International US Foreign Currency Exchange Rates Predictor

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## Blog Post Inspiration and Objectives

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

## Data Preprocessing - Cleaning and Analytics

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

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

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

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

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

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

(5217, 24)

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

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

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

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

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

0

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

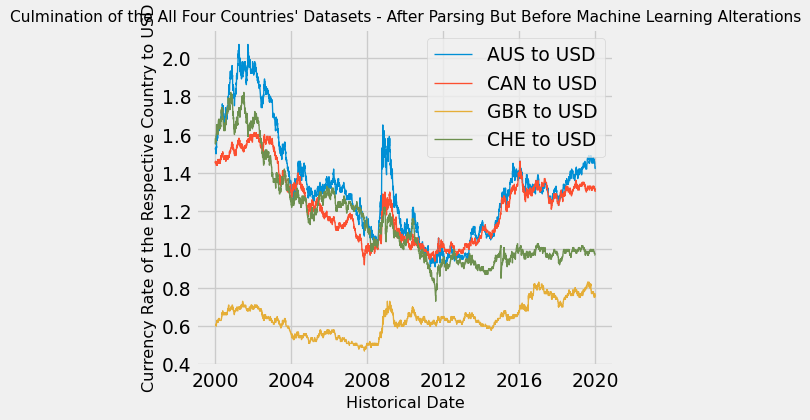
```{python}  
def windowed\_df\_to\_date\_X\_y(windowed\_dataframe: pd.DataFrame):  
 df\_as\_np = windowed\_dataframe.to\_numpy()  
   
 dates = df\_as\_np[:, 0]  
   
 middle\_matrix = df\_as\_np[:, 1:-1]  
 X = middle\_matrix.reshape((len(dates), middle\_matrix.shape[1], 1))  
 Y = df\_as\_np[:, -1]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

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

(5016, 5016, 5016, 5016)

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

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



## Machine Learning - Model Training and Evaluation

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

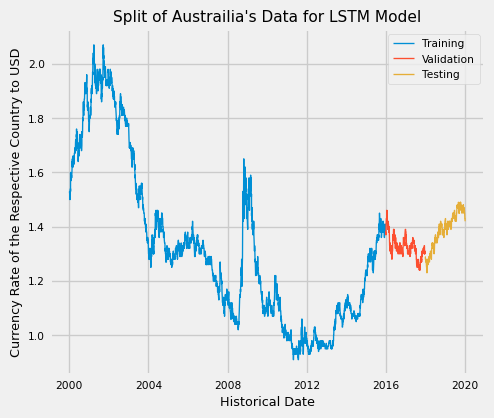
For this blog post, I worked to create Machine Learning models for each country’s dataset separately. I started with Austrailia’s data first (as shown below):

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

(4012, 4514)

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

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



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

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

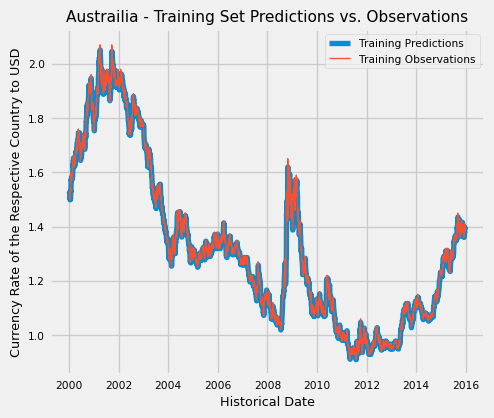
Epoch 1/100  
 1/126 [..............................] - ETA: 3:40 - loss: 1.9580 - mean\_absolute\_error: 1.3677 22/126 [====>.........................] - ETA: 0s - loss: 1.5609 - mean\_absolute\_error: 1.2137 43/126 [=========>....................] - ETA: 0s - loss: 1.0845 - mean\_absolute\_error: 0.9532 64/126 [==============>...............] - ETA: 0s - loss: 0.7399 - mean\_absolute\_error: 0.6924 85/126 [===================>..........] - ETA: 0s - loss: 0.5600 - mean\_absolute\_error: 0.5415107/126 [========================>.....] - ETA: 0s - loss: 0.4462 - mean\_absolute\_error: 0.4445126/126 [==============================] - 3s 6ms/step - loss: 0.3815 - mean\_absolute\_error: 0.3879 - val\_loss: 4.2759e-04 - val\_mean\_absolute\_error: 0.0180  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0053 - mean\_absolute\_error: 0.0620 25/126 [====>.........................] - ETA: 0s - loss: 0.0039 - mean\_absolute\_error: 0.0519 48/126 [==========>...................] - ETA: 0s - loss: 0.0036 - mean\_absolute\_error: 0.0500 71/126 [===============>..............] - ETA: 0s - loss: 0.0034 - mean\_absolute\_error: 0.0481 94/126 [=====================>........] - ETA: 0s - loss: 0.0030 - mean\_absolute\_error: 0.0455115/126 [==========================>...] - ETA: 0s - loss: 0.0028 - mean\_absolute\_error: 0.0432126/126 [==============================] - 0s 3ms/step - loss: 0.0026 - mean\_absolute\_error: 0.0420 - val\_loss: 1.7407e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0012 - mean\_absolute\_error: 0.0292 23/126 [====>.........................] - ETA: 0s - loss: 9.5730e-04 - mean\_absolute\_error: 0.0253 45/126 [=========>....................] - ETA: 0s - loss: 8.6517e-04 - mean\_absolute\_error: 0.0238 67/126 [==============>...............] - ETA: 0s - loss: 7.7144e-04 - mean\_absolute\_error: 0.0224 88/126 [===================>..........] - ETA: 0s - loss: 7.0018e-04 - mean\_absolute\_error: 0.0212105/126 [========================>.....] - ETA: 0s - loss: 6.4650e-04 - mean\_absolute\_error: 0.0202118/126 [===========================>..] - ETA: 0s - loss: 6.2079e-04 - mean\_absolute\_error: 0.0196126/126 [==============================] - 0s 3ms/step - loss: 6.0191e-04 - mean\_absolute\_error: 0.0193 - val\_loss: 1.2347e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5518e-04 - mean\_absolute\_error: 0.0163 21/126 [====>.........................] - ETA: 0s - loss: 3.2000e-04 - mean\_absolute\_error: 0.0137 42/126 [=========>....................] - ETA: 0s - loss: 2.8453e-04 - mean\_absolute\_error: 0.0130 64/126 [==============>...............] - ETA: 0s - loss: 2.8419e-04 - mean\_absolute\_error: 0.0129 85/126 [===================>..........] - ETA: 0s - loss: 2.7839e-04 - mean\_absolute\_error: 0.0126107/126 [========================>.....] - ETA: 0s - loss: 2.7888e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.8511e-04 - mean\_absolute\_error: 0.0125 - val\_loss: 1.2455e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4738e-04 - mean\_absolute\_error: 0.0127 23/126 [====>.........................] - ETA: 0s - loss: 2.5632e-04 - mean\_absolute\_error: 0.0117 44/126 [=========>....................] - ETA: 0s - loss: 2.7981e-04 - mean\_absolute\_error: 0.0120 66/126 [==============>...............] - ETA: 0s - loss: 2.8300e-04 - mean\_absolute\_error: 0.0120 80/126 [==================>...........] - ETA: 0s - loss: 2.8250e-04 - mean\_absolute\_error: 0.0121 96/126 [=====================>........] - ETA: 0s - loss: 2.7349e-04 - mean\_absolute\_error: 0.0120116/126 [==========================>...] - ETA: 0s - loss: 2.6954e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6586e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.4045e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7525e-04 - mean\_absolute\_error: 0.0106 22/126 [====>.........................] - ETA: 0s - loss: 2.4189e-04 - mean\_absolute\_error: 0.0115 44/126 [=========>....................] - ETA: 0s - loss: 2.5505e-04 - mean\_absolute\_error: 0.0118 66/126 [==============>...............] - ETA: 0s - loss: 2.7375e-04 - mean\_absolute\_error: 0.0119 88/126 [===================>..........] - ETA: 0s - loss: 2.6884e-04 - mean\_absolute\_error: 0.0119110/126 [=========================>....] - ETA: 0s - loss: 2.6782e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6549e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.5356e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0458e-04 - mean\_absolute\_error: 0.0141 23/126 [====>.........................] - ETA: 0s - loss: 2.7262e-04 - mean\_absolute\_error: 0.0119 45/126 [=========>....................] - ETA: 0s - loss: 2.9654e-04 - mean\_absolute\_error: 0.0121 59/126 [=============>................] - ETA: 0s - loss: 2.8767e-04 - mean\_absolute\_error: 0.0120 77/126 [=================>............] - ETA: 0s - loss: 2.7736e-04 - mean\_absolute\_error: 0.0118 97/126 [======================>.......] - ETA: 0s - loss: 2.6471e-04 - mean\_absolute\_error: 0.0118118/126 [===========================>..] - ETA: 0s - loss: 2.6682e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6663e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.3722e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8417e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 2.4974e-04 - mean\_absolute\_error: 0.0119 45/126 [=========>....................] - ETA: 0s - loss: 2.5793e-04 - mean\_absolute\_error: 0.0118 67/126 [==============>...............] - ETA: 0s - loss: 2.6523e-04 - mean\_absolute\_error: 0.0118 89/126 [====================>.........] - ETA: 0s - loss: 2.6803e-04 - mean\_absolute\_error: 0.0118111/126 [=========================>....] - ETA: 0s - loss: 2.6943e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6456e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.3296e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4049e-04 - mean\_absolute\_error: 0.0152 23/126 [====>.........................] - ETA: 0s - loss: 2.5671e-04 - mean\_absolute\_error: 0.0117 45/126 [=========>....................] - ETA: 0s - loss: 2.6672e-04 - mean\_absolute\_error: 0.0117 67/126 [==============>...............] - ETA: 0s - loss: 2.5685e-04 - mean\_absolute\_error: 0.0117 89/126 [====================>.........] - ETA: 0s - loss: 2.6785e-04 - mean\_absolute\_error: 0.0120109/126 [========================>.....] - ETA: 0s - loss: 2.7484e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.6966e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.4998e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0386e-04 - mean\_absolute\_error: 0.0106 23/126 [====>.........................] - ETA: 0s - loss: 2.0614e-04 - mean\_absolute\_error: 0.0109 45/126 [=========>....................] - ETA: 0s - loss: 2.2082e-04 - mean\_absolute\_error: 0.0112 67/126 [==============>...............] - ETA: 0s - loss: 2.4917e-04 - mean\_absolute\_error: 0.0117 89/126 [====================>.........] - ETA: 0s - loss: 2.6353e-04 - mean\_absolute\_error: 0.0117110/126 [=========================>....] - ETA: 0s - loss: 2.6066e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6334e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.2541e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6367e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 2.4082e-04 - mean\_absolute\_error: 0.0117 45/126 [=========>....................] - ETA: 0s - loss: 2.4993e-04 - mean\_absolute\_error: 0.0115 67/126 [==============>...............] - ETA: 0s - loss: 2.4626e-04 - mean\_absolute\_error: 0.0114 88/126 [===================>..........] - ETA: 0s - loss: 2.6282e-04 - mean\_absolute\_error: 0.0117110/126 [=========================>....] - ETA: 0s - loss: 2.6182e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6697e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 4.9781e-04 - val\_mean\_absolute\_error: 0.0196  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0687e-04 - mean\_absolute\_error: 0.0175 23/126 [====>.........................] - ETA: 0s - loss: 3.4328e-04 - mean\_absolute\_error: 0.0136 45/126 [=========>....................] - ETA: 0s - loss: 3.0960e-04 - mean\_absolute\_error: 0.0127 67/126 [==============>...............] - ETA: 0s - loss: 3.1424e-04 - mean\_absolute\_error: 0.0127 88/126 [===================>..........] - ETA: 0s - loss: 2.9628e-04 - mean\_absolute\_error: 0.0124110/126 [=========================>....] - ETA: 0s - loss: 2.8991e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 3ms/step - loss: 2.7849e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.3273e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6784e-04 - mean\_absolute\_error: 0.0119 20/126 [===>..........................] - ETA: 0s - loss: 2.2313e-04 - mean\_absolute\_error: 0.0111 39/126 [========>.....................] - ETA: 0s - loss: 2.5379e-04 - mean\_absolute\_error: 0.0114 58/126 [============>.................] - ETA: 0s - loss: 2.5524e-04 - mean\_absolute\_error: 0.0115 76/126 [=================>............] - ETA: 0s - loss: 2.6461e-04 - mean\_absolute\_error: 0.0118 94/126 [=====================>........] - ETA: 0s - loss: 2.6759e-04 - mean\_absolute\_error: 0.0117111/126 [=========================>....] - ETA: 0s - loss: 2.6409e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6276e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.3280e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3634e-04 - mean\_absolute\_error: 0.0083 19/126 [===>..........................] - ETA: 0s - loss: 2.3313e-04 - mean\_absolute\_error: 0.0111 39/126 [========>.....................] - ETA: 0s - loss: 2.5283e-04 - mean\_absolute\_error: 0.0113 59/126 [=============>................] - ETA: 0s - loss: 2.6007e-04 - mean\_absolute\_error: 0.0117 78/126 [=================>............] - ETA: 0s - loss: 2.7097e-04 - mean\_absolute\_error: 0.0119 97/126 [======================>.......] - ETA: 0s - loss: 2.5717e-04 - mean\_absolute\_error: 0.0117116/126 [==========================>...] - ETA: 0s - loss: 2.6080e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6301e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.2609e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6753e-04 - mean\_absolute\_error: 0.0142 20/126 [===>..........................] - ETA: 0s - loss: 3.2043e-04 - mean\_absolute\_error: 0.0129 39/126 [========>.....................] - ETA: 0s - loss: 2.8366e-04 - mean\_absolute\_error: 0.0124 58/126 [============>.................] - ETA: 0s - loss: 2.7873e-04 - mean\_absolute\_error: 0.0122 76/126 [=================>............] - ETA: 0s - loss: 2.7258e-04 - mean\_absolute\_error: 0.0120 94/126 [=====================>........] - ETA: 0s - loss: 2.7985e-04 - mean\_absolute\_error: 0.0120114/126 [==========================>...] - ETA: 0s - loss: 2.6689e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6524e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.3590e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3038e-04 - mean\_absolute\_error: 0.0086 20/126 [===>..........................] - ETA: 0s - loss: 2.7036e-04 - mean\_absolute\_error: 0.0114 38/126 [========>.....................] - ETA: 0s - loss: 2.6784e-04 - mean\_absolute\_error: 0.0118 57/126 [============>.................] - ETA: 0s - loss: 2.8199e-04 - mean\_absolute\_error: 0.0120 77/126 [=================>............] - ETA: 0s - loss: 2.7252e-04 - mean\_absolute\_error: 0.0118 96/126 [=====================>........] - ETA: 0s - loss: 2.6954e-04 - mean\_absolute\_error: 0.0119115/126 [==========================>...] - ETA: 0s - loss: 2.7322e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6778e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.2692e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1840e-04 - mean\_absolute\_error: 0.0099 21/126 [====>.........................] - ETA: 0s - loss: 2.7979e-04 - mean\_absolute\_error: 0.0120 40/126 [========>.....................] - ETA: 0s - loss: 2.3465e-04 - mean\_absolute\_error: 0.0114 59/126 [=============>................] - ETA: 0s - loss: 2.4941e-04 - mean\_absolute\_error: 0.0115 77/126 [=================>............] - ETA: 0s - loss: 2.6155e-04 - mean\_absolute\_error: 0.0116 96/126 [=====================>........] - ETA: 0s - loss: 2.5882e-04 - mean\_absolute\_error: 0.0117114/126 [==========================>...] - ETA: 0s - loss: 2.6338e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6470e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.7871e-04 - val\_mean\_absolute\_error: 0.0105  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9250e-04 - mean\_absolute\_error: 0.0129 21/126 [====>.........................] - ETA: 0s - loss: 2.5106e-04 - mean\_absolute\_error: 0.0115 38/126 [========>.....................] - ETA: 0s - loss: 2.4264e-04 - mean\_absolute\_error: 0.0115 54/126 [===========>..................] - ETA: 0s - loss: 2.4203e-04 - mean\_absolute\_error: 0.0114 72/126 [================>.............] - ETA: 0s - loss: 2.4833e-04 - mean\_absolute\_error: 0.0116 87/126 [===================>..........] - ETA: 0s - loss: 2.4851e-04 - mean\_absolute\_error: 0.0116102/126 [=======================>......] - ETA: 0s - loss: 2.5161e-04 - mean\_absolute\_error: 0.0116122/126 [============================>.] - ETA: 0s - loss: 2.5905e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.6067e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.3142e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3984e-04 - mean\_absolute\_error: 0.0133 23/126 [====>.........................] - ETA: 0s - loss: 2.5206e-04 - mean\_absolute\_error: 0.0117 45/126 [=========>....................] - ETA: 0s - loss: 2.5138e-04 - mean\_absolute\_error: 0.0114 67/126 [==============>...............] - ETA: 0s - loss: 2.7050e-04 - mean\_absolute\_error: 0.0116 89/126 [====================>.........] - ETA: 0s - loss: 2.6403e-04 - mean\_absolute\_error: 0.0115111/126 [=========================>....] - ETA: 0s - loss: 2.5752e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.6050e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.9342e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8834e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 2.6824e-04 - mean\_absolute\_error: 0.0117 46/126 [=========>....................] - ETA: 0s - loss: 2.9182e-04 - mean\_absolute\_error: 0.0124 68/126 [===============>..............] - ETA: 0s - loss: 2.9854e-04 - mean\_absolute\_error: 0.0124 90/126 [====================>.........] - ETA: 0s - loss: 2.8866e-04 - mean\_absolute\_error: 0.0122111/126 [=========================>....] - ETA: 0s - loss: 2.8623e-04 - mean\_absolute\_error: 0.0122126/126 [==============================] - 0s 3ms/step - loss: 2.7919e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 1.2996e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8551e-04 - mean\_absolute\_error: 0.0104 23/126 [====>.........................] - ETA: 0s - loss: 3.0870e-04 - mean\_absolute\_error: 0.0125 45/126 [=========>....................] - ETA: 0s - loss: 2.6265e-04 - mean\_absolute\_error: 0.0118 67/126 [==============>...............] - ETA: 0s - loss: 2.6418e-04 - mean\_absolute\_error: 0.0118 89/126 [====================>.........] - ETA: 0s - loss: 2.6332e-04 - mean\_absolute\_error: 0.0118108/126 [========================>.....] - ETA: 0s - loss: 2.7234e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.7374e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.8813e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2254e-04 - mean\_absolute\_error: 0.0116 23/126 [====>.........................] - ETA: 0s - loss: 2.7274e-04 - mean\_absolute\_error: 0.0127 45/126 [=========>....................] - ETA: 0s - loss: 2.7902e-04 - mean\_absolute\_error: 0.0123 67/126 [==============>...............] - ETA: 0s - loss: 2.7108e-04 - mean\_absolute\_error: 0.0121 89/126 [====================>.........] - ETA: 0s - loss: 2.6398e-04 - mean\_absolute\_error: 0.0119111/126 [=========================>....] - ETA: 0s - loss: 2.6951e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6716e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.5905e-04 - val\_mean\_absolute\_error: 0.0103  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9120e-04 - mean\_absolute\_error: 0.0129 23/126 [====>.........................] - ETA: 0s - loss: 2.8744e-04 - mean\_absolute\_error: 0.0119 45/126 [=========>....................] - ETA: 0s - loss: 2.7991e-04 - mean\_absolute\_error: 0.0120 67/126 [==============>...............] - ETA: 0s - loss: 2.6582e-04 - mean\_absolute\_error: 0.0117 89/126 [====================>.........] - ETA: 0s - loss: 2.6050e-04 - mean\_absolute\_error: 0.0116111/126 [=========================>....] - ETA: 0s - loss: 2.5368e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5762e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.4943e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4308e-04 - mean\_absolute\_error: 0.0125 23/126 [====>.........................] - ETA: 0s - loss: 2.3413e-04 - mean\_absolute\_error: 0.0111 45/126 [=========>....................] - ETA: 0s - loss: 2.5146e-04 - mean\_absolute\_error: 0.0115 67/126 [==============>...............] - ETA: 0s - loss: 2.8908e-04 - mean\_absolute\_error: 0.0122 90/126 [====================>.........] - ETA: 0s - loss: 2.9632e-04 - mean\_absolute\_error: 0.0124112/126 [=========================>....] - ETA: 0s - loss: 2.8570e-04 - mean\_absolute\_error: 0.0122126/126 [==============================] - 0s 3ms/step - loss: 2.7921e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.3735e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3649e-04 - mean\_absolute\_error: 0.0092 22/126 [====>.........................] - ETA: 0s - loss: 2.7827e-04 - mean\_absolute\_error: 0.0119 43/126 [=========>....................] - ETA: 0s - loss: 2.5407e-04 - mean\_absolute\_error: 0.0116 65/126 [==============>...............] - ETA: 0s - loss: 2.5926e-04 - mean\_absolute\_error: 0.0118 87/126 [===================>..........] - ETA: 0s - loss: 2.6229e-04 - mean\_absolute\_error: 0.0119109/126 [========================>.....] - ETA: 0s - loss: 2.6859e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6006e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2425e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1471e-04 - mean\_absolute\_error: 0.0118 23/126 [====>.........................] - ETA: 0s - loss: 2.3926e-04 - mean\_absolute\_