: 0s - loss: 1.0472e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.0091e-04 - mean\_absolute\_error: 0.0076 68/126 [===============>..............] - ETA: 0s - loss: 9.8406e-05 - mean\_absolute\_error: 0.0074 93/126 [=====================>........] - ETA: 0s - loss: 9.5851e-05 - mean\_absolute\_error: 0.0073117/126 [==========================>...] - ETA: 0s - loss: 9.4516e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.4272e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.1059e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4812e-05 - mean\_absolute\_error: 0.0071 23/126 [====>.........................] - ETA: 0s - loss: 8.6090e-05 - mean\_absolute\_error: 0.0071 46/126 [=========>....................] - ETA: 0s - loss: 9.4783e-05 - mean\_absolute\_error: 0.0073 69/126 [===============>..............] - ETA: 0s - loss: 9.7513e-05 - mean\_absolute\_error: 0.0074 93/126 [=====================>........] - ETA: 0s - loss: 9.8698e-05 - mean\_absolute\_error: 0.0075116/126 [==========================>...] - ETA: 0s - loss: 9.7512e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.5922e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0492e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2230e-04 - mean\_absolute\_error: 0.0093 24/126 [====>.........................] - ETA: 0s - loss: 9.7616e-05 - mean\_absolute\_error: 0.0072 44/126 [=========>....................] - ETA: 0s - loss: 9.5310e-05 - mean\_absolute\_error: 0.0072 67/126 [==============>...............] - ETA: 0s - loss: 9.5243e-05 - mean\_absolute\_error: 0.0072 93/126 [=====================>........] - ETA: 0s - loss: 9.4523e-05 - mean\_absolute\_error: 0.0072118/126 [===========================>..] - ETA: 0s - loss: 9.6010e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.5721e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0844e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3183e-05 - mean\_absolute\_error: 0.0075 19/126 [===>..........................] - ETA: 0s - loss: 8.4065e-05 - mean\_absolute\_error: 0.0071 43/126 [=========>....................] - ETA: 0s - loss: 9.1169e-05 - mean\_absolute\_error: 0.0072 68/126 [===============>..............] - ETA: 0s - loss: 9.1104e-05 - mean\_absolute\_error: 0.0072 92/126 [====================>.........] - ETA: 0s - loss: 9.6066e-05 - mean\_absolute\_error: 0.0074117/126 [==========================>...] - ETA: 0s - loss: 9.7397e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.7340e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0828e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9782e-05 - mean\_absolute\_error: 0.0087 19/126 [===>..........................] - ETA: 0s - loss: 9.7016e-05 - mean\_absolute\_error: 0.0076 39/126 [========>.....................] - ETA: 0s - loss: 9.5223e-05 - mean\_absolute\_error: 0.0075 59/126 [=============>................] - ETA: 0s - loss: 9.4991e-05 - mean\_absolute\_error: 0.0074 80/126 [==================>...........] - ETA: 0s - loss: 9.5303e-05 - mean\_absolute\_error: 0.0075100/126 [======================>.......] - ETA: 0s - loss: 9.8380e-05 - mean\_absolute\_error: 0.0075122/126 [============================>.] - ETA: 0s - loss: 9.5780e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.5324e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0497e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0579e-04 - mean\_absolute\_error: 0.0069 22/126 [====>.........................] - ETA: 0s - loss: 9.7041e-05 - mean\_absolute\_error: 0.0076 44/126 [=========>....................] - ETA: 0s - loss: 9.5029e-05 - mean\_absolute\_error: 0.0075 67/126 [==============>...............] - ETA: 0s - loss: 1.0220e-04 - mean\_absolute\_error: 0.0076 91/126 [====================>.........] - ETA: 0s - loss: 9.8494e-05 - mean\_absolute\_error: 0.0076115/126 [==========================>...] - ETA: 0s - loss: 1.0186e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0094e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1629e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0906e-04 - mean\_absolute\_error: 0.0070 24/126 [====>.........................] - ETA: 0s - loss: 1.0506e-04 - mean\_absolute\_error: 0.0078 48/126 [==========>...................] - ETA: 0s - loss: 1.0384e-04 - mean\_absolute\_error: 0.0078 71/126 [===============>..............] - ETA: 0s - loss: 1.0292e-04 - mean\_absolute\_error: 0.0077 93/126 [=====================>........] - ETA: 0s - loss: 1.0159e-04 - mean\_absolute\_error: 0.0076116/126 [==========================>...] - ETA: 0s - loss: 9.8712e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0028e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1326e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0493e-05 - mean\_absolute\_error: 0.0074 25/126 [====>.........................] - ETA: 0s - loss: 1.1117e-04 - mean\_absolute\_error: 0.0079 49/126 [==========>...................] - ETA: 0s - loss: 1.0349e-04 - mean\_absolute\_error: 0.0077 72/126 [================>.............] - ETA: 0s - loss: 9.8383e-05 - mean\_absolute\_error: 0.0075 94/126 [=====================>........] - ETA: 0s - loss: 9.7703e-05 - mean\_absolute\_error: 0.0075119/126 [===========================>..] - ETA: 0s - loss: 9.7992e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 2ms/step - loss: 9.8128e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0453e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1727e-04 - mean\_absolute\_error: 0.0088 24/126 [====>.........................] - ETA: 0s - loss: 9.8673e-05 - mean\_absolute\_error: 0.0075 45/126 [=========>....................] - ETA: 0s - loss: 1.0394e-04 - mean\_absolute\_error: 0.0075 70/126 [===============>..............] - ETA: 0s - loss: 1.0110e-04 - mean\_absolute\_error: 0.0075 96/126 [=====================>........] - ETA: 0s - loss: 1.0122e-04 - mean\_absolute\_error: 0.0076122/126 [============================>.] - ETA: 0s - loss: 1.0059e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 2ms/step - loss: 1.0127e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1158e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8692e-05 - mean\_absolute\_error: 0.0056 20/126 [===>..........................] - ETA: 0s - loss: 9.8078e-05 - mean\_absolute\_error: 0.0073 45/126 [=========>....................] - ETA: 0s - loss: 9.7304e-05 - mean\_absolute\_error: 0.0073 70/126 [===============>..............] - ETA: 0s - loss: 9.4414e-05 - mean\_absolute\_error: 0.0073 95/126 [=====================>........] - ETA: 0s - loss: 9.5170e-05 - mean\_absolute\_error: 0.0073119/126 [===========================>..] - ETA: 0s - loss: 9.5239e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.5146e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0872e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0447e-04 - mean\_absolute\_error: 0.0082 26/126 [=====>........................] - ETA: 0s - loss: 1.1244e-04 - mean\_absolute\_error: 0.0081 51/126 [===========>..................] - ETA: 0s - loss: 1.0673e-04 - mean\_absolute\_error: 0.0078 76/126 [=================>............] - ETA: 0s - loss: 1.0655e-04 - mean\_absolute\_error: 0.0078101/126 [=======================>......] - ETA: 0s - loss: 1.0438e-04 - mean\_absolute\_error: 0.0078125/126 [============================>.] - ETA: 0s - loss: 1.0327e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0326e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0987e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0288e-04 - mean\_absolute\_error: 0.0073 25/126 [====>.........................] - ETA: 0s - loss: 9.4926e-05 - mean\_absolute\_error: 0.0073 50/126 [==========>...................] - ETA: 0s - loss: 9.6576e-05 - mean\_absolute\_error: 0.0074 74/126 [================>.............] - ETA: 0s - loss: 9.6138e-05 - mean\_absolute\_error: 0.0074 96/126 [=====================>........] - ETA: 0s - loss: 9.4372e-05 - mean\_absolute\_error: 0.0073118/126 [===========================>..] - ETA: 0s - loss: 9.5241e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.5763e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0452e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9158e-05 - mean\_absolute\_error: 0.0063 26/126 [=====>........................] - ETA: 0s - loss: 1.2563e-04 - mean\_absolute\_error: 0.0085 50/126 [==========>...................] - ETA: 0s - loss: 1.1593e-04 - mean\_absolute\_error: 0.0081 74/126 [================>.............] - ETA: 0s - loss: 1.1760e-04 - mean\_absolute\_error: 0.0082 98/126 [======================>.......] - ETA: 0s - loss: 1.1528e-04 - mean\_absolute\_error: 0.0082122/126 [============================>.] - ETA: 0s - loss: 1.1379e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 2ms/step - loss: 1.1341e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.1401e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6734e-05 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 1.0196e-04 - mean\_absolute\_error: 0.0077 49/126 [==========>...................] - ETA: 0s - loss: 1.0668e-04 - mean\_absolute\_error: 0.0077 74/126 [================>.............] - ETA: 0s - loss: 1.0465e-04 - mean\_absolute\_error: 0.0077 99/126 [======================>.......] - ETA: 0s - loss: 1.0595e-04 - mean\_absolute\_error: 0.0078123/126 [============================>.] - ETA: 0s - loss: 1.0343e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0311e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0890e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3626e-05 - mean\_absolute\_error: 0.0070 19/126 [===>..........................] - ETA: 0s - loss: 9.2770e-05 - mean\_absolute\_error: 0.0072 41/126 [========>.....................] - ETA: 0s - loss: 9.5373e-05 - mean\_absolute\_error: 0.0073 63/126 [==============>...............] - ETA: 0s - loss: 9.2893e-05 - mean\_absolute\_error: 0.0073 85/126 [===================>..........] - ETA: 0s - loss: 9.5917e-05 - mean\_absolute\_error: 0.0075105/126 [========================>.....] - ETA: 0s - loss: 1.0498e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0573e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0393e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7231e-05 - mean\_absolute\_error: 0.0061 22/126 [====>.........................] - ETA: 0s - loss: 8.6746e-05 - mean\_absolute\_error: 0.0069 44/126 [=========>....................] - ETA: 0s - loss: 8.6760e-05 - mean\_absolute\_error: 0.0069 66/126 [==============>...............] - ETA: 0s - loss: 8.6191e-05 - mean\_absolute\_error: 0.0069 88/126 [===================>..........] - ETA: 0s - loss: 9.3515e-05 - mean\_absolute\_error: 0.0073111/126 [=========================>....] - ETA: 0s - loss: 9.6483e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.9633e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0555e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7728e-05 - mean\_absolute\_error: 0.0068 26/126 [=====>........................] - ETA: 0s - loss: 1.0478e-04 - mean\_absolute\_error: 0.0080 50/126 [==========>...................] - ETA: 0s - loss: 1.2337e-04 - mean\_absolute\_error: 0.0088 75/126 [================>.............] - ETA: 0s - loss: 1.1896e-04 - mean\_absolute\_error: 0.0085100/126 [======================>.......] - ETA: 0s - loss: 1.1876e-04 - mean\_absolute\_error: 0.0085124/126 [============================>.] - ETA: 0s - loss: 1.1649e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.1633e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0587e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3416e-05 - mean\_absolute\_error: 0.0069 25/126 [====>.........................] - ETA: 0s - loss: 9.3990e-05 - mean\_absolute\_error: 0.0073 50/126 [==========>...................] - ETA: 0s - loss: 9.4980e-05 - mean\_absolute\_error: 0.0074 75/126 [================>.............] - ETA: 0s - loss: 9.6040e-05 - mean\_absolute\_error: 0.0074 99/126 [======================>.......] - ETA: 0s - loss: 9.9565e-05 - mean\_absolute\_error: 0.0075121/126 [===========================>..] - ETA: 0s - loss: 1.0023e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 2ms/step - loss: 9.9729e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1028e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0214e-05 - mean\_absolute\_error: 0.0071 25/126 [====>.........................] - ETA: 0s - loss: 9.4234e-05 - mean\_absolute\_error: 0.0072 50/126 [==========>...................] - ETA: 0s - loss: 9.6281e-05 - mean\_absolute\_error: 0.0073 74/126 [================>.............] - ETA: 0s - loss: 9.5350e-05 - mean\_absolute\_error: 0.0073 98/126 [======================>.......] - ETA: 0s - loss: 9.5730e-05 - mean\_absolute\_error: 0.0074122/126 [============================>.] - ETA: 0s - loss: 9.7104e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 2ms/step - loss: 9.6250e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0970e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3287e-04 - mean\_absolute\_error: 0.0081 25/126 [====>.........................] - ETA: 0s - loss: 8.2399e-05 - mean\_absolute\_error: 0.0070 49/126 [==========>...................] - ETA: 0s - loss: 9.3884e-05 - mean\_absolute\_error: 0.0075 72/126 [================>.............] - ETA: 0s - loss: 1.0573e-04 - mean\_absolute\_error: 0.0079 96/126 [=====================>........] - ETA: 0s - loss: 1.0299e-04 - mean\_absolute\_error: 0.0078120/126 [===========================>..] - ETA: 0s - loss: 1.0678e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0619e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0493e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0517e-05 - mean\_absolute\_error: 0.0070 26/126 [=====>........................] - ETA: 0s - loss: 8.6786e-05 - mean\_absolute\_error: 0.0072 51/126 [===========>..................] - ETA: 0s - loss: 1.0596e-04 - mean\_absolute\_error: 0.0079 76/126 [=================>............] - ETA: 0s - loss: 1.0742e-04 - mean\_absolute\_error: 0.0079101/126 [=======================>......] - ETA: 0s - loss: 1.2587e-04 - mean\_absolute\_error: 0.0086125/126 [============================>.] - ETA: 0s - loss: 1.2083e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.2087e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.4397e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3021e-05 - mean\_absolute\_error: 0.0069 25/126 [====>.........................] - ETA: 0s - loss: 1.0614e-04 - mean\_absolute\_error: 0.0077 50/126 [==========>...................] - ETA: 0s - loss: 1.0311e-04 - mean\_absolute\_error: 0.0077 74/126 [================>.............] - ETA: 0s - loss: 1.0694e-04 - mean\_absolute\_error: 0.0080 98/126 [======================>.......] - ETA: 0s - loss: 1.1183e-04 - mean\_absolute\_error: 0.0082122/126 [============================>.] - ETA: 0s - loss: 1.1106e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 2ms/step - loss: 1.1060e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.3216e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2846e-04 - mean\_absolute\_error: 0.0091 25/126 [====>.........................] - ETA: 0s - loss: 1.1099e-04 - mean\_absolute\_error: 0.0080 49/126 [==========>...................] - ETA: 0s - loss: 1.2721e-04 - mean\_absolute\_error: 0.0086 74/126 [================>.............] - ETA: 0s - loss: 1.3207e-04 - mean\_absolute\_error: 0.0088 98/126 [======================>.......] - ETA: 0s - loss: 1.3261e-04 - mean\_absolute\_error: 0.0089122/126 [============================>.] - ETA: 0s - loss: 1.3315e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.3117e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.5614e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0334e-04 - mean\_absolute\_error: 0.0085 25/126 [====>.........................] - ETA: 0s - loss: 1.2234e-04 - mean\_absolute\_error: 0.0086 50/126 [==========>...................] - ETA: 0s - loss: 1.1239e-04 - mean\_absolute\_error: 0.0081 75/126 [================>.............] - ETA: 0s - loss: 1.2553e-04 - mean\_absolute\_error: 0.0086100/126 [======================>.......] - ETA: 0s - loss: 1.2208e-04 - mean\_absolute\_error: 0.0085124/126 [============================>.] - ETA: 0s - loss: 1.2260e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 2ms/step - loss: 1.2234e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.5254e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3884e-04 - mean\_absolute\_error: 0.0092 25/126 [====>.........................] - ETA: 0s - loss: 1.1133e-04 - mean\_absolute\_error: 0.0081 47/126 [==========>...................] - ETA: 0s - loss: 1.2966e-04 - mean\_absolute\_error: 0.0086 69/126 [===============>..............] - ETA: 0s - loss: 1.2068e-04 - mean\_absolute\_error: 0.0083 93/126 [=====================>........] - ETA: 0s - loss: 1.1772e-04 - mean\_absolute\_error: 0.0082117/126 [==========================>...] - ETA: 0s - loss: 1.1585e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1438e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0221e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0316e-05 - mean\_absolute\_error: 0.0053 23/126 [====>.........................] - ETA: 0s - loss: 9.6993e-05 - mean\_absolute\_error: 0.0075 48/126 [==========>...................] - ETA: 0s - loss: 9.4261e-05 - mean\_absolute\_error: 0.0074 72/126 [================>.............] - ETA: 0s - loss: 9.8151e-05 - mean\_absolute\_error: 0.0076 96/126 [=====================>........] - ETA: 0s - loss: 1.0679e-04 - mean\_absolute\_error: 0.0078120/126 [===========================>..] - ETA: 0s - loss: 1.0908e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0979e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.2512e-04 - val\_mean\_absolute\_error: 0.0126  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0146e-04 - mean\_absolute\_error: 0.0072 25/126 [====>.........................] - ETA: 0s - loss: 1.1312e-04 - mean\_absolute\_error: 0.0081 49/126 [==========>...................] - ETA: 0s - loss: 1.1364e-04 - mean\_absolute\_error: 0.0082 73/126 [================>.............] - ETA: 0s - loss: 1.0545e-04 - mean\_absolute\_error: 0.0078 98/126 [======================>.......] - ETA: 0s - loss: 1.2592e-04 - mean\_absolute\_error: 0.0086123/126 [============================>.] - ETA: 0s - loss: 1.3112e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 2ms/step - loss: 1.3086e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 1.0524e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8710e-04 - mean\_absolute\_error: 0.0085 25/126 [====>.........................] - ETA: 0s - loss: 9.4839e-05 - mean\_absolute\_error: 0.0074 49/126 [==========>...................] - ETA: 0s - loss: 9.7801e-05 - mean\_absolute\_error: 0.0074 71/126 [===============>..............] - ETA: 0s - loss: 9.6063e-05 - mean\_absolute\_error: 0.0074 95/126 [=====================>........] - ETA: 0s - loss: 9.5117e-05 - mean\_absolute\_error: 0.0074119/126 [===========================>..] - ETA: 0s - loss: 9.9991e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 1.0036e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1279e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4094e-05 - mean\_absolute\_error: 0.0072 26/126 [=====>........................] - ETA: 0s - loss: 1.0909e-04 - mean\_absolute\_error: 0.0081 49/126 [==========>...................] - ETA: 0s - loss: 1.0078e-04 - mean\_absolute\_error: 0.0077 74/126 [================>.............] - ETA: 0s - loss: 1.0742e-04 - mean\_absolute\_error: 0.0079 99/126 [======================>.......] - ETA: 0s - loss: 1.0453e-04 - mean\_absolute\_error: 0.0078121/126 [===========================>..] - ETA: 0s - loss: 1.0499e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0650e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1066e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7794e-05 - mean\_absolute\_error: 0.0067 25/126 [====>.........................] - ETA: 0s - loss: 1.0717e-04 - mean\_absolute\_error: 0.0079 49/126 [==========>...................] - ETA: 0s - loss: 1.1838e-04 - mean\_absolute\_error: 0.0083 73/126 [================>.............] - ETA: 0s - loss: 1.1587e-04 - mean\_absolute\_error: 0.0083 97/126 [======================>.......] - ETA: 0s - loss: 1.1048e-04 - mean\_absolute\_error: 0.0081121/126 [===========================>..] - ETA: 0s - loss: 1.0777e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0705e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0165e-04 - val\_mean\_absolute\_error: 0.0077  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3111e-05 - mean\_absolute\_error: 0.0064 26/126 [=====>........................] - ETA: 0s - loss: 9.7763e-05 - mean\_absolute\_error: 0.0077 51/126 [===========>..................] - ETA: 0s - loss: 1.0643e-04 - mean\_absolute\_error: 0.0079 75/126 [================>.............] - ETA: 0s - loss: 1.0991e-04 - mean\_absolute\_error: 0.0080 93/126 [=====================>........] - ETA: 0s - loss: 1.0776e-04 - mean\_absolute\_error: 0.0079114/126 [==========================>...] - ETA: 0s - loss: 1.1043e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0934e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1243e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7110e-05 - mean\_absolute\_error: 0.0056 25/126 [====>.........................] - ETA: 0s - loss: 9.4335e-05 - mean\_absolute\_error: 0.0075 50/126 [==========>...................] - ETA: 0s - loss: 9.8088e-05 - mean\_absolute\_error: 0.0076 74/126 [================>.............] - ETA: 0s - loss: 9.7743e-05 - mean\_absolute\_error: 0.0075 98/126 [======================>.......] - ETA: 0s - loss: 1.0094e-04 - mean\_absolute\_error: 0.0076124/126 [============================>.] - ETA: 0s - loss: 1.0363e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0344e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.9239e-04 - val\_mean\_absolute\_error: 0.0115  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3571e-04 - mean\_absolute\_error: 0.0099 26/126 [=====>........................] - ETA: 0s - loss: 9.1993e-05 - mean\_absolute\_error: 0.0074 51/126 [===========>..................] - ETA: 0s - loss: 1.3572e-04 - mean\_absolute\_error: 0.0091 76/126 [=================>............] - ETA: 0s - loss: 1.3973e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.2990e-04 - mean\_absolute\_error: 0.0088123/126 [============================>.] - ETA: 0s - loss: 1.3193e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 2ms/step - loss: 1.3231e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 2.1446e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1665e-04 - mean\_absolute\_error: 0.0128 26/126 [=====>........................] - ETA: 0s - loss: 1.3952e-04 - mean\_absolute\_error: 0.0093 51/126 [===========>..................] - ETA: 0s - loss: 1.2621e-04 - mean\_absolute\_error: 0.0088 76/126 [=================>............] - ETA: 0s - loss: 1.2013e-04 - mean\_absolute\_error: 0.0086100/126 [======================>.......] - ETA: 0s - loss: 1.2243e-04 - mean\_absolute\_error: 0.0086119/126 [===========================>..] - ETA: 0s - loss: 1.2587e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.2606e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.0151e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8076e-05 - mean\_absolute\_error: 0.0060 25/126 [====>.........................] - ETA: 0s - loss: 9.9165e-05 - mean\_absolute\_error: 0.0075 50/126 [==========>...................] - ETA: 0s - loss: 1.0062e-04 - mean\_absolute\_error: 0.0076 75/126 [================>.............] - ETA: 0s - loss: 1.0103e-04 - mean\_absolute\_error: 0.0076 99/126 [======================>.......] - ETA: 0s - loss: 1.0107e-04 - mean\_absolute\_error: 0.0076123/126 [============================>.] - ETA: 0s - loss: 9.9776e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 2ms/step - loss: 9.9447e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0406e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8914e-05 - mean\_absolute\_error: 0.0065 26/126 [=====>........................] - ETA: 0s - loss: 1.0510e-04 - mean\_absolute\_error: 0.0076 50/126 [==========>...................] - ETA: 0s - loss: 1.0321e-04 - mean\_absolute\_error: 0.0076 75/126 [================>.............] - ETA: 0s - loss: 1.0135e-04 - mean\_absolute\_error: 0.0076 99/126 [======================>.......] - ETA: 0s - loss: 1.0042e-04 - mean\_absolute\_error: 0.0076123/126 [============================>.] - ETA: 0s - loss: 9.7479e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 2ms/step - loss: 9.7280e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0118e-04 - val\_mean\_absolute\_error: 0.0077  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0639e-04 - mean\_absolute\_error: 0.0073 25/126 [====>.........................] - ETA: 0s - loss: 9.2554e-05 - mean\_absolute\_error: 0.0073 49/126 [==========>...................] - ETA: 0s - loss: 9.2684e-05 - mean\_absolute\_error: 0.0073 73/126 [================>.............] - ETA: 0s - loss: 1.0979e-04 - mean\_absolute\_error: 0.0079 98/126 [======================>.......] - ETA: 0s - loss: 1.0827e-04 - mean\_absolute\_error: 0.0079123/126 [============================>.] - ETA: 0s - loss: 1.0575e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0603e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.4185e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7092e-05 - mean\_absolute\_error: 0.0076 21/126 [====>.........................] - ETA: 0s - loss: 1.3466e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.2115e-04 - mean\_absolute\_error: 0.0084 69/126 [===============>..............] - ETA: 0s - loss: 1.1013e-04 - mean\_absolute\_error: 0.0080 93/126 [=====================>........] - ETA: 0s - loss: 1.0430e-04 - mean\_absolute\_error: 0.0078117/126 [==========================>...] - ETA: 0s - loss: 1.0882e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0980e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.8225e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5890e-04 - mean\_absolute\_error: 0.0108 26/126 [=====>........................] - ETA: 0s - loss: 1.1880e-04 - mean\_absolute\_error: 0.0084 50/126 [==========>...................] - ETA: 0s - loss: 1.2819e-04 - mean\_absolute\_error: 0.0088 74/126 [================>.............] - ETA: 0s - loss: 1.2544e-04 - mean\_absolute\_error: 0.0086 98/126 [======================>.......] - ETA: 0s - loss: 1.1933e-04 - mean\_absolute\_error: 0.0084122/126 [============================>.] - ETA: 0s - loss: 1.1885e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.1926e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.6370e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5071e-05 - mean\_absolute\_error: 0.0078 26/126 [=====>........................] - ETA: 0s - loss: 1.2687e-04 - mean\_absolute\_error: 0.0090 51/126 [===========>..................] - ETA: 0s - loss: 1.5672e-04 - mean\_absolute\_error: 0.0099 75/126 [================>.............] - ETA: 0s - loss: 1.5708e-04 - mean\_absolute\_error: 0.0098 99/126 [======================>.......] - ETA: 0s - loss: 1.4273e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.3500e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.3514e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 2.3451e-04 - val\_mean\_absolute\_error: 0.0130  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6474e-04 - mean\_absolute\_error: 0.0108 24/126 [====>.........................] - ETA: 0s - loss: 1.2458e-04 - mean\_absolute\_error: 0.0088 46/126 [=========>....................] - ETA: 0s - loss: 1.4138e-04 - mean\_absolute\_error: 0.0095 70/126 [===============>..............] - ETA: 0s - loss: 1.3977e-04 - mean\_absolute\_error: 0.0094 93/126 [=====================>........] - ETA: 0s - loss: 1.3656e-04 - mean\_absolute\_error: 0.0092116/126 [==========================>...] - ETA: 0s - loss: 1.2945e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.2988e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.0238e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 6.5934e-05 - mean\_absolute\_error: 0.0062 25/126 [====>.........................] - ETA: 0s - loss: 1.1784e-04 - mean\_absolute\_error: 0.0083 50/126 [==========>...................] - ETA: 0s - loss: 1.0626e-04 - mean\_absolute\_error: 0.0078 75/126 [================>.............] - ETA: 0s - loss: 1.1043e-04 - mean\_absolute\_error: 0.0080 99/126 [======================>.......] - ETA: 0s - loss: 1.1814e-04 - mean\_absolute\_error: 0.0084124/126 [============================>.] - ETA: 0s - loss: 1.1450e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 2ms/step - loss: 1.1439e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 9.8765e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6842e-05 - mean\_absolute\_error: 0.0076 25/126 [====>.........................] - ETA: 0s - loss: 9.6178e-05 - mean\_absolute\_error: 0.0073 50/126 [==========>...................] - ETA: 0s - loss: 9.6873e-05 - mean\_absolute\_error: 0.0074 75/126 [================>.............] - ETA: 0s - loss: 1.0018e-04 - mean\_absolute\_error: 0.0076100/126 [======================>.......] - ETA: 0s - loss: 1.0072e-04 - mean\_absolute\_error: 0.0076124/126 [============================>.] - ETA: 0s - loss: 1.0097e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0103e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0400e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4728e-05 - mean\_absolute\_error: 0.0069 25/126 [====>.........................] - ETA: 0s - loss: 9.1473e-05 - mean\_absolute\_error: 0.0074 48/126 [==========>...................] - ETA: 0s - loss: 9.5451e-05 - mean\_absolute\_error: 0.0075 70/126 [===============>..............] - ETA: 0s - loss: 1.1032e-04 - mean\_absolute\_error: 0.0081 93/126 [=====================>........] - ETA: 0s - loss: 1.0718e-04 - mean\_absolute\_error: 0.0080117/126 [==========================>...] - ETA: 0s - loss: 1.0712e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0681e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 2.1790e-04 - val\_mean\_absolute\_error: 0.0124  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9139e-04 - mean\_absolute\_error: 0.0117 25/126 [====>.........................] - ETA: 0s - loss: 1.1031e-04 - mean\_absolute\_error: 0.0081 50/126 [==========>...................] - ETA: 0s - loss: 1.2033e-04 - mean\_absolute\_error: 0.0085 75/126 [================>.............] - ETA: 0s - loss: 1.2582e-04 - mean\_absolute\_error: 0.0087100/126 [======================>.......] - ETA: 0s - loss: 1.1984e-04 - mean\_absolute\_error: 0.0085124/126 [============================>.] - ETA: 0s - loss: 1.2270e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.2334e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 2.0708e-04 - val\_mean\_absolute\_error: 0.0118  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7477e-04 - mean\_absolute\_error: 0.0115 25/126 [====>.........................] - ETA: 0s - loss: 1.5240e-04 - mean\_absolute\_error: 0.0098 49/126 [==========>...................] - ETA: 0s - loss: 1.3152e-04 - mean\_absolute\_error: 0.0089 73/126 [================>.............] - ETA: 0s - loss: 1.1777e-04 - mean\_absolute\_error: 0.0084 98/126 [======================>.......] - ETA: 0s - loss: 1.1563e-04 - mean\_absolute\_error: 0.0083118/126 [===========================>..] - ETA: 0s - loss: 1.1265e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1131e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0685e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0790e-04 - mean\_absolute\_error: 0.0084 25/126 [====>.........................] - ETA: 0s - loss: 9.5654e-05 - mean\_absolute\_error: 0.0074 49/126 [==========>...................] - ETA: 0s - loss: 9.2159e-05 - mean\_absolute\_error: 0.0073 72/126 [================>.............] - ETA: 0s - loss: 9.9587e-05 - mean\_absolute\_error: 0.0076 95/126 [=====================>........] - ETA: 0s - loss: 1.1176e-04 - mean\_absolute\_error: 0.0081119/126 [===========================>..] - ETA: 0s - loss: 1.2429e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.2617e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.0714e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7740e-05 - mean\_absolute\_error: 0.0078 25/126 [====>.........................] - ETA: 0s - loss: 9.6814e-05 - mean\_absolute\_error: 0.0076 50/126 [==========>...................] - ETA: 0s - loss: 9.9763e-05 - mean\_absolute\_error: 0.0075 75/126 [================>.............] - ETA: 0s - loss: 9.8322e-05 - mean\_absolute\_error: 0.0075 99/126 [======================>.......] - ETA: 0s - loss: 9.5505e-05 - mean\_absolute\_error: 0.0073123/126 [============================>.] - ETA: 0s - loss: 9.5438e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 2ms/step - loss: 9.5012e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0079e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8302e-05 - mean\_absolute\_error: 0.0078 25/126 [====>.........................] - ETA: 0s - loss: 1.1226e-04 - mean\_absolute\_error: 0.0080 49/126 [==========>...................] - ETA: 0s - loss: 1.2127e-04 - mean\_absolute\_error: 0.0084 74/126 [================>.............] - ETA: 0s - loss: 1.1586e-04 - mean\_absolute\_error: 0.0082 98/126 [======================>.......] - ETA: 0s - loss: 1.1567e-04 - mean\_absolute\_error: 0.0082122/126 [============================>.] - ETA: 0s - loss: 1.1229e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 2ms/step - loss: 1.1300e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.2754e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3896e-04 - mean\_absolute\_error: 0.0098 23/126 [====>.........................] - ETA: 0s - loss: 1.4551e-04 - mean\_absolute\_error: 0.0095 48/126 [==========>...................] - ETA: 0s - loss: 1.3625e-04 - mean\_absolute\_error: 0.0092 73/126 [================>.............] - ETA: 0s - loss: 1.3005e-04 - mean\_absolute\_error: 0.0090 97/126 [======================>.......] - ETA: 0s - loss: 1.2790e-04 - mean\_absolute\_error: 0.0089119/126 [===========================>..] - ETA: 0s - loss: 1.2088e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2089e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.2039e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2181e-05 - mean\_absolute\_error: 0.0073 25/126 [====>.........................] - ETA: 0s - loss: 1.5681e-04 - mean\_absolute\_error: 0.0098 49/126 [==========>...................] - ETA: 0s - loss: 1.2299e-04 - mean\_absolute\_error: 0.0084 73/126 [================>.............] - ETA: 0s - loss: 1.1827e-04 - mean\_absolute\_error: 0.0084 96/126 [=====================>........] - ETA: 0s - loss: 1.2102e-04 - mean\_absolute\_error: 0.0084120/126 [===========================>..] - ETA: 0s - loss: 1.1554e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 2ms/step - loss: 1.1533e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.2943e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2538e-05 - mean\_absolute\_error: 0.0058 26/126 [=====>........................] - ETA: 0s - loss: 1.1231e-04 - mean\_absolute\_error: 0.0083 51/126 [===========>..................] - ETA: 0s - loss: 1.0762e-04 - mean\_absolute\_error: 0.0080 76/126 [=================>............] - ETA: 0s - loss: 1.0649e-04 - mean\_absolute\_error: 0.0080101/126 [=======================>......] - ETA: 0s - loss: 1.1232e-04 - mean\_absolute\_error: 0.0082125/126 [============================>.] - ETA: 0s - loss: 1.0751e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0760e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0648e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6001e-05 - mean\_absolute\_error: 0.0055 23/126 [====>.........................] - ETA: 0s - loss: 9.8200e-05 - mean\_absolute\_error: 0.0076 47/126 [==========>...................] - ETA: 0s - loss: 1.0289e-04 - mean\_absolute\_error: 0.0078 72/126 [================>.............] - ETA: 0s - loss: 9.7700e-05 - mean\_absolute\_error: 0.0076 96/126 [=====================>........] - ETA: 0s - loss: 9.7657e-05 - mean\_absolute\_error: 0.0075119/126 [===========================>..] - ETA: 0s - loss: 9.8946e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0055e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0993e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6386e-05 - mean\_absolute\_error: 0.0075 25/126 [====>.........................] - ETA: 0s - loss: 8.4746e-05 - mean\_absolute\_error: 0.0069 49/126 [==========>...................] - ETA: 0s - loss: 9.8854e-05 - mean\_absolute\_error: 0.0075 73/126 [================>.............] - ETA: 0s - loss: 1.0503e-04 - mean\_absolute\_error: 0.0079 97/126 [======================>.......] - ETA: 0s - loss: 1.0247e-04 - mean\_absolute\_error: 0.0078119/126 [===========================>..] - ETA: 0s - loss: 1.0381e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0296e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.2445e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7006e-05 - mean\_absolute\_error: 0.0072 25/126 [====>.........................] - ETA: 0s - loss: 1.0095e-04 - mean\_absolute\_error: 0.0077 50/126 [==========>...................] - ETA: 0s - loss: 9.8723e-05 - mean\_absolute\_error: 0.0077 74/126 [================>.............] - ETA: 0s - loss: 1.0763e-04 - mean\_absolute\_error: 0.0080 98/126 [======================>.......] - ETA: 0s - loss: 1.0937e-04 - mean\_absolute\_error: 0.0080122/126 [============================>.] - ETA: 0s - loss: 1.0830e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 2ms/step - loss: 1.0784e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1689e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3371e-05 - mean\_absolute\_error: 0.0078 25/126 [====>.........................] - ETA: 0s - loss: 1.1658e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 1.3202e-04 - mean\_absolute\_error: 0.0090 71/126 [===============>..............] - ETA: 0s - loss: 1.3164e-04 - mean\_absolute\_error: 0.0090 95/126 [=====================>........] - ETA: 0s - loss: 1.2845e-04 - mean\_absolute\_error: 0.0088118/126 [===========================>..] - ETA: 0s - loss: 1.2164e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2289e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.5718e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3842e-05 - mean\_absolute\_error: 0.0056 24/126 [====>.........................] - ETA: 0s - loss: 1.1493e-04 - mean\_absolute\_error: 0.0085 47/126 [==========>...................] - ETA: 0s - loss: 1.3619e-04 - mean\_absolute\_error: 0.0092 71/126 [===============>..............] - ETA: 0s - loss: 1.3071e-04 - mean\_absolute\_error: 0.0090 94/126 [=====================>........] - ETA: 0s - loss: 1.3134e-04 - mean\_absolute\_error: 0.0091118/126 [===========================>..] - ETA: 0s - loss: 1.2476e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.2354e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.1878e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1411e-05 - mean\_absolute\_error: 0.0077 25/126 [====>.........................] - ETA: 0s - loss: 1.1403e-04 - mean\_absolute\_error: 0.0083 49/126 [==========>...................] - ETA: 0s - loss: 1.2109e-04 - mean\_absolute\_error: 0.0085 74/126 [================>.............] - ETA: 0s - loss: 1.1700e-04 - mean\_absolute\_error: 0.0083 99/126 [======================>.......] - ETA: 0s - loss: 1.0822e-04 - mean\_absolute\_error: 0.0080123/126 [============================>.] - ETA: 0s - loss: 1.0531e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 2ms/step - loss: 1.0533e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.2136e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4421e-05 - mean\_absolute\_error: 0.0064 25/126 [====>.........................] - ETA: 0s - loss: 1.0252e-04 - mean\_absolute\_error: 0.0078 49/126 [==========>...................] - ETA: 0s - loss: 1.0081e-04 - mean\_absolute\_error: 0.0077 72/126 [================>.............] - ETA: 0s - loss: 9.8760e-05 - mean\_absolute\_error: 0.0077 96/126 [=====================>........] - ETA: 0s - loss: 9.9167e-05 - mean\_absolute\_error: 0.0077119/126 [===========================>..] - ETA: 0s - loss: 1.0189e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0206e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0247e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4975e-05 - mean\_absolute\_error: 0.0056 25/126 [====>.........................] - ETA: 0s - loss: 9.7388e-05 - mean\_absolute\_error: 0.0076 48/126 [==========>...................] - ETA: 0s - loss: 1.0199e-04 - mean\_absolute\_error: 0.0077 72/126 [================>.............] - ETA: 0s - loss: 1.0874e-04 - mean\_absolute\_error: 0.0081 96/126 [=====================>........] - ETA: 0s - loss: 1.2566e-04 - mean\_absolute\_error: 0.0088120/126 [===========================>..] - ETA: 0s - loss: 1.2557e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.2372e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.4767e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0188e-04 - mean\_absolute\_error: 0.0082 25/126 [====>.........................] - ETA: 0s - loss: 9.0841e-05 - mean\_absolute\_error: 0.0073 49/126 [==========>...................] - ETA: 0s - loss: 9.8769e-05 - mean\_absolute\_error: 0.0077 73/126 [================>.............] - ETA: 0s - loss: 1.0461e-04 - mean\_absolute\_error: 0.0079 98/126 [======================>.......] - ETA: 0s - loss: 1.0447e-04 - mean\_absolute\_error: 0.0079121/126 [===========================>..] - ETA: 0s - loss: 1.0337e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0485e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 2.0118e-04 - val\_mean\_absolute\_error: 0.0119  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3264e-04 - mean\_absolute\_error: 0.0124 25/126 [====>.........................] - ETA: 0s - loss: 1.0569e-04 - mean\_absolute\_error: 0.0078 50/126 [==========>...................] - ETA: 0s - loss: 9.7120e-05 - mean\_absolute\_error: 0.0075 75/126 [================>.............] - ETA: 0s - loss: 1.0164e-04 - mean\_absolute\_error: 0.0077 99/126 [======================>.......] - ETA: 0s - loss: 1.0085e-04 - mean\_absolute\_error: 0.0076122/126 [============================>.] - ETA: 0s - loss: 1.0183e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0199e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1544e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1195e-04 - mean\_absolute\_error: 0.0097 25/126 [====>.........................] - ETA: 0s - loss: 1.1947e-04 - mean\_absolute\_error: 0.0079 49/126 [==========>...................] - ETA: 0s - loss: 1.3127e-04 - mean\_absolute\_error: 0.0086 71/126 [===============>..............] - ETA: 0s - loss: 1.2190e-04 - mean\_absolute\_error: 0.0084 93/126 [=====================>........] - ETA: 0s - loss: 1.1551e-04 - mean\_absolute\_error: 0.0082116/126 [==========================>...] - ETA: 0s - loss: 1.1020e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1055e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.7668e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3585e-04 - mean\_absolute\_error: 0.0098 25/126 [====>.........................] - ETA: 0s - loss: 1.1252e-04 - mean\_absolute\_error: 0.0083 49/126 [==========>...................] - ETA: 0s - loss: 1.1669e-04 - mean\_absolute\_error: 0.0084 74/126 [================>.............] - ETA: 0s - loss: 1.3626e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.4136e-04 - mean\_absolute\_error: 0.0094124/126 [============================>.] - ETA: 0s - loss: 1.3900e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.3891e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 9.4411e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 7.2856e-05 - mean\_absolute\_error: 0.0069 25/126 [====>.........................] - ETA: 0s - loss: 1.3912e-04 - mean\_absolute\_error: 0.0091 50/126 [==========>...................] - ETA: 0s - loss: 1.1975e-04 - mean\_absolute\_error: 0.0082 73/126 [================>.............] - ETA: 0s - loss: 1.1152e-04 - mean\_absolute\_error: 0.0080 97/126 [======================>.......] - ETA: 0s - loss: 1.0900e-04 - mean\_absolute\_error: 0.0079121/126 [===========================>..] - ETA: 0s - loss: 1.1957e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.1992e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.4713e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1431e-04 - mean\_absolute\_error: 0.0084 25/126 [====>.........................] - ETA: 0s - loss: 1.1103e-04 - mean\_absolute\_error: 0.0080 49/126 [==========>...................] - ETA: 0s - loss: 1.0275e-04 - mean\_absolute\_error: 0.0076 73/126 [================>.............] - ETA: 0s - loss: 1.1764e-04 - mean\_absolute\_error: 0.0083 95/126 [=====================>........] - ETA: 0s - loss: 1.1371e-04 - mean\_absolute\_error: 0.0082119/126 [===========================>..] - ETA: 0s - loss: 1.0898e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 2ms/step - loss: 1.0811e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.0103e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7038e-05 - mean\_absolute\_error: 0.0072 25/126 [====>.........................] - ETA: 0s - loss: 1.0169e-04 - mean\_absolute\_error: 0.0079 49/126 [==========>...................] - ETA: 0s - loss: 9.9955e-05 - mean\_absolute\_error: 0.0078 73/126 [================>.............] - ETA: 0s - loss: 9.5268e-05 - mean\_absolute\_error: 0.0075 97/126 [======================>.......] - ETA: 0s - loss: 9.4697e-05 - mean\_absolute\_error: 0.0074122/126 [============================>.] - ETA: 0s - loss: 9.3351e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.2849e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 9.5364e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1908e-05 - mean\_absolute\_error: 0.0056 26/126 [=====>........................] - ETA: 0s - loss: 9.1028e-05 - mean\_absolute\_error: 0.0074 51/126 [===========>..................] - ETA: 0s - loss: 9.2638e-05 - mean\_absolute\_error: 0.0073 76/126 [=================>............] - ETA: 0s - loss: 9.8159e-05 - mean\_absolute\_error: 0.0076101/126 [=======================>......] - ETA: 0s - loss: 9.3827e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - ETA: 0s - loss: 9.5389e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 2ms/step - loss: 9.5389e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.0640e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4257e-05 - mean\_absolute\_error: 0.0072 23/126 [====>.........................] - ETA: 0s - loss: 9.8535e-05 - mean\_absolute\_error: 0.0078 48/126 [==========>...................] - ETA: 0s - loss: 1.1944e-04 - mean\_absolute\_error: 0.0085 73/126 [================>.............] - ETA: 0s - loss: 1.2018e-04 - mean\_absolute\_error: 0.0085 97/126 [======================>.......] - ETA: 0s - loss: 1.1495e-04 - mean\_absolute\_error: 0.0083119/126 [===========================>..] - ETA: 0s - loss: 1.0848e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0720e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 9.3359e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8992e-05 - mean\_absolute\_error: 0.0064 25/126 [====>.........................] - ETA: 0s - loss: 9.8344e-05 - mean\_absolute\_error: 0.0075 49/126 [==========>...................] - ETA: 0s - loss: 9.7007e-05 - mean\_absolute\_error: 0.0076 74/126 [================>.............] - ETA: 0s - loss: 1.1052e-04 - mean\_absolute\_error: 0.0082 99/126 [======================>.......] - ETA: 0s - loss: 1.1479e-04 - mean\_absolute\_error: 0.0083124/126 [============================>.] - ETA: 0s - loss: 1.1588e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.1606e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.0822e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6594e-05 - mean\_absolute\_error: 0.0064 25/126 [====>.........................] - ETA: 0s - loss: 9.3850e-05 - mean\_absolute\_error: 0.0075 49/126 [==========>...................] - ETA: 0s - loss: 9.8164e-05 - mean\_absolute\_error: 0.0076 74/126 [================>.............] - ETA: 0s - loss: 1.0699e-04 - mean\_absolute\_error: 0.0078 99/126 [======================>.......] - ETA: 0s - loss: 1.0224e-04 - mean\_absolute\_error: 0.0077124/126 [============================>.] - ETA: 0s - loss: 9.8756e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 2ms/step - loss: 9.8772e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 9.3141e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3061e-05 - mean\_absolute\_error: 0.0058 25/126 [====>.........................] - ETA: 0s - loss: 1.1776e-04 - mean\_absolute\_error: 0.0084 48/126 [==========>...................] - ETA: 0s - loss: 1.0881e-04 - mean\_absolute\_error: 0.0080 72/126 [================>.............] - ETA: 0s - loss: 1.0253e-04 - mean\_absolute\_error: 0.0077 96/126 [=====================>........] - ETA: 0s - loss: 9.7205e-05 - mean\_absolute\_error: 0.0075120/126 [===========================>..] - ETA: 0s - loss: 9.9351e-05 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 9.9014e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.5165e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7676e-04 - mean\_absolute\_error: 0.0118 25/126 [====>.........................] - ETA: 0s - loss: 1.8793e-04 - mean\_absolute\_error: 0.0109 49/126 [==========>...................] - ETA: 0s - loss: 1.6331e-04 - mean\_absolute\_error: 0.0100 73/126 [================>.............] - ETA: 0s - loss: 1.4096e-04 - mean\_absolute\_error: 0.0092 98/126 [======================>.......] - ETA: 0s - loss: 1.3644e-04 - mean\_absolute\_error: 0.0090122/126 [============================>.] - ETA: 0s - loss: 1.2744e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.2749e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.2041e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2393e-04 - mean\_absolute\_error: 0.0084 25/126 [====>.........................] - ETA: 0s - loss: 1.0610e-04 - mean\_absolute\_error: 0.0078 49/126 [==========>...................] - ETA: 0s - loss: 9.9913e-05 - mean\_absolute\_error: 0.0075 73/126 [================>.............] - ETA: 0s - loss: 9.8518e-05 - mean\_absolute\_error: 0.0075 97/126 [======================>.......] - ETA: 0s - loss: 9.7834e-05 - mean\_absolute\_error: 0.0075121/126 [===========================>..] - ETA: 0s - loss: 9.7293e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 2ms/step - loss: 9.7474e-05 - mean\_absolute\_error: 0.0076 - val\_loss: 1.6357e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2638e-04 - mean\_absolute\_error: 0.0129 25/126 [====>.........................] - ETA: 0s - loss: 1.3276e-04 - mean\_absolute\_error: 0.0085 49/126 [==========>...................] - ETA: 0s - loss: 1.1273e-04 - mean\_absolute\_error: 0.0080 72/126 [================>.............] - ETA: 0s - loss: 1.0502e-04 - mean\_absolute\_error: 0.0078 95/126 [=====================>........] - ETA: 0s - loss: 1.0121e-04 - mean\_absolute\_error: 0.0076119/126 [===========================>..] - ETA: 0s - loss: 1.0018e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0075e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.3485e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1762e-04 - mean\_absolute\_error: 0.0087 25/126 [====>.........................] - ETA: 0s - loss: 1.0394e-04 - mean\_absolute\_error: 0.0075 48/126 [==========>...................] - ETA: 0s - loss: 9.6355e-05 - mean\_absolute\_error: 0.0072 71/126 [===============>..............] - ETA: 0s - loss: 9.3029e-05 - mean\_absolute\_error: 0.0072 95/126 [=====================>........] - ETA: 0s - loss: 9.7929e-05 - mean\_absolute\_error: 0.0074119/126 [===========================>..] - ETA: 0s - loss: 9.5302e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 2ms/step - loss: 9.5470e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 9.3864e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5300e-05 - mean\_absolute\_error: 0.0064 26/126 [=====>........................] - ETA: 0s - loss: 7.5214e-05 - mean\_absolute\_error: 0.0067 50/126 [==========>...................] - ETA: 0s - loss: 9.6090e-05 - mean\_absolute\_error: 0.0075 75/126 [================>.............] - ETA: 0s - loss: 1.0391e-04 - mean\_absolute\_error: 0.0077 99/126 [======================>.......] - ETA: 0s - loss: 1.0295e-04 - mean\_absolute\_error: 0.0077123/126 [============================>.] - ETA: 0s - loss: 9.7200e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 2ms/step - loss: 9.7484e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 9.1661e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 6.9997e-05 - mean\_absolute\_error: 0.0066 25/126 [====>.........................] - ETA: 0s - loss: 8.8931e-05 - mean\_absolute\_error: 0.0073 50/126 [==========>...................] - ETA: 0s - loss: 9.6389e-05 - mean\_absolute\_error: 0.0078 74/126 [================>.............] - ETA: 0s - loss: 9.7511e-05 - mean\_absolute\_error: 0.0077 98/126 [======================>.......] - ETA: 0s - loss: 9.8409e-05 - mean\_absolute\_error: 0.0077121/126 [===========================>..] - ETA: 0s - loss: 1.0164e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 2ms/step - loss: 1.0214e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 9.2057e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6698e-05 - mean\_absolute\_error: 0.0066 25/126 [====>.........................] - ETA: 0s - loss: 8.9658e-05 - mean\_absolute\_error: 0.0072 49/126 [==========>...................] - ETA: 0s - loss: 8.7205e-05 - mean\_absolute\_error: 0.0072 71/126 [===============>..............] - ETA: 0s - loss: 8.8014e-05 - mean\_absolute\_error: 0.0072 95/126 [=====================>........] - ETA: 0s - loss: 9.1747e-05 - mean\_absolute\_error: 0.0073119/126 [===========================>..] - ETA: 0s - loss: 9.0266e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.2206e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.2005e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6695e-05 - mean\_absolute\_error: 0.0060 26/126 [=====>........................] - ETA: 0s - loss: 1.1154e-04 - mean\_absolute\_error: 0.0080 50/126 [==========>...................] - ETA: 0s - loss: 1.1901e-04 - mean\_absolute\_error: 0.0083 75/126 [================>.............] - ETA: 0s - loss: 1.1285e-04 - mean\_absolute\_error: 0.0081100/126 [======================>.......] - ETA: 0s - loss: 1.1402e-04 - mean\_absolute\_error: 0.0082124/126 [============================>.] - ETA: 0s - loss: 1.1405e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.1510e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.2671e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1594e-04 - mean\_absolute\_error: 0.0081 25/126 [====>.........................] - ETA: 0s - loss: 1.1880e-04 - mean\_absolute\_error: 0.0085 50/126 [==========>...................] - ETA: 0s - loss: 1.2484e-04 - mean\_absolute\_error: 0.0088 74/126 [================>.............] - ETA: 0s - loss: 1.0969e-04 - mean\_absolute\_error: 0.0081 98/126 [======================>.......] - ETA: 0s - loss: 1.1569e-04 - mean\_absolute\_error: 0.0083122/126 [============================>.] - ETA: 0s - loss: 1.1782e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.1675e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 9.7648e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7419e-04 - mean\_absolute\_error: 0.0102 25/126 [====>.........................] - ETA: 0s - loss: 7.7225e-05 - mean\_absolute\_error: 0.0067 50/126 [==========>...................] - ETA: 0s - loss: 8.4589e-05 - mean\_absolute\_error: 0.0070 74/126 [================>.............] - ETA: 0s - loss: 8.9635e-05 - mean\_absolute\_error: 0.0071 96/126 [=====================>........] - ETA: 0s - loss: 8.9531e-05 - mean\_absolute\_error: 0.0071119/126 [===========================>..] - ETA: 0s - loss: 1.0058e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0093e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 2.7362e-04 - val\_mean\_absolute\_error: 0.0144  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0856e-04 - mean\_absolute\_error: 0.0112 25/126 [====>.........................] - ETA: 0s - loss: 1.8364e-04 - mean\_absolute\_error: 0.0110 50/126 [==========>...................] - ETA: 0s - loss: 1.5061e-04 - mean\_absolute\_error: 0.0097 74/126 [================>.............] - ETA: 0s - loss: 1.3392e-04 - mean\_absolute\_error: 0.0092 98/126 [======================>.......] - ETA: 0s - loss: 1.2911e-04 - mean\_absolute\_error: 0.0089122/126 [============================>.] - ETA: 0s - loss: 1.2469e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.2361e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 9.9768e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 6.9513e-05 - mean\_absolute\_error: 0.0061 23/126 [====>.........................] - ETA: 0s - loss: 9.3105e-05 - mean\_absolute\_error: 0.0077 46/126 [=========>....................] - ETA: 0s - loss: 9.2239e-05 - mean\_absolute\_error: 0.0074 70/126 [===============>..............] - ETA: 0s - loss: 9.5088e-05 - mean\_absolute\_error: 0.0074 95/126 [=====================>........] - ETA: 0s - loss: 9.2198e-05 - mean\_absolute\_error: 0.0073120/126 [===========================>..] - ETA: 0s - loss: 9.2049e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.1287e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0350e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6799e-04 - mean\_absolute\_error: 0.0086 23/126 [====>.........................] - ETA: 0s - loss: 9.8040e-05 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 1.0397e-04 - mean\_absolute\_error: 0.0079 72/126 [================>.............] - ETA: 0s - loss: 1.0667e-04 - mean\_absolute\_error: 0.0080 96/126 [=====================>........] - ETA: 0s - loss: 1.0462e-04 - mean\_absolute\_error: 0.0078118/126 [===========================>..] - ETA: 0s - loss: 1.0133e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0090e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0801e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4187e-05 - mean\_absolute\_error: 0.0073 25/126 [====>.........................] - ETA: 0s - loss: 9.4126e-05 - mean\_absolute\_error: 0.0071 50/126 [==========>...................] - ETA: 0s - loss: 9.2003e-05 - mean\_absolute\_error: 0.0072 75/126 [================>.............] - ETA: 0s - loss: 9.1648e-05 - mean\_absolute\_error: 0.0073 99/126 [======================>.......] - ETA: 0s - loss: 9.2220e-05 - mean\_absolute\_error: 0.0073123/126 [============================>.] - ETA: 0s - loss: 9.0074e-05 - mean\_absolute\_error: 0.0072126/126 [==============================] - 0s 2ms/step - loss: 8.9885e-05 - mean\_absolute\_error: 0.0072 - val\_loss: 1.1298e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7137e-05 - mean\_absolute\_error: 0.0069 26/126 [=====>........................] - ETA: 0s - loss: 9.6739e-05 - mean\_absolute\_error: 0.0076 50/126 [==========>...................] - ETA: 0s - loss: 9.0270e-05 - mean\_absolute\_error: 0.0073 75/126 [================>.............] - ETA: 0s - loss: 8.9088e-05 - mean\_absolute\_error: 0.0072100/126 [======================>.......] - ETA: 0s - loss: 9.1686e-05 - mean\_absolute\_error: 0.0073124/126 [============================>.] - ETA: 0s - loss: 9.2616e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 2ms/step - loss: 9.2824e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 1.9336e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3385e-04 - mean\_absolute\_error: 0.0101 25/126 [====>.........................] - ETA: 0s - loss: 1.0701e-04 - mean\_absolute\_error: 0.0080 47/126 [==========>...................] - ETA: 0s - loss: 1.1058e-04 - mean\_absolute\_error: 0.0081 71/126 [===============>..............] - ETA: 0s - loss: 9.9401e-05 - mean\_absolute\_error: 0.0077 95/126 [=====================>........] - ETA: 0s - loss: 9.9819e-05 - mean\_absolute\_error: 0.0077120/126 [===========================>..] - ETA: 0s - loss: 9.9818e-05 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 2ms/step - loss: 1.0171e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.9744e-04 - val\_mean\_absolute\_error: 0.0119  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6820e-04 - mean\_absolute\_error: 0.0111 24/126 [====>.........................] - ETA: 0s - loss: 9.9724e-05 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 9.1906e-05 - mean\_absolute\_error: 0.0073 70/126 [===============>..............] - ETA: 0s - loss: 8.9115e-05 - mean\_absolute\_error: 0.0072 93/126 [=====================>........] - ETA: 0s - loss: 9.0988e-05 - mean\_absolute\_error: 0.0073118/126 [===========================>..] - ETA: 0s - loss: 9.4994e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.4013e-05 - mean\_absolute\_error: 0.0074 - val\_loss: 9.6582e-05 - val\_mean\_absolute\_error: 0.0076

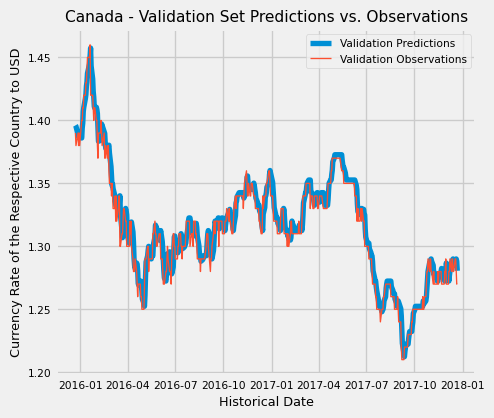
<keras.src.callbacks.History at 0x21152bea310>

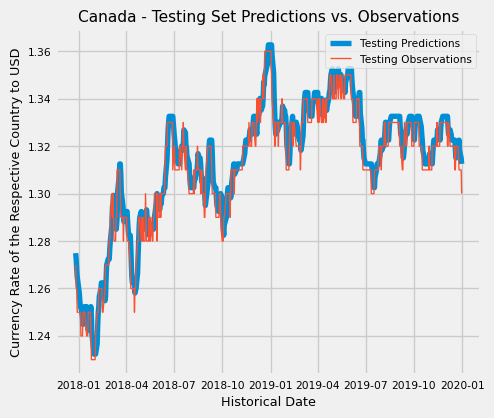
After the training and fitting of the Machine Learning model for Canada, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue 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: 40s 33/126 [======>.......................] - ETA: 0s 68/126 [===============>..............] - ETA: 0s109/126 [========================>.....] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step

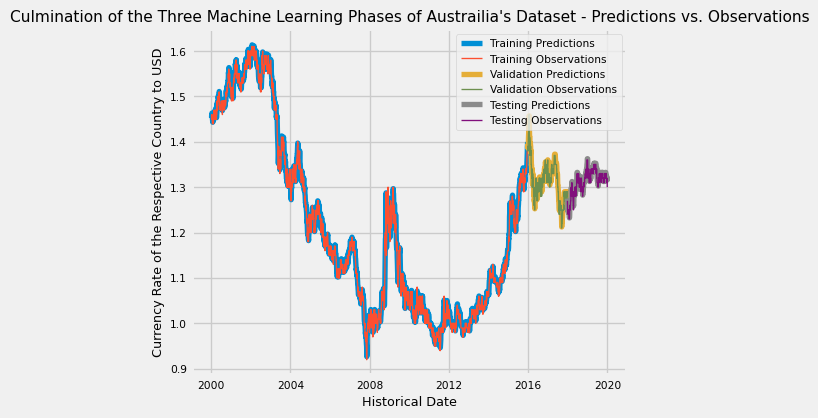






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

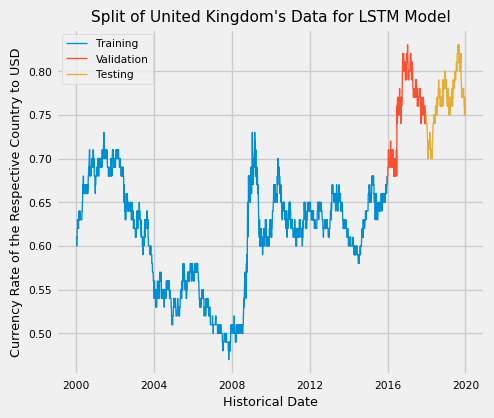
```{python}  
# Plotting Canada's observational (reference) data with the predictions of its   
# Machine Learning Model (as a way to visually inspect the effectiveness of the   
# model)   
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4)  
plt.plot(dates\_canada\_train, y\_canada\_train,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

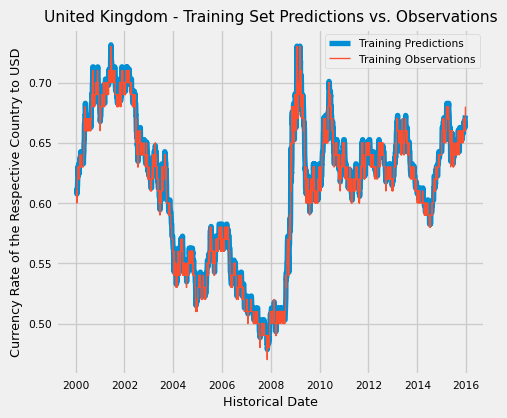
Epoch 1/100  
 1/126 [..............................] - ETA: 3:40 - loss: 0.3881 - mean\_absolute\_error: 0.6206 16/126 [==>...........................] - ETA: 0s - loss: 0.2123 - mean\_absolute\_error: 0.4474 40/126 [========>.....................] - ETA: 0s - loss: 0.0928 - mean\_absolute\_error: 0.2372 65/126 [==============>...............] - ETA: 0s - loss: 0.0577 - mean\_absolute\_error: 0.1579 90/126 [====================>.........] - ETA: 0s - loss: 0.0419 - mean\_absolute\_error: 0.1202116/126 [==========================>...] - ETA: 0s - loss: 0.0326 - mean\_absolute\_error: 0.0979126/126 [==============================] - 2s 6ms/step - loss: 0.0302 - mean\_absolute\_error: 0.0922 - val\_loss: 0.0040 - val\_mean\_absolute\_error: 0.0603  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0272e-04 - mean\_absolute\_error: 0.0229 15/126 [==>...........................] - ETA: 0s - loss: 6.3295e-04 - mean\_absolute\_error: 0.0199 34/126 [=======>......................] - ETA: 0s - loss: 5.9589e-04 - mean\_absolute\_error: 0.0196 56/126 [============>.................] - ETA: 0s - loss: 5.9574e-04 - mean\_absolute\_error: 0.0197 70/126 [===============>..............] - ETA: 0s - loss: 5.8123e-04 - mean\_absolute\_error: 0.0195 82/126 [==================>...........] - ETA: 0s - loss: 5.7844e-04 - mean\_absolute\_error: 0.0195 95/126 [=====================>........] - ETA: 0s - loss: 5.6974e-04 - mean\_absolute\_error: 0.0193105/126 [========================>.....] - ETA: 0s - loss: 5.6296e-04 - mean\_absolute\_error: 0.0192117/126 [==========================>...] - ETA: 0s - loss: 5.5678e-04 - mean\_absolute\_error: 0.0191126/126 [==============================] - 1s 4ms/step - loss: 5.5070e-04 - mean\_absolute\_error: 0.0191 - val\_loss: 0.0025 - val\_mean\_absolute\_error: 0.0474  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4087e-04 - mean\_absolute\_error: 0.0162 20/126 [===>..........................] - ETA: 0s - loss: 4.6626e-04 - mean\_absolute\_error: 0.0175 39/126 [========>.....................] - ETA: 0s - loss: 4.5216e-04 - mean\_absolute\_error: 0.0172 63/126 [==============>...............] - ETA: 0s - loss: 4.3724e-04 - mean\_absolute\_error: 0.0169 87/126 [===================>..........] - ETA: 0s - loss: 4.1600e-04 - mean\_absolute\_error: 0.0165112/126 [=========================>....] - ETA: 0s - loss: 4.0043e-04 - mean\_absolute\_error: 0.0162126/126 [==============================] - 0s 3ms/step - loss: 3.9156e-04 - mean\_absolute\_error: 0.0160 - val\_loss: 0.0015 - val\_mean\_absolute\_error: 0.0364  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7707e-04 - mean\_absolute\_error: 0.0105 25/126 [====>.........................] - ETA: 0s - loss: 2.8541e-04 - mean\_absolute\_error: 0.0135 51/126 [===========>..................] - ETA: 0s - loss: 2.7303e-04 - mean\_absolute\_error: 0.0133 75/126 [================>.............] - ETA: 0s - loss: 2.6727e-04 - mean\_absolute\_error: 0.0132 97/126 [======================>.......] - ETA: 0s - loss: 2.5680e-04 - mean\_absolute\_error: 0.0129120/126 [===========================>..] - ETA: 0s - loss: 2.4574e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 2ms/step - loss: 2.4355e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 0.0010 - val\_mean\_absolute\_error: 0.0305  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0740e-04 - mean\_absolute\_error: 0.0122 25/126 [====>.........................] - ETA: 0s - loss: 1.7304e-04 - mean\_absolute\_error: 0.0106 51/126 [===========>..................] - ETA: 0s - loss: 1.6068e-04 - mean\_absolute\_error: 0.0103 76/126 [=================>............] - ETA: 0s - loss: 1.4973e-04 - mean\_absolute\_error: 0.0098 99/126 [======================>.......] - ETA: 0s - loss: 1.4014e-04 - mean\_absolute\_error: 0.0095122/126 [============================>.] - ETA: 0s - loss: 1.3151e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.3068e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 3.1137e-04 - val\_mean\_absolute\_error: 0.0156  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3707e-05 - mean\_absolute\_error: 0.0061 25/126 [====>.........................] - ETA: 0s - loss: 8.2253e-05 - mean\_absolute\_error: 0.0072 41/126 [========>.....................] - ETA: 0s - loss: 8.0675e-05 - mean\_absolute\_error: 0.0070 57/126 [============>.................] - ETA: 0s - loss: 7.9721e-05 - mean\_absolute\_error: 0.0070 77/126 [=================>............] - ETA: 0s - loss: 7.4932e-05 - mean\_absolute\_error: 0.0068 99/126 [======================>.......] - ETA: 0s - loss: 7.0476e-05 - mean\_absolute\_error: 0.0066124/126 [============================>.] - ETA: 0s - loss: 6.6796e-05 - mean\_absolute\_error: 0.0064126/126 [==============================] - 0s 3ms/step - loss: 6.6898e-05 - mean\_absolute\_error: 0.0064 - val\_loss: 1.3087e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6344e-05 - mean\_absolute\_error: 0.0055 22/126 [====>.........................] - ETA: 0s - loss: 5.5079e-05 - mean\_absolute\_error: 0.0057 44/126 [=========>....................] - ETA: 0s - loss: 5.0419e-05 - mean\_absolute\_error: 0.0055 68/126 [===============>..............] - ETA: 0s - loss: 4.7603e-05 - mean\_absolute\_error: 0.0053 91/126 [====================>.........] - ETA: 0s - loss: 4.5575e-05 - mean\_absolute\_error: 0.0051115/126 [==========================>...] - ETA: 0s - loss: 4.2901e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2319e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.8494e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9510e-05 - mean\_absolute\_error: 0.0053 24/126 [====>.........................] - ETA: 0s - loss: 4.0713e-05 - mean\_absolute\_error: 0.0046 49/126 [==========>...................] - ETA: 0s - loss: 3.5746e-05 - mean\_absolute\_error: 0.0043 74/126 [================>.............] - ETA: 0s - loss: 3.6230e-05 - mean\_absolute\_error: 0.0045 98/126 [======================>.......] - ETA: 0s - loss: 3.6072e-05 - mean\_absolute\_error: 0.0044122/126 [============================>.] - ETA: 0s - loss: 3.5854e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.6052e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.7993e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6355e-05 - mean\_absolute\_error: 0.0026 18/126 [===>..........................] - ETA: 0s - loss: 3.3354e-05 - mean\_absolute\_error: 0.0041 27/126 [=====>........................] - ETA: 0s - loss: 3.3135e-05 - mean\_absolute\_error: 0.0041 42/126 [=========>....................] - ETA: 0s - loss: 3.2593e-05 - mean\_absolute\_error: 0.0041 59/126 [=============>................] - ETA: 0s - loss: 3.4961e-05 - mean\_absolute\_error: 0.0042 75/126 [================>.............] - ETA: 0s - loss: 3.6546e-05 - mean\_absolute\_error: 0.0043 97/126 [======================>.......] - ETA: 0s - loss: 3.5543e-05 - mean\_absolute\_error: 0.0043119/126 [===========================>..] - ETA: 0s - loss: 3.4576e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.4995e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 6.8638e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4815e-05 - mean\_absolute\_error: 0.0043 25/126 [====>.........................] - ETA: 0s - loss: 3.4149e-05 - mean\_absolute\_error: 0.0041 50/126 [==========>...................] - ETA: 0s - loss: 3.4818e-05 - mean\_absolute\_error: 0.0042 72/126 [================>.............] - ETA: 0s - loss: 3.4778e-05 - mean\_absolute\_error: 0.0042 94/126 [=====================>........] - ETA: 0s - loss: 3.4590e-05 - mean\_absolute\_error: 0.0042117/126 [==========================>...] - ETA: 0s - loss: 3.4873e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.4686e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 7.3912e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5147e-05 - mean\_absolute\_error: 0.0042 25/126 [====>.........................] - ETA: 0s - loss: 3.4815e-05 - mean\_absolute\_error: 0.0042 51/126 [===========>..................] - ETA: 0s - loss: 3.4585e-05 - mean\_absolute\_error: 0.0042 75/126 [================>.............] - ETA: 0s - loss: 3.5977e-05 - mean\_absolute\_error: 0.0042 98/126 [======================>.......] - ETA: 0s - loss: 3.4650e-05 - mean\_absolute\_error: 0.0042125/126 [============================>.] - ETA: 0s - loss: 3.4363e-05 - mean\_absolute\_error: 0.0041126/126 [==============================] - 0s 2ms/step - loss: 3.4315e-05 - mean\_absolute\_error: 0.0041 - val\_loss: 7.0140e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7445e-05 - mean\_absolute\_error: 0.0037 24/126 [====>.........................] - ETA: 0s - loss: 3.2289e-05 - mean\_absolute\_error: 0.0040 50/126 [==========>...................] - ETA: 0s - loss: 3.4163e-05 - mean\_absolute\_error: 0.0041 76/126 [=================>............] - ETA: 0s - loss: 3.4699e-05 - mean\_absolute\_error: 0.0042101/126 [=======================>......] - ETA: 0s - loss: 3.5278e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - ETA: 0s - loss: 3.4114e-05 - mean\_absolute\_error: 0.0041126/126 [==============================] - 0s 2ms/step - loss: 3.4114e-05 - mean\_absolute\_error: 0.0041 - val\_loss: 7.7320e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7372e-05 - mean\_absolute\_error: 0.0035 23/126 [====>.........................] - ETA: 0s - loss: 3.0500e-05 - mean\_absolute\_error: 0.0041 48/126 [==========>...................] - ETA: 0s - loss: 3.2847e-05 - mean\_absolute\_error: 0.0042 74/126 [================>.............] - ETA: 0s - loss: 3.3794e-05 - mean\_absolute\_error: 0.0042 97/126 [======================>.......] - ETA: 0s - loss: 3.4206e-05 - mean\_absolute\_error: 0.0042123/126 [============================>.] - ETA: 0s - loss: 3.4813e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.4855e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.4731e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3352e-05 - mean\_absolute\_error: 0.0034 21/126 [====>.........................] - ETA: 0s - loss: 3.7189e-05 - mean\_absolute\_error: 0.0044 43/126 [=========>....................] - ETA: 0s - loss: 3.8374e-05 - mean\_absolute\_error: 0.0046 64/126 [==============>...............] - ETA: 0s - loss: 3.7736e-05 - mean\_absolute\_error: 0.0045 86/126 [===================>..........] - ETA: 0s - loss: 3.6648e-05 - mean\_absolute\_error: 0.0044107/126 [========================>.....] - ETA: 0s - loss: 3.5719e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - ETA: 0s - loss: 3.6010e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6010e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.2564e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7039e-05 - mean\_absolute\_error: 0.0059 24/126 [====>.........................] - ETA: 0s - loss: 4.0037e-05 - mean\_absolute\_error: 0.0047 49/126 [==========>...................] - ETA: 0s - loss: 3.7016e-05 - mean\_absolute\_error: 0.0045 74/126 [================>.............] - ETA: 0s - loss: 3.5477e-05 - mean\_absolute\_error: 0.0043100/126 [======================>.......] - ETA: 0s - loss: 3.6329e-05 - mean\_absolute\_error: 0.0044125/126 [============================>.] - ETA: 0s - loss: 3.6395e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.6487e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.0633e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0745e-05 - mean\_absolute\_error: 0.0035 22/126 [====>.........................] - ETA: 0s - loss: 3.6955e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.8475e-05 - mean\_absolute\_error: 0.0046 72/126 [================>.............] - ETA: 0s - loss: 3.4894e-05 - mean\_absolute\_error: 0.0043 96/126 [=====================>........] - ETA: 0s - loss: 3.5857e-05 - mean\_absolute\_error: 0.0043120/126 [===========================>..] - ETA: 0s - loss: 3.4788e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.5095e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 7.1230e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8261e-05 - mean\_absolute\_error: 0.0038 26/126 [=====>........................] - ETA: 0s - loss: 3.2151e-05 - mean\_absolute\_error: 0.0040 51/126 [===========>..................] - ETA: 0s - loss: 3.2829e-05 - mean\_absolute\_error: 0.0042 77/126 [=================>............] - ETA: 0s - loss: 3.3595e-05 - mean\_absolute\_error: 0.0042104/126 [=======================>......] - ETA: 0s - loss: 3.5359e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.5824e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 1.0204e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0412e-05 - mean\_absolute\_error: 0.0070 21/126 [====>.........................] - ETA: 0s - loss: 3.5512e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 3.3789e-05 - mean\_absolute\_error: 0.0041 71/126 [===============>..............] - ETA: 0s - loss: 3.5062e-05 - mean\_absolute\_error: 0.0042 96/126 [=====================>........] - ETA: 0s - loss: 3.4116e-05 - mean\_absolute\_error: 0.0042122/126 [============================>.] - ETA: 0s - loss: 3.4713e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 2ms/step - loss: 3.4918e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 9.8701e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2378e-05 - mean\_absolute\_error: 0.0055 23/126 [====>.........................] - ETA: 0s - loss: 3.6587e-05 - mean\_absolute\_error: 0.0043 47/126 [==========>...................] - ETA: 0s - loss: 3.6015e-05 - mean\_absolute\_error: 0.0045 72/126 [================>.............] - ETA: 0s - loss: 3.7712e-05 - mean\_absolute\_error: 0.0046 96/126 [=====================>........] - ETA: 0s - loss: 3.7551e-05 - mean\_absolute\_error: 0.0045121/126 [===========================>..] - ETA: 0s - loss: 3.8045e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7822e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.8198e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3198e-05 - mean\_absolute\_error: 0.0038 25/126 [====>.........................] - ETA: 0s - loss: 3.6101e-05 - mean\_absolute\_error: 0.0044 50/126 [==========>...................] - ETA: 0s - loss: 3.8738e-05 - mean\_absolute\_error: 0.0046 74/126 [================>.............] - ETA: 0s - loss: 3.9092e-05 - mean\_absolute\_error: 0.0047 99/126 [======================>.......] - ETA: 0s - loss: 3.7768e-05 - mean\_absolute\_error: 0.0046123/126 [============================>.] - ETA: 0s - loss: 3.8535e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.8444e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.5368e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5815e-05 - mean\_absolute\_error: 0.0045 26/126 [=====>........................] - ETA: 0s - loss: 3.5999e-05 - mean\_absolute\_error: 0.0044 50/126 [==========>...................] - ETA: 0s - loss: 3.4800e-05 - mean\_absolute\_error: 0.0043 74/126 [================>.............] - ETA: 0s - loss: 3.4800e-05 - mean\_absolute\_error: 0.0044 97/126 [======================>.......] - ETA: 0s - loss: 3.6019e-05 - mean\_absolute\_error: 0.0045121/126 [===========================>..] - ETA: 0s - loss: 3.6616e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.6447e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 8.3048e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5907e-05 - mean\_absolute\_error: 0.0049 25/126 [====>.........................] - ETA: 0s - loss: 3.6493e-05 - mean\_absolute\_error: 0.0045 50/126 [==========>...................] - ETA: 0s - loss: 3.7367e-05 - mean\_absolute\_error: 0.0045 72/126 [================>.............] - ETA: 0s - loss: 3.6409e-05 - mean\_absolute\_error: 0.0045 96/126 [=====================>........] - ETA: 0s - loss: 3.6568e-05 - mean\_absolute\_error: 0.0045120/126 [===========================>..] - ETA: 0s - loss: 3.6037e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.5756e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.0106e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9068e-05 - mean\_absolute\_error: 0.0041 23/126 [====>.........................] - ETA: 0s - loss: 4.1413e-05 - mean\_absolute\_error: 0.0048 46/126 [=========>....................] - ETA: 0s - loss: 4.1293e-05 - mean\_absolute\_error: 0.0048 70/126 [===============>..............] - ETA: 0s - loss: 3.8066e-05 - mean\_absolute\_error: 0.0045 94/126 [=====================>........] - ETA: 0s - loss: 3.6466e-05 - mean\_absolute\_error: 0.0044119/126 [===========================>..] - ETA: 0s - loss: 3.5853e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.6009e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.9408e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5359e-05 - mean\_absolute\_error: 0.0050 26/126 [=====>........................] - ETA: 0s - loss: 3.5236e-05 - mean\_absolute\_error: 0.0043 51/126 [===========>..................] - ETA: 0s - loss: 3.3993e-05 - mean\_absolute\_error: 0.0042 76/126 [=================>............] - ETA: 0s - loss: 3.4833e-05 - mean\_absolute\_error: 0.0043101/126 [=======================>......] - ETA: 0s - loss: 3.6322e-05 - mean\_absolute\_error: 0.0044125/126 [============================>.] - ETA: 0s - loss: 3.6086e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.6077e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.7551e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3669e-05 - mean\_absolute\_error: 0.0050 24/126 [====>.........................] - ETA: 0s - loss: 3.1657e-05 - mean\_absolute\_error: 0.0043 49/126 [==========>...................] - ETA: 0s - loss: 3.7503e-05 - mean\_absolute\_error: 0.0046 74/126 [================>.............] - ETA: 0s - loss: 4.0255e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 3.9408e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 4.0391e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 4.0584e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.0514e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7333e-05 - mean\_absolute\_error: 0.0057 25/126 [====>.........................] - ETA: 0s - loss: 4.4019e-05 - mean\_absolute\_error: 0.0050 47/126 [==========>...................] - ETA: 0s - loss: 3.9597e-05 - mean\_absolute\_error: 0.0047 71/126 [===============>..............] - ETA: 0s - loss: 3.9851e-05 - mean\_absolute\_error: 0.0047 95/126 [=====================>........] - ETA: 0s - loss: 4.0248e-05 - mean\_absolute\_error: 0.0048119/126 [===========================>..] - ETA: 0s - loss: 3.9992e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 3.9694e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.5707e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0127e-05 - mean\_absolute\_error: 0.0058 25/126 [====>.........................] - ETA: 0s - loss: 4.1606e-05 - mean\_absolute\_error: 0.0049 50/126 [==========>...................] - ETA: 0s - loss: 3.6234e-05 - mean\_absolute\_error: 0.0046 74/126 [================>.............] - ETA: 0s - loss: 3.5915e-05 - mean\_absolute\_error: 0.0045 99/126 [======================>.......] - ETA: 0s - loss: 3.6795e-05 - mean\_absolute\_error: 0.0046123/126 [============================>.] - ETA: 0s - loss: 3.7816e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7873e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.2068e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4832e-05 - mean\_absolute\_error: 0.0044 25/126 [====>.........................] - ETA: 0s - loss: 3.5205e-05 - mean\_absolute\_error: 0.0043 49/126 [==========>...................] - ETA: 0s - loss: 3.3139e-05 - mean\_absolute\_error: 0.0041 74/126 [================>.............] - ETA: 0s - loss: 3.4402e-05 - mean\_absolute\_error: 0.0043 98/126 [======================>.......] - ETA: 0s - loss: 3.4511e-05 - mean\_absolute\_error: 0.0042121/126 [===========================>..] - ETA: 0s - loss: 3.5865e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.5965e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.7032e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0534e-05 - mean\_absolute\_error: 0.0039 26/126 [=====>........................] - ETA: 0s - loss: 3.4379e-05 - mean\_absolute\_error: 0.0042 51/126 [===========>..................] - ETA: 0s - loss: 3.5763e-05 - mean\_absolute\_error: 0.0043 75/126 [================>.............] - ETA: 0s - loss: 3.8540e-05 - mean\_absolute\_error: 0.0045 98/126 [======================>.......] - ETA: 0s - loss: 3.8135e-05 - mean\_absolute\_error: 0.0045121/126 [===========================>..] - ETA: 0s - loss: 3.7502e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.7645e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.0667e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4284e-05 - mean\_absolute\_error: 0.0063 26/126 [=====>........................] - ETA: 0s - loss: 4.5861e-05 - mean\_absolute\_error: 0.0053 51/126 [===========>..................] - ETA: 0s - loss: 4.3015e-05 - mean\_absolute\_error: 0.0050 75/126 [================>.............] - ETA: 0s - loss: 4.0484e-05 - mean\_absolute\_error: 0.0047100/126 [======================>.......] - ETA: 0s - loss: 4.0027e-05 - mean\_absolute\_error: 0.0046124/126 [============================>.] - ETA: 0s - loss: 4.3601e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 2ms/step - loss: 4.3538e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 8.7751e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 6.9491e-05 - mean\_absolute\_error: 0.0065 25/126 [====>.........................] - ETA: 0s - loss: 4.5781e-05 - mean\_absolute\_error: 0.0050 49/126 [==========>...................] - ETA: 0s - loss: 4.2542e-05 - mean\_absolute\_error: 0.0049 72/126 [================>.............] - ETA: 0s - loss: 4.1421e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 3.9416e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 3.9114e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.8912e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.1715e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6644e-05 - mean\_absolute\_error: 0.0035 25/126 [====>.........................] - ETA: 0s - loss: 3.3096e-05 - mean\_absolute\_error: 0.0042 49/126 [==========>...................] - ETA: 0s - loss: 3.4669e-05 - mean\_absolute\_error: 0.0042 73/126 [================>.............] - ETA: 0s - loss: 3.6088e-05 - mean\_absolute\_error: 0.0044 97/126 [======================>.......] - ETA: 0s - loss: 3.7522e-05 - mean\_absolute\_error: 0.0045119/126 [===========================>..] - ETA: 0s - loss: 3.6871e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.6661e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.6166e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7612e-05 - mean\_absolute\_error: 0.0032 24/126 [====>.........................] - ETA: 0s - loss: 3.5871e-05 - mean\_absolute\_error: 0.0045 49/126 [==========>...................] - ETA: 0s - loss: 3.6495e-05 - mean\_absolute\_error: 0.0045 74/126 [================>.............] - ETA: 0s - loss: 3.5847e-05 - mean\_absolute\_error: 0.0044 98/126 [======================>.......] - ETA: 0s - loss: 3.8536e-05 - mean\_absolute\_error: 0.0046122/126 [============================>.] - ETA: 0s - loss: 3.8039e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.7782e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.6717e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8034e-05 - mean\_absolute\_error: 0.0033 26/126 [=====>........................] - ETA: 0s - loss: 3.5463e-05 - mean\_absolute\_error: 0.0044 49/126 [==========>...................] - ETA: 0s - loss: 3.9601e-05 - mean\_absolute\_error: 0.0047 72/126 [================>.............] - ETA: 0s - loss: 3.9104e-05 - mean\_absolute\_error: 0.0046 95/126 [=====================>........] - ETA: 0s - loss: 4.0003e-05 - mean\_absolute\_error: 0.0047119/126 [===========================>..] - ETA: 0s - loss: 3.9751e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.9316e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.1215e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9154e-05 - mean\_absolute\_error: 0.0050 25/126 [====>.........................] - ETA: 0s - loss: 3.9059e-05 - mean\_absolute\_error: 0.0048 48/126 [==========>...................] - ETA: 0s - loss: 3.7471e-05 - mean\_absolute\_error: 0.0046 72/126 [================>.............] - ETA: 0s - loss: 3.5241e-05 - mean\_absolute\_error: 0.0045 96/126 [=====================>........] - ETA: 0s - loss: 3.5862e-05 - mean\_absolute\_error: 0.0045120/126 [===========================>..] - ETA: 0s - loss: 3.6628e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.6424e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.8463e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3836e-05 - mean\_absolute\_error: 0.0036 23/126 [====>.........................] - ETA: 0s - loss: 3.8443e-05 - mean\_absolute\_error: 0.0046 47/126 [==========>...................] - ETA: 0s - loss: 3.9781e-05 - mean\_absolute\_error: 0.0047 71/126 [===============>..............] - ETA: 0s - loss: 4.0300e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 4.1140e-05 - mean\_absolute\_error: 0.0049120/126 [===========================>..] - ETA: 0s - loss: 3.9419e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.9392e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.2448e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9692e-05 - mean\_absolute\_error: 0.0054 25/126 [====>.........................] - ETA: 0s - loss: 4.0658e-05 - mean\_absolute\_error: 0.0046 49/126 [==========>...................] - ETA: 0s - loss: 4.1454e-05 - mean\_absolute\_error: 0.0049 73/126 [================>.............] - ETA: 0s - loss: 4.3215e-05 - mean\_absolute\_error: 0.0050 97/126 [======================>.......] - ETA: 0s - loss: 4.0859e-05 - mean\_absolute\_error: 0.0048120/126 [===========================>..] - ETA: 0s - loss: 4.1147e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 2ms/step - loss: 4.1407e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 1.2597e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0414e-04 - mean\_absolute\_error: 0.0093 25/126 [====>.........................] - ETA: 0s - loss: 4.1575e-05 - mean\_absolute\_error: 0.0049 49/126 [==========>...................] - ETA: 0s - loss: 4.2661e-05 - mean\_absolute\_error: 0.0049 72/126 [================>.............] - ETA: 0s - loss: 4.2532e-05 - mean\_absolute\_error: 0.0050 96/126 [=====================>........] - ETA: 0s - loss: 4.1340e-05 - mean\_absolute\_error: 0.0049120/126 [===========================>..] - ETA: 0s - loss: 4.0564e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 4.0196e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.7974e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5767e-05 - mean\_absolute\_error: 0.0036 23/126 [====>.........................] - ETA: 0s - loss: 4.0400e-05 - mean\_absolute\_error: 0.0047 48/126 [==========>...................] - ETA: 0s - loss: 3.8399e-05 - mean\_absolute\_error: 0.0047 72/126 [================>.............] - ETA: 0s - loss: 4.1502e-05 - mean\_absolute\_error: 0.0049 96/126 [=====================>........] - ETA: 0s - loss: 4.1201e-05 - mean\_absolute\_error: 0.0048120/126 [===========================>..] - ETA: 0s - loss: 4.0091e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 4.0152e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.4926e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0437e-05 - mean\_absolute\_error: 0.0045 26/126 [=====>........................] - ETA: 0s - loss: 3.5001e-05 - mean\_absolute\_error: 0.0043 51/126 [===========>..................] - ETA: 0s - loss: 3.5615e-05 - mean\_absolute\_error: 0.0043 76/126 [=================>............] - ETA: 0s - loss: 4.1724e-05 - mean\_absolute\_error: 0.0049100/126 [======================>.......] - ETA: 0s - loss: 5.0646e-05 - mean\_absolute\_error: 0.0055124/126 [============================>.] - ETA: 0s - loss: 5.1714e-05 - mean\_absolute\_error: 0.0055126/126 [==============================] - 0s 2ms/step - loss: 5.1783e-05 - mean\_absolute\_error: 0.0055 - val\_loss: 8.9591e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6575e-05 - mean\_absolute\_error: 0.0056 22/126 [====>.........................] - ETA: 0s - loss: 3.5913e-05 - mean\_absolute\_error: 0.0044 44/126 [=========>....................] - ETA: 0s - loss: 3.6107e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 4.1157e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 3.9024e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 4.0853e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0128e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.5635e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0421e-05 - mean\_absolute\_error: 0.0041 25/126 [====>.........................] - ETA: 0s - loss: 3.7724e-05 - mean\_absolute\_error: 0.0045 48/126 [==========>...................] - ETA: 0s - loss: 3.8081e-05 - mean\_absolute\_error: 0.0045 71/126 [===============>..............] - ETA: 0s - loss: 4.0904e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 3.8922e-05 - mean\_absolute\_error: 0.0046120/126 [===========================>..] - ETA: 0s - loss: 3.8758e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.9285e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 8.1033e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9458e-05 - mean\_absolute\_error: 0.0050 26/126 [=====>........................] - ETA: 0s - loss: 3.8978e-05 - mean\_absolute\_error: 0.0048 51/126 [===========>..................] - ETA: 0s - loss: 4.3334e-05 - mean\_absolute\_error: 0.0051 76/126 [=================>............] - ETA: 0s - loss: 4.1232e-05 - mean\_absolute\_error: 0.0049100/126 [======================>.......] - ETA: 0s - loss: 3.9888e-05 - mean\_absolute\_error: 0.0048124/126 [============================>.] - ETA: 0s - loss: 3.9414e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.9347e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.1802e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5270e-05 - mean\_absolute\_error: 0.0025 25/126 [====>.........................] - ETA: 0s - loss: 2.8232e-05 - mean\_absolute\_error: 0.0038 50/126 [==========>...................] - ETA: 0s - loss: 3.4959e-05 - mean\_absolute\_error: 0.0044 74/126 [================>.............] - ETA: 0s - loss: 3.6211e-05 - mean\_absolute\_error: 0.0044 98/126 [======================>.......] - ETA: 0s - loss: 3.6027e-05 - mean\_absolute\_error: 0.0045120/126 [===========================>..] - ETA: 0s - loss: 3.7657e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.9024e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.0179e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8759e-05 - mean\_absolute\_error: 0.0055 26/126 [=====>........................] - ETA: 0s - loss: 4.2942e-05 - mean\_absolute\_error: 0.0049 50/126 [==========>...................] - ETA: 0s - loss: 3.8458e-05 - mean\_absolute\_error: 0.0046 72/126 [================>.............] - ETA: 0s - loss: 4.3688e-05 - mean\_absolute\_error: 0.0050 96/126 [=====================>........] - ETA: 0s - loss: 4.4977e-05 - mean\_absolute\_error: 0.0051120/126 [===========================>..] - ETA: 0s - loss: 4.4967e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 2ms/step - loss: 4.5377e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 1.4151e-04 - val\_mean\_absolute\_error: 0.0100  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2365e-05 - mean\_absolute\_error: 0.0061 26/126 [=====>........................] - ETA: 0s - loss: 5.6999e-05 - mean\_absolute\_error: 0.0060 51/126 [===========>..................] - ETA: 0s - loss: 4.8813e-05 - mean\_absolute\_error: 0.0054 75/126 [================>.............] - ETA: 0s - loss: 5.3317e-05 - mean\_absolute\_error: 0.0057 99/126 [======================>.......] - ETA: 0s - loss: 5.1399e-05 - mean\_absolute\_error: 0.0056123/126 [============================>.] - ETA: 0s - loss: 4.8799e-05 - mean\_absolute\_error: 0.0054126/126 [==============================] - 0s 2ms/step - loss: 4.8361e-05 - mean\_absolute\_error: 0.0054 - val\_loss: 7.3159e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5393e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.9077e-05 - mean\_absolute\_error: 0.0048 49/126 [==========>...................] - ETA: 0s - loss: 3.9314e-05 - mean\_absolute\_error: 0.0048 74/126 [================>.............] - ETA: 0s - loss: 3.8118e-05 - mean\_absolute\_error: 0.0047 98/126 [======================>.......] - ETA: 0s - loss: 3.7202e-05 - mean\_absolute\_error: 0.0046122/126 [============================>.] - ETA: 0s - loss: 3.8820e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.8863e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.2848e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 6.6360e-05 - mean\_absolute\_error: 0.0070 25/126 [====>.........................] - ETA: 0s - loss: 3.5376e-05 - mean\_absolute\_error: 0.0045 50/126 [==========>...................] - ETA: 0s - loss: 4.3473e-05 - mean\_absolute\_error: 0.0050 74/126 [================>.............] - ETA: 0s - loss: 4.4655e-05 - mean\_absolute\_error: 0.0051 96/126 [=====================>........] - ETA: 0s - loss: 4.4899e-05 - mean\_absolute\_error: 0.0051119/126 [===========================>..] - ETA: 0s - loss: 4.3856e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.3814e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.5588e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9112e-05 - mean\_absolute\_error: 0.0039 22/126 [====>.........................] - ETA: 0s - loss: 3.5169e-05 - mean\_absolute\_error: 0.0047 42/126 [=========>....................] - ETA: 0s - loss: 3.8410e-05 - mean\_absolute\_error: 0.0048 62/126 [=============>................] - ETA: 0s - loss: 3.7073e-05 - mean\_absolute\_error: 0.0047 81/126 [==================>...........] - ETA: 0s - loss: 3.6504e-05 - mean\_absolute\_error: 0.0045101/126 [=======================>......] - ETA: 0s - loss: 3.8154e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 4.2574e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.3880e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 1.9896e-04 - val\_mean\_absolute\_error: 0.0120  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1032e-04 - mean\_absolute\_error: 0.0094 24/126 [====>.........................] - ETA: 0s - loss: 5.6254e-05 - mean\_absolute\_error: 0.0060 49/126 [==========>...................] - ETA: 0s - loss: 4.8550e-05 - mean\_absolute\_error: 0.0054 74/126 [================>.............] - ETA: 0s - loss: 4.3440e-05 - mean\_absolute\_error: 0.0050 94/126 [=====================>........] - ETA: 0s - loss: 4.2408e-05 - mean\_absolute\_error: 0.0050118/126 [===========================>..] - ETA: 0s - loss: 4.0786e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1159e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 2.8848e-04 - val\_mean\_absolute\_error: 0.0155  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6058e-04 - mean\_absolute\_error: 0.0113 23/126 [====>.........................] - ETA: 0s - loss: 6.2639e-05 - mean\_absolute\_error: 0.0063 46/126 [=========>....................] - ETA: 0s - loss: 4.9702e-05 - mean\_absolute\_error: 0.0054 70/126 [===============>..............] - ETA: 0s - loss: 4.4549e-05 - mean\_absolute\_error: 0.0051 92/126 [====================>.........] - ETA: 0s - loss: 4.1424e-05 - mean\_absolute\_error: 0.0049116/126 [==========================>...] - ETA: 0s - loss: 4.0869e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0675e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.8544e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1426e-05 - mean\_absolute\_error: 0.0065 26/126 [=====>........................] - ETA: 0s - loss: 4.5126e-05 - mean\_absolute\_error: 0.0051 51/126 [===========>..................] - ETA: 0s - loss: 4.2854e-05 - mean\_absolute\_error: 0.0048 76/126 [=================>............] - ETA: 0s - loss: 4.0928e-05 - mean\_absolute\_error: 0.0048101/126 [=======================>......] - ETA: 0s - loss: 4.0820e-05 - mean\_absolute\_error: 0.0047125/126 [============================>.] - ETA: 0s - loss: 3.9671e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.9948e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.2944e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8549e-05 - mean\_absolute\_error: 0.0037 22/126 [====>.........................] - ETA: 0s - loss: 3.6332e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 4.2451e-05 - mean\_absolute\_error: 0.0050 70/126 [===============>..............] - ETA: 0s - loss: 4.2205e-05 - mean\_absolute\_error: 0.0050 95/126 [=====================>........] - ETA: 0s - loss: 3.9289e-05 - mean\_absolute\_error: 0.0047116/126 [==========================>...] - ETA: 0s - loss: 3.8989e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9626e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.7900e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8892e-05 - mean\_absolute\_error: 0.0060 25/126 [====>.........................] - ETA: 0s - loss: 3.5750e-05 - mean\_absolute\_error: 0.0044 49/126 [==========>...................] - ETA: 0s - loss: 3.6815e-05 - mean\_absolute\_error: 0.0046 74/126 [================>.............] - ETA: 0s - loss: 3.8405e-05 - mean\_absolute\_error: 0.0047 98/126 [======================>.......] - ETA: 0s - loss: 3.8970e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 3.7662e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7277e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.4627e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5949e-05 - mean\_absolute\_error: 0.0048 25/126 [====>.........................] - ETA: 0s - loss: 5.1561e-05 - mean\_absolute\_error: 0.0053 50/126 [==========>...................] - ETA: 0s - loss: 4.7406e-05 - mean\_absolute\_error: 0.0051 76/126 [=================>............] - ETA: 0s - loss: 4.2081e-05 - mean\_absolute\_error: 0.0049101/126 [=======================>......] - ETA: 0s - loss: 4.0263e-05 - mean\_absolute\_error: 0.0048125/126 [============================>.] - ETA: 0s - loss: 3.8991e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.9077e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.0495e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4810e-05 - mean\_absolute\_error: 0.0070 26/126 [=====>........................] - ETA: 0s - loss: 5.1562e-05 - mean\_absolute\_error: 0.0058 51/126 [===========>..................] - ETA: 0s - loss: 4.4443e-05 - mean\_absolute\_error: 0.0051 76/126 [=================>............] - ETA: 0s - loss: 4.2299e-05 - mean\_absolute\_error: 0.0050101/126 [=======================>......] - ETA: 0s - loss: 4.0986e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - ETA: 0s - loss: 4.0133e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 4.0133e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.7583e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7970e-05 - mean\_absolute\_error: 0.0054 25/126 [====>.........................] - ETA: 0s - loss: 4.4164e-05 - mean\_absolute\_error: 0.0052 50/126 [==========>...................] - ETA: 0s - loss: 4.4863e-05 - mean\_absolute\_error: 0.0051 74/126 [================>.............] - ETA: 0s - loss: 4.4017e-05 - mean\_absolute\_error: 0.0050 98/126 [======================>.......] - ETA: 0s - loss: 4.4002e-05 - mean\_absolute\_error: 0.0051122/126 [============================>.] - ETA: 0s - loss: 4.6476e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 2ms/step - loss: 4.7134e-05 - mean\_absolute\_error: 0.0053 - val\_loss: 1.0972e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3972e-05 - mean\_absolute\_error: 0.0066 25/126 [====>.........................] - ETA: 0s - loss: 6.5299e-05 - mean\_absolute\_error: 0.0066 50/126 [==========>...................] - ETA: 0s - loss: 5.9014e-05 - mean\_absolute\_error: 0.0062 75/126 [================>.............] - ETA: 0s - loss: 5.3790e-05 - mean\_absolute\_error: 0.0057 99/126 [======================>.......] - ETA: 0s - loss: 5.1328e-05 - mean\_absolute\_error: 0.0056123/126 [============================>.] - ETA: 0s - loss: 5.2173e-05 - mean\_absolute\_error: 0.0057126/126 [==============================] - 0s 2ms/step - loss: 5.2221e-05 - mean\_absolute\_error: 0.0057 - val\_loss: 1.0092e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2655e-05 - mean\_absolute\_error: 0.0062 26/126 [=====>........................] - ETA: 0s - loss: 4.4663e-05 - mean\_absolute\_error: 0.0052 51/126 [===========>..................] - ETA: 0s - loss: 3.9272e-05 - mean\_absolute\_error: 0.0047 75/126 [================>.............] - ETA: 0s - loss: 4.4513e-05 - mean\_absolute\_error: 0.0050 99/126 [======================>.......] - ETA: 0s - loss: 4.3048e-05 - mean\_absolute\_error: 0.0050124/126 [============================>.] - ETA: 0s - loss: 4.1918e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 2ms/step - loss: 4.2118e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.4798e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2105e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 3.5918e-05 - mean\_absolute\_error: 0.0043 47/126 [==========>...................] - ETA: 0s - loss: 4.0647e-05 - mean\_absolute\_error: 0.0048 69/126 [===============>..............] - ETA: 0s - loss: 4.4435e-05 - mean\_absolute\_error: 0.0051 92/126 [====================>.........] - ETA: 0s - loss: 4.3454e-05 - mean\_absolute\_error: 0.0051115/126 [==========================>...] - ETA: 0s - loss: 4.2941e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2412e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 6.3964e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6974e-05 - mean\_absolute\_error: 0.0052 23/126 [====>.........................] - ETA: 0s - loss: 3.4364e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 3.2021e-05 - mean\_absolute\_error: 0.0043 69/126 [===============>..............] - ETA: 0s - loss: 3.3115e-05 - mean\_absolute\_error: 0.0044 93/126 [=====================>........] - ETA: 0s - loss: 3.4520e-05 - mean\_absolute\_error: 0.0044118/126 [===========================>..] - ETA: 0s - loss: 3.5317e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.5268e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.1816e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4700e-05 - mean\_absolute\_error: 0.0045 26/126 [=====>........................] - ETA: 0s - loss: 3.8024e-05 - mean\_absolute\_error: 0.0047 51/126 [===========>..................] - ETA: 0s - loss: 4.2378e-05 - mean\_absolute\_error: 0.0050 76/126 [=================>............] - ETA: 0s - loss: 4.7280e-05 - mean\_absolute\_error: 0.0053101/126 [=======================>......] - ETA: 0s - loss: 4.7870e-05 - mean\_absolute\_error: 0.0054125/126 [============================>.] - ETA: 0s - loss: 4.4912e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 2ms/step - loss: 4.4889e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 6.3644e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6018e-05 - mean\_absolute\_error: 0.0029 25/126 [====>.........................] - ETA: 0s - loss: 3.5613e-05 - mean\_absolute\_error: 0.0043 49/126 [==========>...................] - ETA: 0s - loss: 3.7744e-05 - mean\_absolute\_error: 0.0045 72/126 [================>.............] - ETA: 0s - loss: 3.9208e-05 - mean\_absolute\_error: 0.0047 96/126 [=====================>........] - ETA: 0s - loss: 3.9364e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 4.0393e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 4.0581e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.1707e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1127e-05 - mean\_absolute\_error: 0.0053 26/126 [=====>........................] - ETA: 0s - loss: 3.9970e-05 - mean\_absolute\_error: 0.0047 50/126 [==========>...................] - ETA: 0s - loss: 3.6092e-05 - mean\_absolute\_error: 0.0044 73/126 [================>.............] - ETA: 0s - loss: 3.6620e-05 - mean\_absolute\_error: 0.0044 97/126 [======================>.......] - ETA: 0s - loss: 3.8543e-05 - mean\_absolute\_error: 0.0046121/126 [===========================>..] - ETA: 0s - loss: 3.7778e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7508e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.0338e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9236e-05 - mean\_absolute\_error: 0.0045 26/126 [=====>........................] - ETA: 0s - loss: 4.6480e-05 - mean\_absolute\_error: 0.0055 51/126 [===========>..................] - ETA: 0s - loss: 4.2113e-05 - mean\_absolute\_error: 0.0051 75/126 [================>.............] - ETA: 0s - loss: 4.2755e-05 - mean\_absolute\_error: 0.0051100/126 [======================>.......] - ETA: 0s - loss: 4.1787e-05 - mean\_absolute\_error: 0.0050124/126 [============================>.] - ETA: 0s - loss: 4.0327e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 2ms/step - loss: 4.0425e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.2307e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8212e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 3.7430e-05 - mean\_absolute\_error: 0.0043 49/126 [==========>...................] - ETA: 0s - loss: 3.6331e-05 - mean\_absolute\_error: 0.0044 74/126 [================>.............] - ETA: 0s - loss: 4.0615e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 4.1881e-05 - mean\_absolute\_error: 0.0049120/126 [===========================>..] - ETA: 0s - loss: 4.4299e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 2ms/step - loss: 4.4350e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 7.2783e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3260e-05 - mean\_absolute\_error: 0.0043 25/126 [====>.........................] - ETA: 0s - loss: 4.0564e-05 - mean\_absolute\_error: 0.0046 50/126 [==========>...................] - ETA: 0s - loss: 4.1159e-05 - mean\_absolute\_error: 0.0048 75/126 [================>.............] - ETA: 0s - loss: 3.9293e-05 - mean\_absolute\_error: 0.0046 97/126 [======================>.......] - ETA: 0s - loss: 4.0752e-05 - mean\_absolute\_error: 0.0048119/126 [===========================>..] - ETA: 0s - loss: 4.0033e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.9583e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.3826e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3341e-05 - mean\_absolute\_error: 0.0041 25/126 [====>.........................] - ETA: 0s - loss: 3.1191e-05 - mean\_absolute\_error: 0.0041 50/126 [==========>...................] - ETA: 0s - loss: 3.7391e-05 - mean\_absolute\_error: 0.0045 75/126 [================>.............] - ETA: 0s - loss: 3.6840e-05 - mean\_absolute\_error: 0.0045100/126 [======================>.......] - ETA: 0s - loss: 3.6331e-05 - mean\_absolute\_error: 0.0045124/126 [============================>.] - ETA: 0s - loss: 3.8788e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.8733e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.4745e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6399e-05 - mean\_absolute\_error: 0.0044 25/126 [====>.........................] - ETA: 0s - loss: 4.2938e-05 - mean\_absolute\_error: 0.0050 49/126 [==========>...................] - ETA: 0s - loss: 4.3652e-05 - mean\_absolute\_error: 0.0050 73/126 [================>.............] - ETA: 0s - loss: 4.0559e-05 - mean\_absolute\_error: 0.0048 97/126 [======================>.......] - ETA: 0s - loss: 4.0450e-05 - mean\_absolute\_error: 0.0048119/126 [===========================>..] - ETA: 0s - loss: 3.9634e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 3.9712e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.3749e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7040e-05 - mean\_absolute\_error: 0.0049 26/126 [=====>........................] - ETA: 0s - loss: 3.2692e-05 - mean\_absolute\_error: 0.0041 49/126 [==========>...................] - ETA: 0s - loss: 3.5046e-05 - mean\_absolute\_error: 0.0043 74/126 [================>.............] - ETA: 0s - loss: 3.5734e-05 - mean\_absolute\_error: 0.0044 98/126 [======================>.......] - ETA: 0s - loss: 3.5053e-05 - mean\_absolute\_error: 0.0044120/126 [===========================>..] - ETA: 0s - loss: 3.6034e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6102e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.1172e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4365e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 3.5555e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 4.2705e-05 - mean\_absolute\_error: 0.0050 67/126 [==============>...............] - ETA: 0s - loss: 4.3840e-05 - mean\_absolute\_error: 0.0050 89/126 [====================>.........] - ETA: 0s - loss: 4.1103e-05 - mean\_absolute\_error: 0.0049111/126 [=========================>....] - ETA: 0s - loss: 4.0363e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 3.9467e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 5.9686e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0456e-05 - mean\_absolute\_error: 0.0043 25/126 [====>.........................] - ETA: 0s - loss: 4.3348e-05 - mean\_absolute\_error: 0.0050 49/126 [==========>...................] - ETA: 0s - loss: 3.8496e-05 - mean\_absolute\_error: 0.0047 73/126 [================>.............] - ETA: 0s - loss: 3.8582e-05 - mean\_absolute\_error: 0.0047 97/126 [======================>.......] - ETA: 0s - loss: 3.6738e-05 - mean\_absolute\_error: 0.0045120/126 [===========================>..] - ETA: 0s - loss: 3.6678e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7414e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.5881e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7200e-05 - mean\_absolute\_error: 0.0038 25/126 [====>.........................] - ETA: 0s - loss: 4.5695e-05 - mean\_absolute\_error: 0.0050 51/126 [===========>..................] - ETA: 0s - loss: 4.3878e-05 - mean\_absolute\_error: 0.0049 75/126 [================>.............] - ETA: 0s - loss: 4.1936e-05 - mean\_absolute\_error: 0.0049100/126 [======================>.......] - ETA: 0s - loss: 4.0255e-05 - mean\_absolute\_error: 0.0047122/126 [============================>.] - ETA: 0s - loss: 3.8379e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.8318e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.1053e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4742e-05 - mean\_absolute\_error: 0.0062 24/126 [====>.........................] - ETA: 0s - loss: 3.1740e-05 - mean\_absolute\_error: 0.0043 48/126 [==========>...................] - ETA: 0s - loss: 3.3520e-05 - mean\_absolute\_error: 0.0043 72/126 [================>.............] - ETA: 0s - loss: 3.6250e-05 - mean\_absolute\_error: 0.0045 97/126 [======================>.......] - ETA: 0s - loss: 3.5780e-05 - mean\_absolute\_error: 0.0045121/126 [===========================>..] - ETA: 0s - loss: 3.7294e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7053e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.9633e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6284e-05 - mean\_absolute\_error: 0.0058 25/126 [====>.........................] - ETA: 0s - loss: 2.9915e-05 - mean\_absolute\_error: 0.0039 50/126 [==========>...................] - ETA: 0s - loss: 3.3068e-05 - mean\_absolute\_error: 0.0042 74/126 [================>.............] - ETA: 0s - loss: 3.3565e-05 - mean\_absolute\_error: 0.0043 98/126 [======================>.......] - ETA: 0s - loss: 3.2996e-05 - mean\_absolute\_error: 0.0042122/126 [============================>.] - ETA: 0s - loss: 3.4801e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.4867e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.1002e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 4.2791e-05 - mean\_absolute\_error: 0.0051 24/126 [====>.........................] - ETA: 0s - loss: 3.9343e-05 - mean\_absolute\_error: 0.0047 48/126 [==========>...................] - ETA: 0s - loss: 3.8169e-05 - mean\_absolute\_error: 0.0047 73/126 [================>.............] - ETA: 0s - loss: 3.7074e-05 - mean\_absolute\_error: 0.0046 97/126 [======================>.......] - ETA: 0s - loss: 3.7219e-05 - mean\_absolute\_error: 0.0046121/126 [===========================>..] - ETA: 0s - loss: 3.5597e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.5864e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 9.3485e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6581e-05 - mean\_absolute\_error: 0.0063 23/126 [====>.........................] - ETA: 0s - loss: 4.3022e-05 - mean\_absolute\_error: 0.0052 48/126 [==========>...................] - ETA: 0s - loss: 3.9356e-05 - mean\_absolute\_error: 0.0048 72/126 [================>.............] - ETA: 0s - loss: 3.9260e-05 - mean\_absolute\_error: 0.0047 96/126 [=====================>........] - ETA: 0s - loss: 3.9452e-05 - mean\_absolute\_error: 0.0047120/126 [===========================>..] - ETA: 0s - loss: 3.8929e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.8255e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 5.8210e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1302e-05 - mean\_absolute\_error: 0.0039 26/126 [=====>........................] - ETA: 0s - loss: 3.9923e-05 - mean\_absolute\_error: 0.0050 51/126 [===========>..................] - ETA: 0s - loss: 4.3336e-05 - mean\_absolute\_error: 0.0051 76/126 [=================>............] - ETA: 0s - loss: 4.0447e-05 - mean\_absolute\_error: 0.0049100/126 [======================>.......] - ETA: 0s - loss: 3.8403e-05 - mean\_absolute\_error: 0.0047124/126 [============================>.] - ETA: 0s - loss: 3.7961e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.7843e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.1674e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2684e-05 - mean\_absolute\_error: 0.0038 26/126 [=====>........................] - ETA: 0s - loss: 3.3730e-05 - mean\_absolute\_error: 0.0042 48/126 [==========>...................] - ETA: 0s - loss: 3.4616e-05 - mean\_absolute\_error: 0.0043 72/126 [================>.............] - ETA: 0s - loss: 3.5007e-05 - mean\_absolute\_error: 0.0043 96/126 [=====================>........] - ETA: 0s - loss: 3.8519e-05 - mean\_absolute\_error: 0.0046120/126 [===========================>..] - ETA: 0s - loss: 3.9609e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 2ms/step - loss: 3.9835e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.4049e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0351e-05 - mean\_absolute\_error: 0.0030 25/126 [====>.........................] - ETA: 0s - loss: 3.8150e-05 - mean\_absolute\_error: 0.0048 48/126 [==========>...................] - ETA: 0s - loss: 3.4382e-05 - mean\_absolute\_error: 0.0044 70/126 [===============>..............] - ETA: 0s - loss: 3.3586e-05 - mean\_absolute\_error: 0.0044 94/126 [=====================>........] - ETA: 0s - loss: 3.4578e-05 - mean\_absolute\_error: 0.0044118/126 [===========================>..] - ETA: 0s - loss: 3.5856e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6569e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.2887e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8281e-05 - mean\_absolute\_error: 0.0085 26/126 [=====>........................] - ETA: 0s - loss: 4.0388e-05 - mean\_absolute\_error: 0.0047 51/126 [===========>..................] - ETA: 0s - loss: 3.9842e-05 - mean\_absolute\_error: 0.0047 76/126 [=================>............] - ETA: 0s - loss: 3.5614e-05 - mean\_absolute\_error: 0.0044100/126 [======================>.......] - ETA: 0s - loss: 3.5240e-05 - mean\_absolute\_error: 0.0044124/126 [============================>.] - ETA: 0s - loss: 3.6485e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.6446e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.3627e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0568e-05 - mean\_absolute\_error: 0.0045 24/126 [====>.........................] - ETA: 0s - loss: 3.9591e-05 - mean\_absolute\_error: 0.0049 50/126 [==========>...................] - ETA: 0s - loss: 3.6484e-05 - mean\_absolute\_error: 0.0046 72/126 [================>.............] - ETA: 0s - loss: 3.8809e-05 - mean\_absolute\_error: 0.0048 96/126 [=====================>........] - ETA: 0s - loss: 3.7811e-05 - mean\_absolute\_error: 0.0047119/126 [===========================>..] - ETA: 0s - loss: 4.5415e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.6598e-05 - mean\_absolute\_error: 0.0053 - val\_loss: 2.2765e-04 - val\_mean\_absolute\_error: 0.0136  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0738e-04 - mean\_absolute\_error: 0.0093 22/126 [====>.........................] - ETA: 0s - loss: 5.2329e-05 - mean\_absolute\_error: 0.0057 43/126 [=========>....................] - ETA: 0s - loss: 4.6746e-05 - mean\_absolute\_error: 0.0052 64/126 [==============>...............] - ETA: 0s - loss: 4.1540e-05 - mean\_absolute\_error: 0.0048 85/126 [===================>..........] - ETA: 0s - loss: 3.9312e-05 - mean\_absolute\_error: 0.0047106/126 [========================>.....] - ETA: 0s - loss: 3.8259e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 4.1481e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.8284e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0663e-05 - mean\_absolute\_error: 0.0058 26/126 [=====>........................] - ETA: 0s - loss: 5.6583e-05 - mean\_absolute\_error: 0.0060 51/126 [===========>..................] - ETA: 0s - loss: 4.4776e-05 - mean\_absolute\_error: 0.0050 75/126 [================>.............] - ETA: 0s - loss: 4.1418e-05 - mean\_absolute\_error: 0.0048100/126 [======================>.......] - ETA: 0s - loss: 3.8613e-05 - mean\_absolute\_error: 0.0046124/126 [============================>.] - ETA: 0s - loss: 3.7635e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 2ms/step - loss: 3.7596e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.0034e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1922e-05 - mean\_absolute\_error: 0.0055 25/126 [====>.........................] - ETA: 0s - loss: 3.0315e-05 - mean\_absolute\_error: 0.0040 49/126 [==========>...................] - ETA: 0s - loss: 3.2432e-05 - mean\_absolute\_error: 0.0042 73/126 [================>.............] - ETA: 0s - loss: 3.3219e-05 - mean\_absolute\_error: 0.0041 96/126 [=====================>........] - ETA: 0s - loss: 3.3057e-05 - mean\_absolute\_error: 0.0042120/126 [===========================>..] - ETA: 0s - loss: 3.3892e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.4048e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 9.0430e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7974e-05 - mean\_absolute\_error: 0.0064 25/126 [====>.........................] - ETA: 0s - loss: 3.8994e-05 - mean\_absolute\_error: 0.0047 50/126 [==========>...................] - ETA: 0s - loss: 3.4191e-05 - mean\_absolute\_error: 0.0044 73/126 [================>.............] - ETA: 0s - loss: 3.4387e-05 - mean\_absolute\_error: 0.0044 95/126 [=====================>........] - ETA: 0s - loss: 3.3710e-05 - mean\_absolute\_error: 0.0043117/126 [==========================>...] - ETA: 0s - loss: 3.4223e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5942e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 5.6112e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9028e-05 - mean\_absolute\_error: 0.0039 24/126 [====>.........................] - ETA: 0s - loss: 3.7901e-05 - mean\_absolute\_error: 0.0046 49/126 [==========>...................] - ETA: 0s - loss: 3.8804e-05 - mean\_absolute\_error: 0.0048 74/126 [================>.............] - ETA: 0s - loss: 3.8471e-05 - mean\_absolute\_error: 0.0047 99/126 [======================>.......] - ETA: 0s - loss: 4.2073e-05 - mean\_absolute\_error: 0.0050124/126 [============================>.] - ETA: 0s - loss: 4.2504e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 2ms/step - loss: 4.2641e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 7.0084e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3439e-05 - mean\_absolute\_error: 0.0049 25/126 [====>.........................] - ETA: 0s - loss: 4.2399e-05 - mean\_absolute\_error: 0.0049 50/126 [==========>...................] - ETA: 0s - loss: 3.6373e-05 - mean\_absolute\_error: 0.0045 75/126 [================>.............] - ETA: 0s - loss: 4.0847e-05 - mean\_absolute\_error: 0.0048100/126 [======================>.......] - ETA: 0s - loss: 3.8646e-05 - mean\_absolute\_error: 0.0047123/126 [============================>.] - ETA: 0s - loss: 3.7482e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7466e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 5.6331e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7912e-05 - mean\_absolute\_error: 0.0035 26/126 [=====>........................] - ETA: 0s - loss: 3.2059e-05 - mean\_absolute\_error: 0.0039 51/126 [===========>..................] - ETA: 0s - loss: 3.3222e-05 - mean\_absolute\_error: 0.0041 76/126 [=================>............] - ETA: 0s - loss: 3.3104e-05 - mean\_absolute\_error: 0.0041100/126 [======================>.......] - ETA: 0s - loss: 3.3155e-05 - mean\_absolute\_error: 0.0041122/126 [============================>.] - ETA: 0s - loss: 3.2190e-05 - mean\_absolute\_error: 0.0041126/126 [==============================] - 0s 2ms/step - loss: 3.2095e-05 - mean\_absolute\_error: 0.0041 - val\_loss: 5.6673e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5327e-05 - mean\_absolute\_error: 0.0047 25/126 [====>.........................] - ETA: 0s - loss: 2.8446e-05 - mean\_absolute\_error: 0.0040 47/126 [==========>...................] - ETA: 0s - loss: 3.1218e-05 - mean\_absolute\_error: 0.0041 69/126 [===============>..............] - ETA: 0s - loss: 3.4010e-05 - mean\_absolute\_error: 0.0042 83/126 [==================>...........] - ETA: 0s - loss: 3.3042e-05 - mean\_absolute\_error: 0.0041104/126 [=======================>......] - ETA: 0s - loss: 3.2599e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.3361e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 7.3919e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5193e-05 - mean\_absolute\_error: 0.0055 26/126 [=====>........................] - ETA: 0s - loss: 4.4685e-05 - mean\_absolute\_error: 0.0051 51/126 [===========>..................] - ETA: 0s - loss: 4.5122e-05 - mean\_absolute\_error: 0.0052 75/126 [================>.............] - ETA: 0s - loss: 4.1888e-05 - mean\_absolute\_error: 0.0050100/126 [======================>.......] - ETA: 0s - loss: 4.0184e-05 - mean\_absolute\_error: 0.0048122/126 [============================>.] - ETA: 0s - loss: 3.8528e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.8339e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.1922e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7822e-05 - mean\_absolute\_error: 0.0039 25/126 [====>.........................] - ETA: 0s - loss: 3.5675e-05 - mean\_absolute\_error: 0.0044 50/126 [==========>...................] - ETA: 0s - loss: 4.0482e-05 - mean\_absolute\_error: 0.0048 75/126 [================>.............] - ETA: 0s - loss: 3.9225e-05 - mean\_absolute\_error: 0.0047100/126 [======================>.......] - ETA: 0s - loss: 4.4958e-05 - mean\_absolute\_error: 0.0052122/126 [============================>.] - ETA: 0s - loss: 4.2548e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 2ms/step - loss: 4.2291e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.4415e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7337e-05 - mean\_absolute\_error: 0.0050 25/126 [====>.........................] - ETA: 0s - loss: 4.5420e-05 - mean\_absolute\_error: 0.0054 50/126 [==========>...................] - ETA: 0s - loss: 3.8313e-05 - mean\_absolute\_error: 0.0048 74/126 [================>.............] - ETA: 0s - loss: 3.7942e-05 - mean\_absolute\_error: 0.0048 98/126 [======================>.......] - ETA: 0s - loss: 3.7391e-05 - mean\_absolute\_error: 0.0047122/126 [============================>.] - ETA: 0s - loss: 3.8063e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 2ms/step - loss: 3.8625e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 9.6217e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0232e-05 - mean\_absolute\_error: 0.0050 26/126 [=====>........................] - ETA: 0s - loss: 3.1978e-05 - mean\_absolute\_error: 0.0043 51/126 [===========>..................] - ETA: 0s - loss: 3.1341e-05 - mean\_absolute\_error: 0.0042 76/126 [=================>............] - ETA: 0s - loss: 3.3658e-05 - mean\_absolute\_error: 0.0043101/126 [=======================>......] - ETA: 0s - loss: 3.4410e-05 - mean\_absolute\_error: 0.0044125/126 [============================>.] - ETA: 0s - loss: 3.5017e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 2ms/step - loss: 3.5022e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.7156e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 4.9697e-05 - mean\_absolute\_error: 0.0057 24/126 [====>.........................] - ETA: 0s - loss: 3.1405e-05 - mean\_absolute\_error: 0.0042 48/126 [==========>...................] - ETA: 0s - loss: 3.4676e-05 - mean\_absolute\_error: 0.0044 72/126 [================>.............] - ETA: 0s - loss: 4.1417e-05 - mean\_absolute\_error: 0.0049 96/126 [=====================>........] - ETA: 0s - loss: 3.7828e-05 - mean\_absolute\_error: 0.0046120/126 [===========================>..] - ETA: 0s - loss: 3.6992e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.6573e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.6006e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6037e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 3.7361e-05 - mean\_absolute\_error: 0.0046 48/126 [==========>...................] - ETA: 0s - loss: 3.4302e-05 - mean\_absolute\_error: 0.0043 73/126 [================>.............] - ETA: 0s - loss: 3.0913e-05 - mean\_absolute\_error: 0.0040 97/126 [======================>.......] - ETA: 0s - loss: 3.2025e-05 - mean\_absolute\_error: 0.0041121/126 [===========================>..] - ETA: 0s - loss: 3.3459e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 2ms/step - loss: 3.3462e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 6.8206e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8949e-05 - mean\_absolute\_error: 0.0044 26/126 [=====>........................] - ETA: 0s - loss: 4.1239e-05 - mean\_absolute\_error: 0.0050 51/126 [===========>..................] - ETA: 0s - loss: 4.0995e-05 - mean\_absolute\_error: 0.0050 76/126 [=================>............] - ETA: 0s - loss: 3.7673e-05 - mean\_absolute\_error: 0.0046101/126 [=======================>......] - ETA: 0s - loss: 3.5707e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - ETA: 0s - loss: 3.4443e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.4443e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 6.4609e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6532e-05 - mean\_absolute\_error: 0.0063 25/126 [====>.........................] - ETA: 0s - loss: 3.2201e-05 - mean\_absolute\_error: 0.0042 47/126 [==========>...................] - ETA: 0s - loss: 3.2015e-05 - mean\_absolute\_error: 0.0042 71/126 [===============>..............] - ETA: 0s - loss: 3.0858e-05 - mean\_absolute\_error: 0.0040 94/126 [=====================>........] - ETA: 0s - loss: 3.3605e-05 - mean\_absolute\_error: 0.0042118/126 [===========================>..] - ETA: 0s - loss: 3.3354e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 2ms/step - loss: 3.3138e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 6.1187e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6718e-05 - mean\_absolute\_error: 0.0029 26/126 [=====>........................] - ETA: 0s - loss: 3.5583e-05 - mean\_absolute\_error: 0.0042 49/126 [==========>...................] - ETA: 0s - loss: 3.7705e-05 - mean\_absolute\_error: 0.0045 71/126 [===============>..............] - ETA: 0s - loss: 3.4634e-05 - mean\_absolute\_error: 0.0043 95/126 [=====================>........] - ETA: 0s - loss: 3.2788e-05 - mean\_absolute\_error: 0.0041120/126 [===========================>..] - ETA: 0s - loss: 3.4466e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 2ms/step - loss: 3.4469e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 1.0369e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7173e-05 - mean\_absolute\_error: 0.0086 26/126 [=====>........................] - ETA: 0s - loss: 5.0546e-05 - mean\_absolute\_error: 0.0058 51/126 [===========>..................] - ETA: 0s - loss: 4.2602e-05 - mean\_absolute\_error: 0.0050 76/126 [=================>............] - ETA: 0s - loss: 4.0061e-05 - mean\_absolute\_error: 0.0048101/126 [=======================>......] - ETA: 0s - loss: 3.9176e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - ETA: 0s - loss: 3.7439e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 2ms/step - loss: 3.7439e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.5549e-05 - val\_mean\_absolute\_error: 0.0062

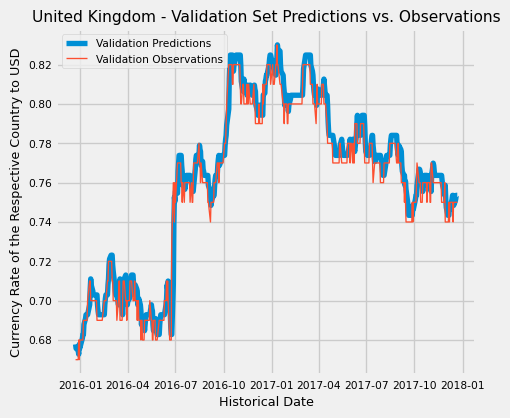
<keras.src.callbacks.History at 0x2115f2ac610>

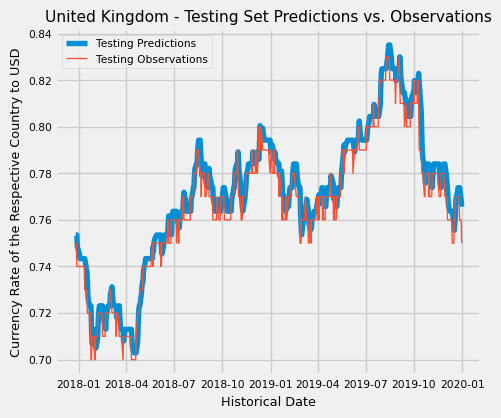
After the training and fitting of the Machine Learning model for the United Kingdom, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and 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 70/126 [===============>..............] - ETA: 0s109/126 [========================>.....] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step

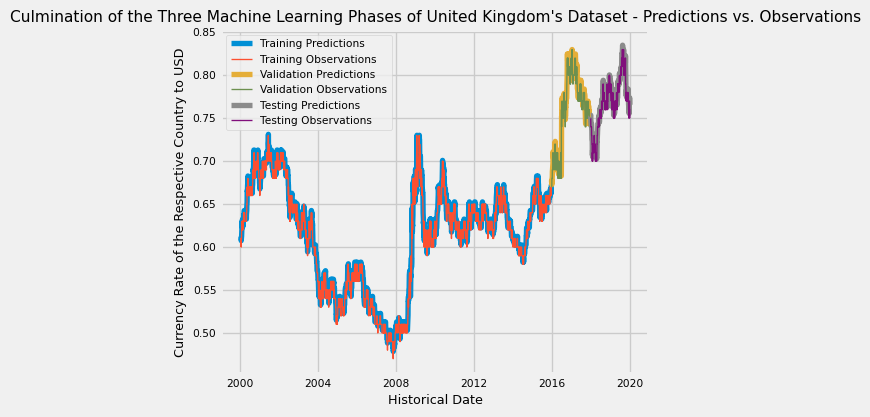






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

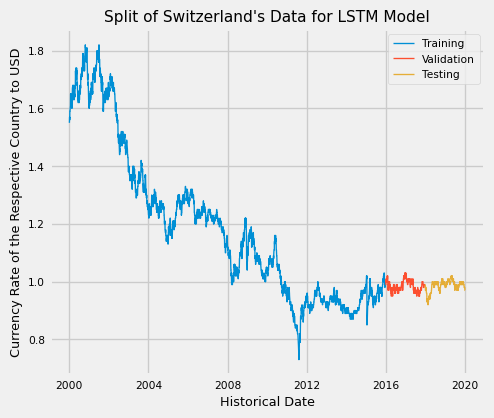
```{python}  
# Plotting United Kingdom's observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model)   
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_train,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

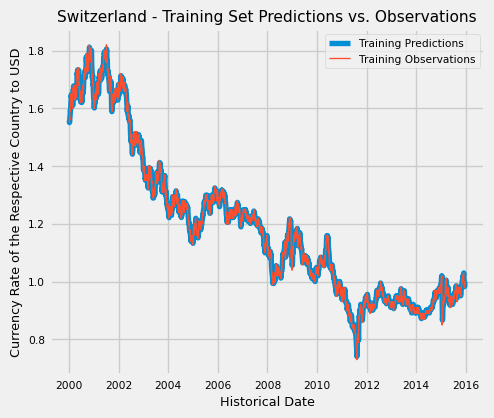
Epoch 1/100  
 1/126 [..............................] - ETA: 3:42 - loss: 1.5903 - mean\_absolute\_error: 1.2360 19/126 [===>..........................] - ETA: 0s - loss: 1.1401 - mean\_absolute\_error: 1.0303 45/126 [=========>....................] - ETA: 0s - loss: 0.5949 - mean\_absolute\_error: 0.6416 70/126 [===============>..............] - ETA: 0s - loss: 0.3879 - mean\_absolute\_error: 0.4477 96/126 [=====================>........] - ETA: 0s - loss: 0.2843 - mean\_absolute\_error: 0.3436123/126 [============================>.] - ETA: 0s - loss: 0.2229 - mean\_absolute\_error: 0.2804126/126 [==============================] - 2s 5ms/step - loss: 0.2188 - mean\_absolute\_error: 0.2761 - val\_loss: 0.0039 - val\_mean\_absolute\_error: 0.0623  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0040 - mean\_absolute\_error: 0.0571 23/126 [====>.........................] - ETA: 0s - loss: 0.0039 - mean\_absolute\_error: 0.0519 49/126 [==========>...................] - ETA: 0s - loss: 0.0033 - mean\_absolute\_error: 0.0478 74/126 [================>.............] - ETA: 0s - loss: 0.0029 - mean\_absolute\_error: 0.0447 99/126 [======================>.......] - ETA: 0s - loss: 0.0026 - mean\_absolute\_error: 0.0419124/126 [============================>.] - ETA: 0s - loss: 0.0023 - mean\_absolute\_error: 0.0390126/126 [==============================] - 0s 2ms/step - loss: 0.0023 - mean\_absolute\_error: 0.0389 - val\_loss: 0.0011 - val\_mean\_absolute\_error: 0.0325  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0398e-04 - mean\_absolute\_error: 0.0229 24/126 [====>.........................] - ETA: 0s - loss: 8.2609e-04 - mean\_absolute\_error: 0.0238 47/126 [==========>...................] - ETA: 0s - loss: 7.0610e-04 - mean\_absolute\_error: 0.0218 71/126 [===============>..............] - ETA: 0s - loss: 6.3119e-04 - mean\_absolute\_error: 0.0204 96/126 [=====================>........] - ETA: 0s - loss: 5.5809e-04 - mean\_absolute\_error: 0.0190121/126 [===========================>..] - ETA: 0s - loss: 4.9713e-04 - mean\_absolute\_error: 0.0177126/126 [==============================] - 0s 2ms/step - loss: 4.8703e-04 - mean\_absolute\_error: 0.0175 - val\_loss: 1.6081e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7183e-04 - mean\_absolute\_error: 0.0112 23/126 [====>.........................] - ETA: 0s - loss: 2.2977e-04 - mean\_absolute\_error: 0.0115 50/126 [==========>...................] - ETA: 0s - loss: 2.1337e-04 - mean\_absolute\_error: 0.0111 76/126 [=================>............] - ETA: 0s - loss: 1.9503e-04 - mean\_absolute\_error: 0.0107101/126 [=======================>......] - ETA: 0s - loss: 1.8443e-04 - mean\_absolute\_error: 0.0104126/126 [==============================] - 0s 2ms/step - loss: 1.7496e-04 - mean\_absolute\_error: 0.0102 - val\_loss: 5.6392e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6834e-04 - mean\_absolute\_error: 0.0096 22/126 [====>.........................] - ETA: 0s - loss: 1.5487e-04 - mean\_absolute\_error: 0.0095 46/126 [=========>....................] - ETA: 0s - loss: 1.5594e-04 - mean\_absolute\_error: 0.0094 70/126 [===============>..............] - ETA: 0s - loss: 1.5889e-04 - mean\_absolute\_error: 0.0094 97/126 [======================>.......] - ETA: 0s - loss: 1.5451e-04 - mean\_absolute\_error: 0.0094123/126 [============================>.] - ETA: 0s - loss: 1.5630e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5526e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.9472e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0844e-04 - mean\_absolute\_error: 0.0116 25/126 [====>.........................] - ETA: 0s - loss: 1.4828e-04 - mean\_absolute\_error: 0.0094 52/126 [===========>..................] - ETA: 0s - loss: 1.5192e-04 - mean\_absolute\_error: 0.0094 79/126 [=================>............] - ETA: 0s - loss: 1.5459e-04 - mean\_absolute\_error: 0.0093105/126 [========================>.....] - ETA: 0s - loss: 1.4841e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5342e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.9570e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7327e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 1.7461e-04 - mean\_absolute\_error: 0.0091 49/126 [==========>...................] - ETA: 0s - loss: 1.5541e-04 - mean\_absolute\_error: 0.0091 72/126 [================>.............] - ETA: 0s - loss: 1.5152e-04 - mean\_absolute\_error: 0.0091 99/126 [======================>.......] - ETA: 0s - loss: 1.4992e-04 - mean\_absolute\_error: 0.0091125/126 [============================>.] - ETA: 0s - loss: 1.5148e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5171e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9798e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2531e-04 - mean\_absolute\_error: 0.0092 19/126 [===>..........................] - ETA: 0s - loss: 1.9469e-04 - mean\_absolute\_error: 0.0092 45/126 [=========>....................] - ETA: 0s - loss: 1.5632e-04 - mean\_absolute\_error: 0.0090 67/126 [==============>...............] - ETA: 0s - loss: 1.5061e-04 - mean\_absolute\_error: 0.0090 94/126 [=====================>........] - ETA: 0s - loss: 1.5087e-04 - mean\_absolute\_error: 0.0091120/126 [===========================>..] - ETA: 0s - loss: 1.5195e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5171e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.2485e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2936e-04 - mean\_absolute\_error: 0.0093 22/126 [====>.........................] - ETA: 0s - loss: 1.6737e-04 - mean\_absolute\_error: 0.0093 47/126 [==========>...................] - ETA: 0s - loss: 1.7362e-04 - mean\_absolute\_error: 0.0099 74/126 [================>.............] - ETA: 0s - loss: 1.6488e-04 - mean\_absolute\_error: 0.0097 99/126 [======================>.......] - ETA: 0s - loss: 1.6916e-04 - mean\_absolute\_error: 0.0098124/126 [============================>.] - ETA: 0s - loss: 1.6445e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 2ms/step - loss: 1.6353e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.1855e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0135e-04 - mean\_absolute\_error: 0.0098 24/126 [====>.........................] - ETA: 0s - loss: 1.5034e-04 - mean\_absolute\_error: 0.0093 50/126 [==========>...................] - ETA: 0s - loss: 1.4369e-04 - mean\_absolute\_error: 0.0091 77/126 [=================>............] - ETA: 0s - loss: 1.4751e-04 - mean\_absolute\_error: 0.0091 99/126 [======================>.......] - ETA: 0s - loss: 1.4763e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - ETA: 0s - loss: 1.5196e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5196e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 6.4939e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4562e-04 - mean\_absolute\_error: 0.0134 25/126 [====>.........................] - ETA: 0s - loss: 1.7313e-04 - mean\_absolute\_error: 0.0092 49/126 [==========>...................] - ETA: 0s - loss: 1.5860e-04 - mean\_absolute\_error: 0.0091 76/126 [=================>............] - ETA: 0s - loss: 1.5815e-04 - mean\_absolute\_error: 0.0092100/126 [======================>.......] - ETA: 0s - loss: 1.5506e-04 - mean\_absolute\_error: 0.0092123/126 [============================>.] - ETA: 0s - loss: 1.5306e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5350e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.2518e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5523e-04 - mean\_absolute\_error: 0.0091 26/126 [=====>........................] - ETA: 0s - loss: 1.4474e-04 - mean\_absolute\_error: 0.0092 53/126 [===========>..................] - ETA: 0s - loss: 1.5728e-04 - mean\_absolute\_error: 0.0091 79/126 [=================>............] - ETA: 0s - loss: 1.5639e-04 - mean\_absolute\_error: 0.0092100/126 [======================>.......] - ETA: 0s - loss: 1.5726e-04 - mean\_absolute\_error: 0.0093125/126 [============================>.] - ETA: 0s - loss: 1.5545e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5579e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.0582e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1899e-04 - mean\_absolute\_error: 0.0087 26/126 [=====>........................] - ETA: 0s - loss: 1.5378e-04 - mean\_absolute\_error: 0.0097 53/126 [===========>..................] - ETA: 0s - loss: 1.5884e-04 - mean\_absolute\_error: 0.0095 78/126 [=================>............] - ETA: 0s - loss: 1.6087e-04 - mean\_absolute\_error: 0.0094104/126 [=======================>......] - ETA: 0s - loss: 1.5556e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5398e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.8060e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1556e-04 - mean\_absolute\_error: 0.0086 24/126 [====>.........................] - ETA: 0s - loss: 1.4193e-04 - mean\_absolute\_error: 0.0090 51/126 [===========>..................] - ETA: 0s - loss: 1.3865e-04 - mean\_absolute\_error: 0.0089 78/126 [=================>............] - ETA: 0s - loss: 1.4265e-04 - mean\_absolute\_error: 0.0091103/126 [=======================>......] - ETA: 0s - loss: 1.5184e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5156e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.9513e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4147e-04 - mean\_absolute\_error: 0.0080 21/126 [====>.........................] - ETA: 0s - loss: 1.3639e-04 - mean\_absolute\_error: 0.0088 48/126 [==========>...................] - ETA: 0s - loss: 1.3802e-04 - mean\_absolute\_error: 0.0090 74/126 [================>.............] - ETA: 0s - loss: 1.4350e-04 - mean\_absolute\_error: 0.0091100/126 [======================>.......] - ETA: 0s - loss: 1.4691e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - ETA: 0s - loss: 1.5288e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5288e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 4.9874e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3768e-04 - mean\_absolute\_error: 0.0078 26/126 [=====>........................] - ETA: 0s - loss: 1.4237e-04 - mean\_absolute\_error: 0.0092 53/126 [===========>..................] - ETA: 0s - loss: 1.4506e-04 - mean\_absolute\_error: 0.0092 79/126 [=================>............] - ETA: 0s - loss: 1.4756e-04 - mean\_absolute\_error: 0.0092106/126 [========================>.....] - ETA: 0s - loss: 1.4598e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.5121e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 7.1507e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7132e-04 - mean\_absolute\_error: 0.0102 22/126 [====>.........................] - ETA: 0s - loss: 1.9303e-04 - mean\_absolute\_error: 0.0100 44/126 [=========>....................] - ETA: 0s - loss: 1.7315e-04 - mean\_absolute\_error: 0.0097 71/126 [===============>..............] - ETA: 0s - loss: 1.5769e-04 - mean\_absolute\_error: 0.0094 98/126 [======================>.......] - ETA: 0s - loss: 1.5785e-04 - mean\_absolute\_error: 0.0093124/126 [============================>.] - ETA: 0s - loss: 1.5568e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5586e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.1546e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0839e-04 - mean\_absolute\_error: 0.0081 20/126 [===>..........................] - ETA: 0s - loss: 1.3047e-04 - mean\_absolute\_error: 0.0090 41/126 [========>.....................] - ETA: 0s - loss: 1.3780e-04 - mean\_absolute\_error: 0.0090 65/126 [==============>...............] - ETA: 0s - loss: 1.3837e-04 - mean\_absolute\_error: 0.0090 91/126 [====================>.........] - ETA: 0s - loss: 1.3991e-04 - mean\_absolute\_error: 0.0091116/126 [==========================>...] - ETA: 0s - loss: 1.4978e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4926e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9277e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8120e-05 - mean\_absolute\_error: 0.0072 25/126 [====>.........................] - ETA: 0s - loss: 1.5384e-04 - mean\_absolute\_error: 0.0094 50/126 [==========>...................] - ETA: 0s - loss: 1.6959e-04 - mean\_absolute\_error: 0.0097 75/126 [================>.............] - ETA: 0s - loss: 1.6538e-04 - mean\_absolute\_error: 0.0096102/126 [=======================>......] - ETA: 0s - loss: 1.5920e-04 - mean\_absolute\_error: 0.0095125/126 [============================>.] - ETA: 0s - loss: 1.6159e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.6144e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.2381e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6775e-04 - mean\_absolute\_error: 0.0099 25/126 [====>.........................] - ETA: 0s - loss: 1.5859e-04 - mean\_absolute\_error: 0.0091 50/126 [==========>...................] - ETA: 0s - loss: 1.5922e-04 - mean\_absolute\_error: 0.0094 74/126 [================>.............] - ETA: 0s - loss: 1.6046e-04 - mean\_absolute\_error: 0.0094100/126 [======================>.......] - ETA: 0s - loss: 1.5391e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4942e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.0004e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0487e-04 - mean\_absolute\_error: 0.0073 19/126 [===>..........................] - ETA: 0s - loss: 1.2395e-04 - mean\_absolute\_error: 0.0085 44/126 [=========>....................] - ETA: 0s - loss: 1.3364e-04 - mean\_absolute\_error: 0.0088 67/126 [==============>...............] - ETA: 0s - loss: 1.5445e-04 - mean\_absolute\_error: 0.0091 93/126 [=====================>........] - ETA: 0s - loss: 1.5020e-04 - mean\_absolute\_error: 0.0091118/126 [===========================>..] - ETA: 0s - loss: 1.4854e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4615e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.5431e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0715e-04 - mean\_absolute\_error: 0.0088 25/126 [====>.........................] - ETA: 0s - loss: 1.5720e-04 - mean\_absolute\_error: 0.0089 52/126 [===========>..................] - ETA: 0s - loss: 1.5521e-04 - mean\_absolute\_error: 0.0090 78/126 [=================>............] - ETA: 0s - loss: 1.5423e-04 - mean\_absolute\_error: 0.0091103/126 [=======================>......] - ETA: 0s - loss: 1.4680e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4414e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.1005e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7346e-05 - mean\_absolute\_error: 0.0073 26/126 [=====>........................] - ETA: 0s - loss: 1.4750e-04 - mean\_absolute\_error: 0.0092 52/126 [===========>..................] - ETA: 0s - loss: 1.4044e-04 - mean\_absolute\_error: 0.0090 77/126 [=================>............] - ETA: 0s - loss: 1.4756e-04 - mean\_absolute\_error: 0.0091100/126 [======================>.......] - ETA: 0s - loss: 1.4566e-04 - mean\_absolute\_error: 0.0091125/126 [============================>.] - ETA: 0s - loss: 1.4854e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4852e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.1100e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7130e-05 - mean\_absolute\_error: 0.0071 26/126 [=====>........................] - ETA: 0s - loss: 1.2939e-04 - mean\_absolute\_error: 0.0087 51/126 [===========>..................] - ETA: 0s - loss: 1.3892e-04 - mean\_absolute\_error: 0.0090 76/126 [=================>............] - ETA: 0s - loss: 1.4163e-04 - mean\_absolute\_error: 0.0089100/126 [======================>.......] - ETA: 0s - loss: 1.4904e-04 - mean\_absolute\_error: 0.0091124/126 [============================>.] - ETA: 0s - loss: 1.5017e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.5012e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.9080e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0003e-04 - mean\_absolute\_error: 0.0079 25/126 [====>.........................] - ETA: 0s - loss: 1.4027e-04 - mean\_absolute\_error: 0.0091 50/126 [==========>...................] - ETA: 0s - loss: 1.5265e-04 - mean\_absolute\_error: 0.0092 74/126 [================>.............] - ETA: 0s - loss: 1.5515e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.5992e-04 - mean\_absolute\_error: 0.0094124/126 [============================>.] - ETA: 0s - loss: 1.5798e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.5832e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.1234e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2794e-04 - mean\_absolute\_error: 0.0116 26/126 [=====>........................] - ETA: 0s - loss: 1.6436e-04 - mean\_absolute\_error: 0.0092 51/126 [===========>..................] - ETA: 0s - loss: 1.4576e-04 - mean\_absolute\_error: 0.0090 77/126 [=================>............] - ETA: 0s - loss: 1.4794e-04 - mean\_absolute\_error: 0.0091102/126 [=======================>......] - ETA: 0s - loss: 1.4878e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5795e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0605e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4226e-05 - mean\_absolute\_error: 0.0075 26/126 [=====>........................] - ETA: 0s - loss: 1.9357e-04 - mean\_absolute\_error: 0.0103 51/126 [===========>..................] - ETA: 0s - loss: 1.7779e-04 - mean\_absolute\_error: 0.0098 76/126 [=================>............] - ETA: 0s - loss: 1.6270e-04 - mean\_absolute\_error: 0.0094101/126 [=======================>......] - ETA: 0s - loss: 1.5607e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - ETA: 0s - loss: 1.5200e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5200e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9642e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3048e-04 - mean\_absolute\_error: 0.0088 26/126 [=====>........................] - ETA: 0s - loss: 1.3181e-04 - mean\_absolute\_error: 0.0089 51/126 [===========>..................] - ETA: 0s - loss: 1.4461e-04 - mean\_absolute\_error: 0.0089 76/126 [=================>............] - ETA: 0s - loss: 1.4993e-04 - mean\_absolute\_error: 0.0090101/126 [=======================>......] - ETA: 0s - loss: 1.4473e-04 - mean\_absolute\_error: 0.0089125/126 [============================>.] - ETA: 0s - loss: 1.4674e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4663e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.9628e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4387e-04 - mean\_absolute\_error: 0.0088 26/126 [=====>........................] - ETA: 0s - loss: 1.5353e-04 - mean\_absolute\_error: 0.0091 50/126 [==========>...................] - ETA: 0s - loss: 1.5121e-04 - mean\_absolute\_error: 0.0092 75/126 [================>.............] - ETA: 0s - loss: 1.5976e-04 - mean\_absolute\_error: 0.0095100/126 [======================>.......] - ETA: 0s - loss: 1.5864e-04 - mean\_absolute\_error: 0.0095124/126 [============================>.] - ETA: 0s - loss: 1.5922e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.5882e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 6.8488e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0386e-04 - mean\_absolute\_error: 0.0084 26/126 [=====>........................] - ETA: 0s - loss: 1.5239e-04 - mean\_absolute\_error: 0.0096 49/126 [==========>...................] - ETA: 0s - loss: 1.6751e-04 - mean\_absolute\_error: 0.0099 73/126 [================>.............] - ETA: 0s - loss: 1.5532e-04 - mean\_absolute\_error: 0.0095 98/126 [======================>.......] - ETA: 0s - loss: 1.6152e-04 - mean\_absolute\_error: 0.0095123/126 [============================>.] - ETA: 0s - loss: 1.6076e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.6119e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 6.8432e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9908e-04 - mean\_absolute\_error: 0.0110 25/126 [====>.........................] - ETA: 0s - loss: 1.6961e-04 - mean\_absolute\_error: 0.0093 48/126 [==========>...................] - ETA: 0s - loss: 1.6103e-04 - mean\_absolute\_error: 0.0093 71/126 [===============>..............] - ETA: 0s - loss: 1.7273e-04 - mean\_absolute\_error: 0.0099 95/126 [=====================>........] - ETA: 0s - loss: 1.7240e-04 - mean\_absolute\_error: 0.0099119/126 [===========================>..] - ETA: 0s - loss: 1.7565e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7387e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 5.0669e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4302e-04 - mean\_absolute\_error: 0.0087 26/126 [=====>........................] - ETA: 0s - loss: 1.5940e-04 - mean\_absolute\_error: 0.0093 51/126 [===========>..................] - ETA: 0s - loss: 1.4975e-04 - mean\_absolute\_error: 0.0092 76/126 [=================>............] - ETA: 0s - loss: 1.5198e-04 - mean\_absolute\_error: 0.0093100/126 [======================>.......] - ETA: 0s - loss: 1.5087e-04 - mean\_absolute\_error: 0.0093125/126 [============================>.] - ETA: 0s - loss: 1.5636e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5630e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 7.5528e-05 - val\_mean\_absolute\_error: 0.0071  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1679e-04 - mean\_absolute\_error: 0.0088 25/126 [====>.........................] - ETA: 0s - loss: 1.3112e-04 - mean\_absolute\_error: 0.0087 50/126 [==========>...................] - ETA: 0s - loss: 1.4445e-04 - mean\_absolute\_error: 0.0092 72/126 [================>.............] - ETA: 0s - loss: 1.4908e-04 - mean\_absolute\_error: 0.0091 96/126 [=====================>........] - ETA: 0s - loss: 1.5351e-04 - mean\_absolute\_error: 0.0091120/126 [===========================>..] - ETA: 0s - loss: 1.5384e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5323e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.5039e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3335e-04 - mean\_absolute\_error: 0.0091 26/126 [=====>........................] - ETA: 0s - loss: 1.5899e-04 - mean\_absolute\_error: 0.0097 51/126 [===========>..................] - ETA: 0s - loss: 1.6176e-04 - mean\_absolute\_error: 0.0095 74/126 [================>.............] - ETA: 0s - loss: 1.5505e-04 - mean\_absolute\_error: 0.0093 99/126 [======================>.......] - ETA: 0s - loss: 1.4813e-04 - mean\_absolute\_error: 0.0091123/126 [============================>.] - ETA: 0s - loss: 1.6299e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.6335e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0844e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1953e-04 - mean\_absolute\_error: 0.0090 25/126 [====>.........................] - ETA: 0s - loss: 1.4776e-04 - mean\_absolute\_error: 0.0089 50/126 [==========>...................] - ETA: 0s - loss: 1.6068e-04 - mean\_absolute\_error: 0.0096 75/126 [================>.............] - ETA: 0s - loss: 1.5896e-04 - mean\_absolute\_error: 0.0096100/126 [======================>.......] - ETA: 0s - loss: 1.5265e-04 - mean\_absolute\_error: 0.0094125/126 [============================>.] - ETA: 0s - loss: 1.5563e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5560e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 8.0196e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4306e-05 - mean\_absolute\_error: 0.0069 25/126 [====>.........................] - ETA: 0s - loss: 1.5238e-04 - mean\_absolute\_error: 0.0096 50/126 [==========>...................] - ETA: 0s - loss: 2.0410e-04 - mean\_absolute\_error: 0.0113 75/126 [================>.............] - ETA: 0s - loss: 1.8990e-04 - mean\_absolute\_error: 0.0107 99/126 [======================>.......] - ETA: 0s - loss: 1.7892e-04 - mean\_absolute\_error: 0.0103122/126 [============================>.] - ETA: 0s - loss: 1.7588e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7477e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 6.0615e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7113e-04 - mean\_absolute\_error: 0.0102 26/126 [=====>........................] - ETA: 0s - loss: 1.5706e-04 - mean\_absolute\_error: 0.0098 51/126 [===========>..................] - ETA: 0s - loss: 1.4810e-04 - mean\_absolute\_error: 0.0094 76/126 [=================>............] - ETA: 0s - loss: 1.6618e-04 - mean\_absolute\_error: 0.0098100/126 [======================>.......] - ETA: 0s - loss: 1.6036e-04 - mean\_absolute\_error: 0.0097122/126 [============================>.] - ETA: 0s - loss: 1.6495e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 2ms/step - loss: 1.6410e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.1596e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3177e-05 - mean\_absolute\_error: 0.0072 26/126 [=====>........................] - ETA: 0s - loss: 1.8352e-04 - mean\_absolute\_error: 0.0102 52/126 [===========>..................] - ETA: 0s - loss: 1.9299e-04 - mean\_absolute\_error: 0.0104 77/126 [=================>............] - ETA: 0s - loss: 1.6869e-04 - mean\_absolute\_error: 0.0098102/126 [=======================>......] - ETA: 0s - loss: 1.6518e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 2ms/step - loss: 1.6036e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 8.0531e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8150e-04 - mean\_absolute\_error: 0.0119 26/126 [=====>........................] - ETA: 0s - loss: 1.7353e-04 - mean\_absolute\_error: 0.0101 51/126 [===========>..................] - ETA: 0s - loss: 2.0224e-04 - mean\_absolute\_error: 0.0110 76/126 [=================>............] - ETA: 0s - loss: 1.9520e-04 - mean\_absolute\_error: 0.0107101/126 [=======================>......] - ETA: 0s - loss: 1.8664e-04 - mean\_absolute\_error: 0.0103126/126 [==============================] - ETA: 0s - loss: 1.7688e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7688e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 7.3738e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6402e-04 - mean\_absolute\_error: 0.0102 26/126 [=====>........................] - ETA: 0s - loss: 1.4153e-04 - mean\_absolute\_error: 0.0093 51/126 [===========>..................] - ETA: 0s - loss: 1.4313e-04 - mean\_absolute\_error: 0.0092 75/126 [================>.............] - ETA: 0s - loss: 1.4894e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.6242e-04 - mean\_absolute\_error: 0.0096124/126 [============================>.] - ETA: 0s - loss: 1.6158e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 2ms/step - loss: 1.6129e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 8.7711e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3471e-04 - mean\_absolute\_error: 0.0094 25/126 [====>.........................] - ETA: 0s - loss: 1.4532e-04 - mean\_absolute\_error: 0.0091 50/126 [==========>...................] - ETA: 0s - loss: 1.6286e-04 - mean\_absolute\_error: 0.0097 75/126 [================>.............] - ETA: 0s - loss: 1.6108e-04 - mean\_absolute\_error: 0.0095100/126 [======================>.......] - ETA: 0s - loss: 1.6347e-04 - mean\_absolute\_error: 0.0096124/126 [============================>.] - ETA: 0s - loss: 1.5770e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5729e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.8846e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3914e-04 - mean\_absolute\_error: 0.0089 26/126 [=====>........................] - ETA: 0s - loss: 1.4089e-04 - mean\_absolute\_error: 0.0090 51/126 [===========>..................] - ETA: 0s - loss: 1.3615e-04 - mean\_absolute\_error: 0.0089 76/126 [=================>............] - ETA: 0s - loss: 1.6373e-04 - mean\_absolute\_error: 0.0096101/126 [=======================>......] - ETA: 0s - loss: 1.7610e-04 - mean\_absolute\_error: 0.0100125/126 [============================>.] - ETA: 0s - loss: 1.7247e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 2ms/step - loss: 1.7257e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 1.1838e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7553e-04 - mean\_absolute\_error: 0.0105 26/126 [=====>........................] - ETA: 0s - loss: 1.3309e-04 - mean\_absolute\_error: 0.0089 49/126 [==========>...................] - ETA: 0s - loss: 1.4651e-04 - mean\_absolute\_error: 0.0092 74/126 [================>.............] - ETA: 0s - loss: 1.5808e-04 - mean\_absolute\_error: 0.0093 99/126 [======================>.......] - ETA: 0s - loss: 1.6194e-04 - mean\_absolute\_error: 0.0095124/126 [============================>.] - ETA: 0s - loss: 1.6279e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 2ms/step - loss: 1.6265e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 1.1967e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3899e-04 - mean\_absolute\_error: 0.0127 26/126 [=====>........................] - ETA: 0s - loss: 1.6732e-04 - mean\_absolute\_error: 0.0101 50/126 [==========>...................] - ETA: 0s - loss: 1.5588e-04 - mean\_absolute\_error: 0.0094 74/126 [================>.............] - ETA: 0s - loss: 1.5460e-04 - mean\_absolute\_error: 0.0094 98/126 [======================>.......] - ETA: 0s - loss: 1.5017e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.5292e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5169e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 6.7242e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3952e-05 - mean\_absolute\_error: 0.0069 26/126 [=====>........................] - ETA: 0s - loss: 1.5313e-04 - mean\_absolute\_error: 0.0090 51/126 [===========>..................] - ETA: 0s - loss: 1.4541e-04 - mean\_absolute\_error: 0.0090 76/126 [=================>............] - ETA: 0s - loss: 1.4412e-04 - mean\_absolute\_error: 0.0091100/126 [======================>.......] - ETA: 0s - loss: 1.4748e-04 - mean\_absolute\_error: 0.0092124/126 [============================>.] - ETA: 0s - loss: 1.4943e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.4934e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 9.0455e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8978e-04 - mean\_absolute\_error: 0.0112 24/126 [====>.........................] - ETA: 0s - loss: 1.6392e-04 - mean\_absolute\_error: 0.0099 49/126 [==========>...................] - ETA: 0s - loss: 1.8267e-04 - mean\_absolute\_error: 0.0106 74/126 [================>.............] - ETA: 0s - loss: 1.8121e-04 - mean\_absolute\_error: 0.0103 97/126 [======================>.......] - ETA: 0s - loss: 1.7067e-04 - mean\_absolute\_error: 0.0100121/126 [===========================>..] - ETA: 0s - loss: 1.6157e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 2ms/step - loss: 1.6490e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.2240e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1446e-04 - mean\_absolute\_error: 0.0084 25/126 [====>.........................] - ETA: 0s - loss: 1.5319e-04 - mean\_absolute\_error: 0.0096 50/126 [==========>...................] - ETA: 0s - loss: 1.5488e-04 - mean\_absolute\_error: 0.0092 75/126 [================>.............] - ETA: 0s - loss: 1.4993e-04 - mean\_absolute\_error: 0.0093 98/126 [======================>.......] - ETA: 0s - loss: 1.4622e-04 - mean\_absolute\_error: 0.0091123/126 [============================>.] - ETA: 0s - loss: 1.4796e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.4757e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 1.2033e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0473e-04 - mean\_absolute\_error: 0.0119 26/126 [=====>........................] - ETA: 0s - loss: 1.5007e-04 - mean\_absolute\_error: 0.0092 52/126 [===========>..................] - ETA: 0s - loss: 1.4163e-04 - mean\_absolute\_error: 0.0090 78/126 [=================>............] - ETA: 0s - loss: 1.3674e-04 - mean\_absolute\_error: 0.0089103/126 [=======================>......] - ETA: 0s - loss: 1.4992e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5911e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.0329e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3398e-04 - mean\_absolute\_error: 0.0125 26/126 [=====>........................] - ETA: 0s - loss: 1.7748e-04 - mean\_absolute\_error: 0.0102 52/126 [===========>..................] - ETA: 0s - loss: 1.6992e-04 - mean\_absolute\_error: 0.0098 78/126 [=================>............] - ETA: 0s - loss: 1.9507e-04 - mean\_absolute\_error: 0.0105103/126 [=======================>......] - ETA: 0s - loss: 1.8070e-04 - mean\_absolute\_error: 0.0102125/126 [============================>.] - ETA: 0s - loss: 1.7544e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7573e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 5.7437e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8454e-04 - mean\_absolute\_error: 0.0116 26/126 [=====>........................] - ETA: 0s - loss: 1.7726e-04 - mean\_absolute\_error: 0.0103 51/126 [===========>..................] - ETA: 0s - loss: 1.6681e-04 - mean\_absolute\_error: 0.0097 76/126 [=================>............] - ETA: 0s - loss: 1.5666e-04 - mean\_absolute\_error: 0.0094101/126 [=======================>......] - ETA: 0s - loss: 1.6120e-04 - mean\_absolute\_error: 0.0096123/126 [============================>.] - ETA: 0s - loss: 1.6439e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 2ms/step - loss: 1.6473e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 7.9204e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1386e-04 - mean\_absolute\_error: 0.0089 25/126 [====>.........................] - ETA: 0s - loss: 2.2583e-04 - mean\_absolute\_error: 0.0111 49/126 [==========>...................] - ETA: 0s - loss: 2.0370e-04 - mean\_absolute\_error: 0.0108 74/126 [================>.............] - ETA: 0s - loss: 1.8069e-04 - mean\_absolute\_error: 0.0102 99/126 [======================>.......] - ETA: 0s - loss: 1.6845e-04 - mean\_absolute\_error: 0.0099124/126 [============================>.] - ETA: 0s - loss: 1.6183e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 2ms/step - loss: 1.6233e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.8052e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0591e-04 - mean\_absolute\_error: 0.0104 26/126 [=====>........................] - ETA: 0s - loss: 1.6648e-04 - mean\_absolute\_error: 0.0100 51/126 [===========>..................] - ETA: 0s - loss: 1.5076e-04 - mean\_absolute\_error: 0.0094 76/126 [=================>............] - ETA: 0s - loss: 1.4598e-04 - mean\_absolute\_error: 0.0093101/126 [=======================>......] - ETA: 0s - loss: 1.5994e-04 - mean\_absolute\_error: 0.0095125/126 [============================>.] - ETA: 0s - loss: 1.6651e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 2ms/step - loss: 1.6672e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 5.6847e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 7.2283e-05 - mean\_absolute\_error: 0.0070 24/126 [====>.........................] - ETA: 0s - loss: 1.9637e-04 - mean\_absolute\_error: 0.0099 49/126 [==========>...................] - ETA: 0s - loss: 1.5515e-04 - mean\_absolute\_error: 0.0091 74/126 [================>.............] - ETA: 0s - loss: 1.5306e-04 - mean\_absolute\_error: 0.0091 99/126 [======================>.......] - ETA: 0s - loss: 1.4842e-04 - mean\_absolute\_error: 0.0090124/126 [============================>.] - ETA: 0s - loss: 1.5387e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5372e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.9116e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4028e-04 - mean\_absolute\_error: 0.0087 24/126 [====>.........................] - ETA: 0s - loss: 1.2529e-04 - mean\_absolute\_error: 0.0085 50/126 [==========>...................] - ETA: 0s - loss: 1.3564e-04 - mean\_absolute\_error: 0.0086 76/126 [=================>............] - ETA: 0s - loss: 1.3945e-04 - mean\_absolute\_error: 0.0087101/126 [=======================>......] - ETA: 0s - loss: 1.3937e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - ETA: 0s - loss: 1.5347e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5347e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 1.0744e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5682e-04 - mean\_absolute\_error: 0.0104 26/126 [=====>........................] - ETA: 0s - loss: 1.6286e-04 - mean\_absolute\_error: 0.0099 52/126 [===========>..................] - ETA: 0s - loss: 1.9712e-04 - mean\_absolute\_error: 0.0106 77/126 [=================>............] - ETA: 0s - loss: 1.7981e-04 - mean\_absolute\_error: 0.0101103/126 [=======================>......] - ETA: 0s - loss: 1.6688e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 2ms/step - loss: 1.6468e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.0499e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8710e-05 - mean\_absolute\_error: 0.0084 26/126 [=====>........................] - ETA: 0s - loss: 1.1769e-04 - mean\_absolute\_error: 0.0083 50/126 [==========>...................] - ETA: 0s - loss: 1.2446e-04 - mean\_absolute\_error: 0.0086 73/126 [================>.............] - ETA: 0s - loss: 1.2406e-04 - mean\_absolute\_error: 0.0086 98/126 [======================>.......] - ETA: 0s - loss: 1.2703e-04 - mean\_absolute\_error: 0.0086122/126 [============================>.] - ETA: 0s - loss: 1.6070e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.6198e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 1.4548e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1084e-04 - mean\_absolute\_error: 0.0149 25/126 [====>.........................] - ETA: 0s - loss: 1.5106e-04 - mean\_absolute\_error: 0.0093 50/126 [==========>...................] - ETA: 0s - loss: 1.4511e-04 - mean\_absolute\_error: 0.0089 72/126 [================>.............] - ETA: 0s - loss: 1.4478e-04 - mean\_absolute\_error: 0.0090 95/126 [=====================>........] - ETA: 0s - loss: 1.3721e-04 - mean\_absolute\_error: 0.0087119/126 [===========================>..] - ETA: 0s - loss: 1.4995e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5398e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 1.1380e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4116e-04 - mean\_absolute\_error: 0.0142 26/126 [=====>........................] - ETA: 0s - loss: 2.2529e-04 - mean\_absolute\_error: 0.0115 50/126 [==========>...................] - ETA: 0s - loss: 2.1015e-04 - mean\_absolute\_error: 0.0112 75/126 [================>.............] - ETA: 0s - loss: 1.8668e-04 - mean\_absolute\_error: 0.0104100/126 [======================>.......] - ETA: 0s - loss: 1.7583e-04 - mean\_absolute\_error: 0.0101124/126 [============================>.] - ETA: 0s - loss: 1.7721e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 2ms/step - loss: 1.7634e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 9.1709e-05 - val\_mean\_absolute\_error: 0.0079  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1931e-04 - mean\_absolute\_error: 0.0087 26/126 [=====>........................] - ETA: 0s - loss: 1.5075e-04 - mean\_absolute\_error: 0.0090 51/126 [===========>..................] - ETA: 0s - loss: 1.4606e-04 - mean\_absolute\_error: 0.0091 76/126 [=================>............] - ETA: 0s - loss: 1.4708e-04 - mean\_absolute\_error: 0.0092 97/126 [======================>.......] - ETA: 0s - loss: 1.6834e-04 - mean\_absolute\_error: 0.0098121/126 [===========================>..] - ETA: 0s - loss: 1.7679e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 2ms/step - loss: 1.7602e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 8.4018e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3960e-04 - mean\_absolute\_error: 0.0098 25/126 [====>.........................] - ETA: 0s - loss: 1.1901e-04 - mean\_absolute\_error: 0.0086 50/126 [==========>...................] - ETA: 0s - loss: 1.3748e-04 - mean\_absolute\_error: 0.0089 75/126 [================>.............] - ETA: 0s - loss: 1.2904e-04 - mean\_absolute\_error: 0.0086 97/126 [======================>.......] - ETA: 0s - loss: 1.3047e-04 - mean\_absolute\_error: 0.0087121/126 [===========================>..] - ETA: 0s - loss: 1.3740e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3731e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 6.6012e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3838e-04 - mean\_absolute\_error: 0.0092 26/126 [=====>........................] - ETA: 0s - loss: 1.2602e-04 - mean\_absolute\_error: 0.0085 49/126 [==========>...................] - ETA: 0s - loss: 1.2924e-04 - mean\_absolute\_error: 0.0087 72/126 [================>.............] - ETA: 0s - loss: 1.3055e-04 - mean\_absolute\_error: 0.0088 97/126 [======================>.......] - ETA: 0s - loss: 1.2819e-04 - mean\_absolute\_error: 0.0087122/126 [============================>.] - ETA: 0s - loss: 1.5008e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5155e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 2.3298e-04 - val\_mean\_absolute\_error: 0.0137  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6811e-04 - mean\_absolute\_error: 0.0167 25/126 [====>.........................] - ETA: 0s - loss: 2.1051e-04 - mean\_absolute\_error: 0.0110 50/126 [==========>...................] - ETA: 0s - loss: 1.7886e-04 - mean\_absolute\_error: 0.0102 76/126 [=================>............] - ETA: 0s - loss: 1.7488e-04 - mean\_absolute\_error: 0.0100101/126 [=======================>......] - ETA: 0s - loss: 1.7237e-04 - mean\_absolute\_error: 0.0100123/126 [============================>.] - ETA: 0s - loss: 1.7179e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7152e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 1.0784e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1597e-04 - mean\_absolute\_error: 0.0149 26/126 [=====>........................] - ETA: 0s - loss: 1.5428e-04 - mean\_absolute\_error: 0.0096 51/126 [===========>..................] - ETA: 0s - loss: 1.7049e-04 - mean\_absolute\_error: 0.0098 76/126 [=================>............] - ETA: 0s - loss: 1.5776e-04 - mean\_absolute\_error: 0.0095101/126 [=======================>......] - ETA: 0s - loss: 1.6193e-04 - mean\_absolute\_error: 0.0095124/126 [============================>.] - ETA: 0s - loss: 1.5889e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.5857e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.6721e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6174e-04 - mean\_absolute\_error: 0.0086 24/126 [====>.........................] - ETA: 0s - loss: 1.9134e-04 - mean\_absolute\_error: 0.0111 49/126 [==========>...................] - ETA: 0s - loss: 1.6224e-04 - mean\_absolute\_error: 0.0099 73/126 [================>.............] - ETA: 0s - loss: 1.6245e-04 - mean\_absolute\_error: 0.0096 98/126 [======================>.......] - ETA: 0s - loss: 1.7435e-04 - mean\_absolute\_error: 0.0100122/126 [============================>.] - ETA: 0s - loss: 1.7561e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 2ms/step - loss: 1.7542e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 4.6301e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7202e-05 - mean\_absolute\_error: 0.0082 26/126 [=====>........................] - ETA: 0s - loss: 1.1784e-04 - mean\_absolute\_error: 0.0083 51/126 [===========>..................] - ETA: 0s - loss: 1.3936e-04 - mean\_absolute\_error: 0.0088 76/126 [=================>............] - ETA: 0s - loss: 1.3479e-04 - mean\_absolute\_error: 0.0088101/126 [=======================>......] - ETA: 0s - loss: 1.4332e-04 - mean\_absolute\_error: 0.0089125/126 [============================>.] - ETA: 0s - loss: 1.4329e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4333e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.0916e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6273e-04 - mean\_absolute\_error: 0.0107 23/126 [====>.........................] - ETA: 0s - loss: 1.5433e-04 - mean\_absolute\_error: 0.0096 48/126 [==========>...................] - ETA: 0s - loss: 1.6015e-04 - mean\_absolute\_error: 0.0095 73/126 [================>.............] - ETA: 0s - loss: 1.5912e-04 - mean\_absolute\_error: 0.0096 97/126 [======================>.......] - ETA: 0s - loss: 1.5712e-04 - mean\_absolute\_error: 0.0095122/126 [============================>.] - ETA: 0s - loss: 1.5435e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5470e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.7153e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5882e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 1.2462e-04 - mean\_absolute\_error: 0.0087 48/126 [==========>...................] - ETA: 0s - loss: 1.5005e-04 - mean\_absolute\_error: 0.0091 73/126 [================>.............] - ETA: 0s - loss: 1.4236e-04 - mean\_absolute\_error: 0.0090 98/126 [======================>.......] - ETA: 0s - loss: 1.5465e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.7339e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.7658e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 4.6363e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6928e-05 - mean\_absolute\_error: 0.0083 26/126 [=====>........................] - ETA: 0s - loss: 1.9038e-04 - mean\_absolute\_error: 0.0104 51/126 [===========>..................] - ETA: 0s - loss: 1.5603e-04 - mean\_absolute\_error: 0.0094 74/126 [================>.............] - ETA: 0s - loss: 1.4568e-04 - mean\_absolute\_error: 0.0091 99/126 [======================>.......] - ETA: 0s - loss: 1.4569e-04 - mean\_absolute\_error: 0.0090123/126 [============================>.] - ETA: 0s - loss: 1.4499e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 2ms/step - loss: 1.4434e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 6.2106e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6767e-04 - mean\_absolute\_error: 0.0101 26/126 [=====>........................] - ETA: 0s - loss: 1.4596e-04 - mean\_absolute\_error: 0.0092 49/126 [==========>...................] - ETA: 0s - loss: 1.3586e-04 - mean\_absolute\_error: 0.0090 73/126 [================>.............] - ETA: 0s - loss: 1.3949e-04 - mean\_absolute\_error: 0.0089 97/126 [======================>.......] - ETA: 0s - loss: 1.3327e-04 - mean\_absolute\_error: 0.0087122/126 [============================>.] - ETA: 0s - loss: 1.3556e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3580e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 7.1648e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4928e-04 - mean\_absolute\_error: 0.0094 26/126 [=====>........................] - ETA: 0s - loss: 1.4843e-04 - mean\_absolute\_error: 0.0088 50/126 [==========>...................] - ETA: 0s - loss: 1.4101e-04 - mean\_absolute\_error: 0.0088 72/126 [================>.............] - ETA: 0s - loss: 1.4593e-04 - mean\_absolute\_error: 0.0090 95/126 [=====================>........] - ETA: 0s - loss: 1.4315e-04 - mean\_absolute\_error: 0.0090120/126 [===========================>..] - ETA: 0s - loss: 1.3949e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 2ms/step - loss: 1.3774e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 5.2909e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4235e-04 - mean\_absolute\_error: 0.0088 25/126 [====>.........................] - ETA: 0s - loss: 1.7216e-04 - mean\_absolute\_error: 0.0097 50/126 [==========>...................] - ETA: 0s - loss: 1.6632e-04 - mean\_absolute\_error: 0.0097 75/126 [================>.............] - ETA: 0s - loss: 1.5884e-04 - mean\_absolute\_error: 0.0096 99/126 [======================>.......] - ETA: 0s - loss: 1.5853e-04 - mean\_absolute\_error: 0.0094124/126 [============================>.] - ETA: 0s - loss: 1.5410e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5448e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.7587e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5446e-05 - mean\_absolute\_error: 0.0071 26/126 [=====>........................] - ETA: 0s - loss: 1.6784e-04 - mean\_absolute\_error: 0.0103 52/126 [===========>..................] - ETA: 0s - loss: 1.8193e-04 - mean\_absolute\_error: 0.0107 78/126 [=================>............] - ETA: 0s - loss: 1.6698e-04 - mean\_absolute\_error: 0.0101101/126 [=======================>......] - ETA: 0s - loss: 1.6684e-04 - mean\_absolute\_error: 0.0101125/126 [============================>.] - ETA: 0s - loss: 1.6687e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 2ms/step - loss: 1.6661e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 7.0248e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1422e-04 - mean\_absolute\_error: 0.0107 26/126 [=====>........................] - ETA: 0s - loss: 1.5050e-04 - mean\_absolute\_error: 0.0088 51/126 [===========>..................] - ETA: 0s - loss: 1.4199e-04 - mean\_absolute\_error: 0.0087 77/126 [=================>............] - ETA: 0s - loss: 1.5640e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.5544e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.4718e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.4749e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 7.8418e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5038e-04 - mean\_absolute\_error: 0.0145 26/126 [=====>........................] - ETA: 0s - loss: 1.5057e-04 - mean\_absolute\_error: 0.0095 51/126 [===========>..................] - ETA: 0s - loss: 1.3971e-04 - mean\_absolute\_error: 0.0092 75/126 [================>.............] - ETA: 0s - loss: 1.4416e-04 - mean\_absolute\_error: 0.0092 99/126 [======================>.......] - ETA: 0s - loss: 1.4720e-04 - mean\_absolute\_error: 0.0092124/126 [============================>.] - ETA: 0s - loss: 1.4806e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 2ms/step - loss: 1.5004e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 8.1585e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3564e-04 - mean\_absolute\_error: 0.0115 26/126 [=====>........................] - ETA: 0s - loss: 1.3713e-04 - mean\_absolute\_error: 0.0088 51/126 [===========>..................] - ETA: 0s - loss: 1.4085e-04 - mean\_absolute\_error: 0.0089 76/126 [=================>............] - ETA: 0s - loss: 1.4645e-04 - mean\_absolute\_error: 0.0090101/126 [=======================>......] - ETA: 0s - loss: 1.3923e-04 - mean\_absolute\_error: 0.0088124/126 [============================>.] - ETA: 0s - loss: 1.3969e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 2ms/step - loss: 1.3972e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 4.5483e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5026e-05 - mean\_absolute\_error: 0.0074 26/126 [=====>........................] - ETA: 0s - loss: 9.9575e-05 - mean\_absolute\_error: 0.0074 51/126 [===========>..................] - ETA: 0s - loss: 1.1574e-04 - mean\_absolute\_error: 0.0079 77/126 [=================>............] - ETA: 0s - loss: 1.2450e-04 - mean\_absolute\_error: 0.0083101/126 [=======================>......] - ETA: 0s - loss: 1.3396e-04 - mean\_absolute\_error: 0.0086125/126 [============================>.] - ETA: 0s - loss: 1.3498e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3542e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 6.0740e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2074e-04 - mean\_absolute\_error: 0.0082 24/126 [====>.........................] - ETA: 0s - loss: 1.5215e-04 - mean\_absolute\_error: 0.0097 48/126 [==========>...................] - ETA: 0s - loss: 1.4529e-04 - mean\_absolute\_error: 0.0093 73/126 [================>.............] - ETA: 0s - loss: 1.3998e-04 - mean\_absolute\_error: 0.0091 98/126 [======================>.......] - ETA: 0s - loss: 1.4792e-04 - mean\_absolute\_error: 0.0093123/126 [============================>.] - ETA: 0s - loss: 1.5907e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.5869e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 6.8668e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1477e-04 - mean\_absolute\_error: 0.0086 26/126 [=====>........................] - ETA: 0s - loss: 1.4434e-04 - mean\_absolute\_error: 0.0093 52/126 [===========>..................] - ETA: 0s - loss: 1.5007e-04 - mean\_absolute\_error: 0.0092 77/126 [=================>............] - ETA: 0s - loss: 1.4724e-04 - mean\_absolute\_error: 0.0090102/126 [=======================>......] - ETA: 0s - loss: 1.4196e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 2ms/step - loss: 1.3833e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 9.6004e-05 - val\_mean\_absolute\_error: 0.0082  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4275e-04 - mean\_absolute\_error: 0.0097 23/126 [====>.........................] - ETA: 0s - loss: 1.4694e-04 - mean\_absolute\_error: 0.0094 48/126 [==========>...................] - ETA: 0s - loss: 1.5139e-04 - mean\_absolute\_error: 0.0096 74/126 [================>.............] - ETA: 0s - loss: 1.4669e-04 - mean\_absolute\_error: 0.0094 98/126 [======================>.......] - ETA: 0s - loss: 1.4178e-04 - mean\_absolute\_error: 0.0092123/126 [============================>.] - ETA: 0s - loss: 1.5068e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 2ms/step - loss: 1.5014e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.2804e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3828e-04 - mean\_absolute\_error: 0.0102 24/126 [====>.........................] - ETA: 0s - loss: 1.1735e-04 - mean\_absolute\_error: 0.0082 49/126 [==========>...................] - ETA: 0s - loss: 1.3231e-04 - mean\_absolute\_error: 0.0083 74/126 [================>.............] - ETA: 0s - loss: 1.3409e-04 - mean\_absolute\_error: 0.0084 99/126 [======================>.......] - ETA: 0s - loss: 1.3039e-04 - mean\_absolute\_error: 0.0084124/126 [============================>.] - ETA: 0s - loss: 1.3022e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.2965e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 4.4170e-05 - val\_mean\_absolute\_error: 0.0050  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8487e-05 - mean\_absolute\_error: 0.0082 23/126 [====>.........................] - ETA: 0s - loss: 1.3516e-04 - mean\_absolute\_error: 0.0090 43/126 [=========>....................] - ETA: 0s - loss: 1.7399e-04 - mean\_absolute\_error: 0.0100 63/126 [==============>...............] - ETA: 0s - loss: 1.6695e-04 - mean\_absolute\_error: 0.0099 84/126 [===================>..........] - ETA: 0s - loss: 1.6864e-04 - mean\_absolute\_error: 0.0100104/126 [=======================>......] - ETA: 0s - loss: 1.6676e-04 - mean\_absolute\_error: 0.0100121/126 [===========================>..] - ETA: 0s - loss: 1.6603e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6393e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 4.7212e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1406e-04 - mean\_absolute\_error: 0.0078 25/126 [====>.........................] - ETA: 0s - loss: 1.4030e-04 - mean\_absolute\_error: 0.0091 49/126 [==========>...................] - ETA: 0s - loss: 1.5571e-04 - mean\_absolute\_error: 0.0094 74/126 [================>.............] - ETA: 0s - loss: 1.5605e-04 - mean\_absolute\_error: 0.0095 99/126 [======================>.......] - ETA: 0s - loss: 1.8436e-04 - mean\_absolute\_error: 0.0103123/126 [============================>.] - ETA: 0s - loss: 1.8731e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 2ms/step - loss: 1.8713e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 7.1415e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5821e-04 - mean\_absolute\_error: 0.0100 26/126 [=====>........................] - ETA: 0s - loss: 1.7258e-04 - mean\_absolute\_error: 0.0094 49/126 [==========>...................] - ETA: 0s - loss: 1.5778e-04 - mean\_absolute\_error: 0.0095 73/126 [================>.............] - ETA: 0s - loss: 1.5088e-04 - mean\_absolute\_error: 0.0091 97/126 [======================>.......] - ETA: 0s - loss: 1.5170e-04 - mean\_absolute\_error: 0.0092121/126 [===========================>..] - ETA: 0s - loss: 1.4531e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 2ms/step - loss: 1.4399e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.0175e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3393e-04 - mean\_absolute\_error: 0.0116 25/126 [====>.........................] - ETA: 0s - loss: 1.1972e-04 - mean\_absolute\_error: 0.0085 50/126 [==========>...................] - ETA: 0s - loss: 1.2239e-04 - mean\_absolute\_error: 0.0085 76/126 [=================>............] - ETA: 0s - loss: 1.2630e-04 - mean\_absolute\_error: 0.0086101/126 [=======================>......] - ETA: 0s - loss: 1.2426e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - ETA: 0s - loss: 1.3347e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.3347e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 9.8312e-05 - val\_mean\_absolute\_error: 0.0083  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9816e-04 - mean\_absolute\_error: 0.0120 26/126 [=====>........................] - ETA: 0s - loss: 1.5391e-04 - mean\_absolute\_error: 0.0096 51/126 [===========>..................] - ETA: 0s - loss: 1.4513e-04 - mean\_absolute\_error: 0.0089 73/126 [================>.............] - ETA: 0s - loss: 1.4153e-04 - mean\_absolute\_error: 0.0088 98/126 [======================>.......] - ETA: 0s - loss: 1.3725e-04 - mean\_absolute\_error: 0.0088123/126 [============================>.] - ETA: 0s - loss: 1.3638e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 2ms/step - loss: 1.3625e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 7.2805e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1262e-04 - mean\_absolute\_error: 0.0074 25/126 [====>.........................] - ETA: 0s - loss: 1.1825e-04 - mean\_absolute\_error: 0.0083 50/126 [==========>...................] - ETA: 0s - loss: 1.2756e-04 - mean\_absolute\_error: 0.0083 73/126 [================>.............] - ETA: 0s - loss: 1.2382e-04 - mean\_absolute\_error: 0.0084 98/126 [======================>.......] - ETA: 0s - loss: 1.2402e-04 - mean\_absolute\_error: 0.0084123/126 [============================>.] - ETA: 0s - loss: 1.2586e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 2ms/step - loss: 1.2540e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 4.8445e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4124e-04 - mean\_absolute\_error: 0.0090 26/126 [=====>........................] - ETA: 0s - loss: 1.4509e-04 - mean\_absolute\_error: 0.0094 52/126 [===========>..................] - ETA: 0s - loss: 1.5597e-04 - mean\_absolute\_error: 0.0098 78/126 [=================>............] - ETA: 0s - loss: 1.5137e-04 - mean\_absolute\_error: 0.0096104/126 [=======================>......] - ETA: 0s - loss: 1.5502e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 2ms/step - loss: 1.5221e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 4.3229e-05 - val\_mean\_absolute\_error: 0.0049  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0801e-05 - mean\_absolute\_error: 0.0068 26/126 [=====>........................] - ETA: 0s - loss: 1.4362e-04 - mean\_absolute\_error: 0.0091 52/126 [===========>..................] - ETA: 0s - loss: 1.5900e-04 - mean\_absolute\_error: 0.0097 78/126 [=================>............] - ETA: 0s - loss: 1.6009e-04 - mean\_absolute\_error: 0.0097103/126 [=======================>......] - ETA: 0s - loss: 1.5413e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - ETA: 0s - loss: 1.5422e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 2ms/step - loss: 1.5422e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 7.3504e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3720e-04 - mean\_absolute\_error: 0.0090 26/126 [=====>........................] - ETA: 0s - loss: 1.6555e-04 - mean\_absolute\_error: 0.0094 51/126 [===========>..................] - ETA: 0s - loss: 1.4527e-04 - mean\_absolute\_error: 0.0090 76/126 [=================>............] - ETA: 0s - loss: 1.4182e-04 - mean\_absolute\_error: 0.0088101/126 [=======================>......] - ETA: 0s - loss: 1.3585e-04 - mean\_absolute\_error: 0.0087123/126 [============================>.] - ETA: 0s - loss: 1.3352e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.3301e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 4.7604e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8491e-04 - mean\_absolute\_error: 0.0108 26/126 [=====>........................] - ETA: 0s - loss: 1.0473e-04 - mean\_absolute\_error: 0.0077 51/126 [===========>..................] - ETA: 0s - loss: 1.1279e-04 - mean\_absolute\_error: 0.0081 76/126 [=================>............] - ETA: 0s - loss: 1.2598e-04 - mean\_absolute\_error: 0.0084100/126 [======================>.......] - ETA: 0s - loss: 1.3307e-04 - mean\_absolute\_error: 0.0086124/126 [============================>.] - ETA: 0s - loss: 1.3669e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3659e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 4.2772e-05 - val\_mean\_absolute\_error: 0.0049  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8684e-05 - mean\_absolute\_error: 0.0071 25/126 [====>.........................] - ETA: 0s - loss: 1.1249e-04 - mean\_absolute\_error: 0.0081 51/126 [===========>..................] - ETA: 0s - loss: 1.3554e-04 - mean\_absolute\_error: 0.0087 77/126 [=================>............] - ETA: 0s - loss: 1.5653e-04 - mean\_absolute\_error: 0.0095102/126 [=======================>......] - ETA: 0s - loss: 1.7107e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 2ms/step - loss: 1.6549e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 4.4368e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0016e-04 - mean\_absolute\_error: 0.0075 25/126 [====>.........................] - ETA: 0s - loss: 1.2570e-04 - mean\_absolute\_error: 0.0081 50/126 [==========>...................] - ETA: 0s - loss: 1.2567e-04 - mean\_absolute\_error: 0.0081 74/126 [================>.............] - ETA: 0s - loss: 1.3801e-04 - mean\_absolute\_error: 0.0087 99/126 [======================>.......] - ETA: 0s - loss: 1.3508e-04 - mean\_absolute\_error: 0.0087124/126 [============================>.] - ETA: 0s - loss: 1.2855e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 2ms/step - loss: 1.2830e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.2592e-05 - val\_mean\_absolute\_error: 0.0049  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8416e-05 - mean\_absolute\_error: 0.0044 24/126 [====>.........................] - ETA: 0s - loss: 1.2617e-04 - mean\_absolute\_error: 0.0088 50/126 [==========>...................] - ETA: 0s - loss: 1.3131e-04 - mean\_absolute\_error: 0.0089 75/126 [================>.............] - ETA: 0s - loss: 1.3303e-04 - mean\_absolute\_error: 0.0087100/126 [======================>.......] - ETA: 0s - loss: 1.3907e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - ETA: 0s - loss: 1.3867e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 2ms/step - loss: 1.3867e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 4.4787e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6277e-05 - mean\_absolute\_error: 0.0055 26/126 [=====>........................] - ETA: 0s - loss: 1.3135e-04 - mean\_absolute\_error: 0.0087 51/126 [===========>..................] - ETA: 0s - loss: 1.2031e-04 - mean\_absolute\_error: 0.0084 76/126 [=================>............] - ETA: 0s - loss: 1.2446e-04 - mean\_absolute\_error: 0.0083101/126 [=======================>......] - ETA: 0s - loss: 1.3060e-04 - mean\_absolute\_error: 0.0085125/126 [============================>.] - ETA: 0s - loss: 1.3177e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 2ms/step - loss: 1.3177e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 4.6092e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6747e-04 - mean\_absolute\_error: 0.0092 26/126 [=====>........................] - ETA: 0s - loss: 1.1159e-04 - mean\_absolute\_error: 0.0077 49/126 [==========>...................] - ETA: 0s - loss: 1.1597e-04 - mean\_absolute\_error: 0.0081 74/126 [================>.............] - ETA: 0s - loss: 1.3803e-04 - mean\_absolute\_error: 0.0087 98/126 [======================>.......] - ETA: 0s - loss: 1.3491e-04 - mean\_absolute\_error: 0.0087122/126 [============================>.] - ETA: 0s - loss: 1.3631e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 2ms/step - loss: 1.3747e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 1.8768e-04 - val\_mean\_absolute\_error: 0.0122  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7290e-04 - mean\_absolute\_error: 0.0131 25/126 [====>.........................] - ETA: 0s - loss: 1.4617e-04 - mean\_absolute\_error: 0.0087 49/126 [==========>...................] - ETA: 0s - loss: 1.2857e-04 - mean\_absolute\_error: 0.0084 73/126 [================>.............] - ETA: 0s - loss: 1.2315e-04 - mean\_absolute\_error: 0.0082 97/126 [======================>.......] - ETA: 0s - loss: 1.2845e-04 - mean\_absolute\_error: 0.0085121/126 [===========================>..] - ETA: 0s - loss: 1.2948e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 2ms/step - loss: 1.2778e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 6.3569e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0855e-04 - mean\_absolute\_error: 0.0079 26/126 [=====>........................] - ETA: 0s - loss: 1.6923e-04 - mean\_absolute\_error: 0.0092 51/126 [===========>..................] - ETA: 0s - loss: 1.4648e-04 - mean\_absolute\_error: 0.0088 76/126 [=================>............] - ETA: 0s - loss: 1.4680e-04 - mean\_absolute\_error: 0.0089101/126 [=======================>......] - ETA: 0s - loss: 1.4175e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - ETA: 0s - loss: 1.3380e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 2ms/step - loss: 1.3380e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 5.9797e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2692e-04 - mean\_absolute\_error: 0.0089 26/126 [=====>........................] - ETA: 0s - loss: 1.2621e-04 - mean\_absolute\_error: 0.0088 51/126 [===========>..................] - ETA: 0s - loss: 1.2848e-04 - mean\_absolute\_error: 0.0085 76/126 [=================>............] - ETA: 0s - loss: 1.2455e-04 - mean\_absolute\_error: 0.0084 99/126 [======================>.......] - ETA: 0s - loss: 1.1820e-04 - mean\_absolute\_error: 0.0082124/126 [============================>.] - ETA: 0s - loss: 1.2247e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 2ms/step - loss: 1.2224e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 8.7233e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2299e-04 - mean\_absolute\_error: 0.0086 26/126 [=====>........................] - ETA: 0s - loss: 1.3179e-04 - mean\_absolute\_error: 0.0086 52/126 [===========>..................] - ETA: 0s - loss: 1.3636e-04 - mean\_absolute\_error: 0.0084 77/126 [=================>............] - ETA: 0s - loss: 1.3295e-04 - mean\_absolute\_error: 0.0085 99/126 [======================>.......] - ETA: 0s - loss: 1.3146e-04 - mean\_absolute\_error: 0.0086124/126 [============================>.] - ETA: 0s - loss: 1.3415e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 2ms/step - loss: 1.3406e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 4.9092e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 9.2781e-05 - mean\_absolute\_error: 0.0082 25/126 [====>.........................] - ETA: 0s - loss: 1.3662e-04 - mean\_absolute\_error: 0.0087 51/126 [===========>..................] - ETA: 0s - loss: 1.2215e-04 - mean\_absolute\_error: 0.0083 72/126 [================>.............] - ETA: 0s - loss: 1.2985e-04 - mean\_absolute\_error: 0.0084 89/126 [====================>.........] - ETA: 0s - loss: 1.3632e-04 - mean\_absolute\_error: 0.0086108/126 [========================>.....] - ETA: 0s - loss: 1.3438e-04 - mean\_absolute\_error: 0.0086122/126 [============================>.] - ETA: 0s - loss: 1.3297e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.3287e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 4.1475e-05 - val\_mean\_absolute\_error: 0.0049

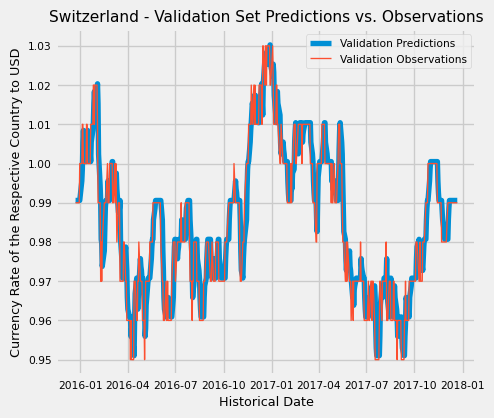
<keras.src.callbacks.History at 0x2116571e350>

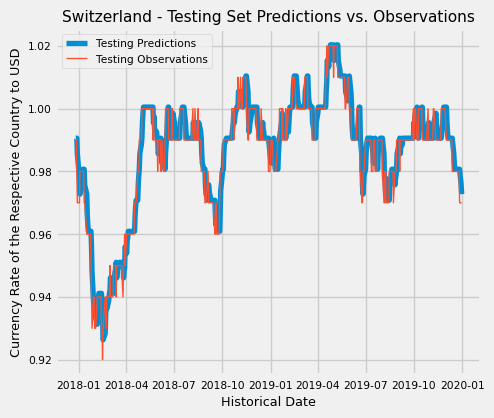
After the training and fitting of the Machine Learning model for Switzerland, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 43s 36/126 [=======>......................] - ETA: 0s 76/126 [=================>............] - ETA: 0s113/126 [=========================>....] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 2ms/step  
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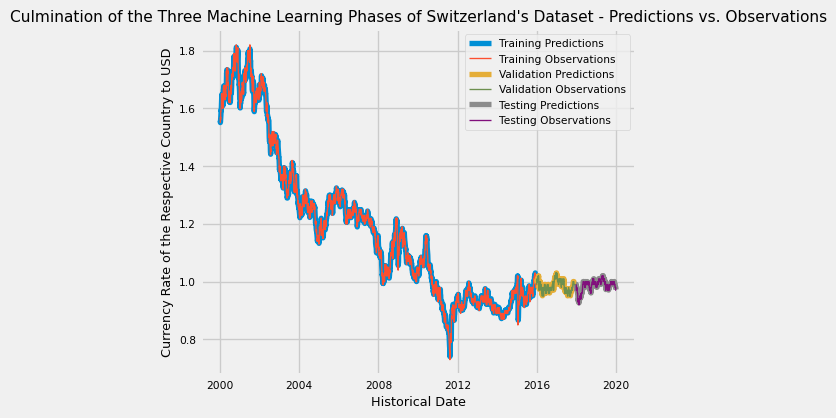






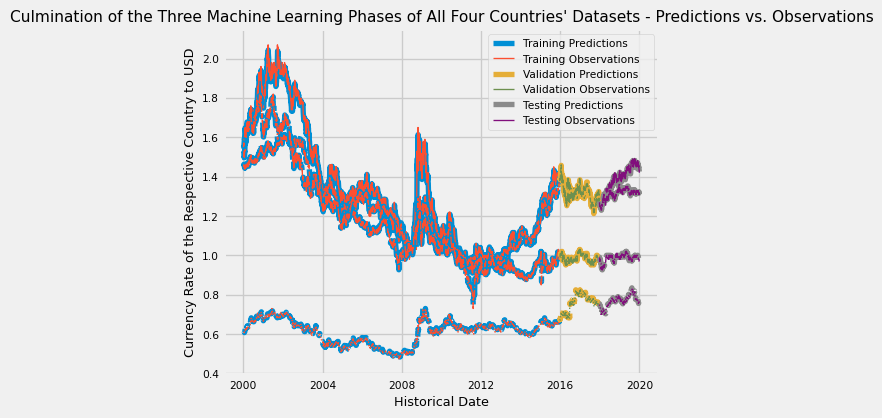
Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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



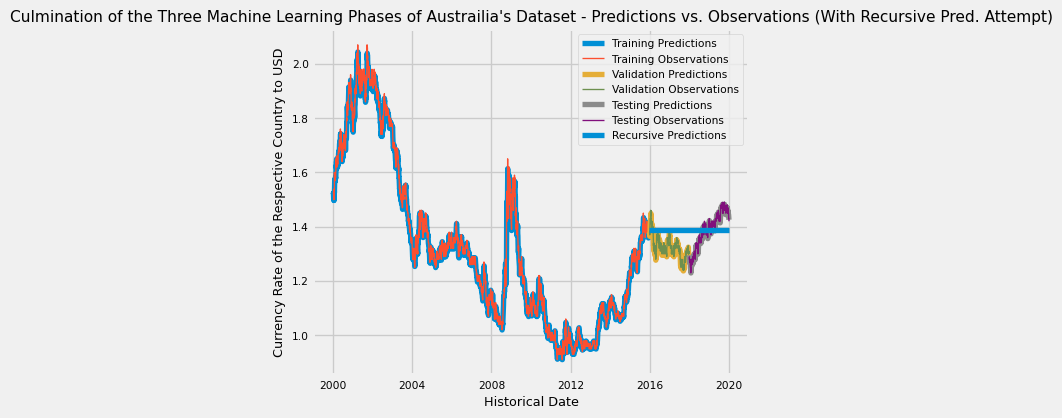
Ultimately, here is the moment of truth: I tried to recursively predict Austrailia’s future expected projection on its international currency rate between the United States through using my LSTM prediction model as shown below. By using the data from the training dataset for Austrailia, I tried to contrast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

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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].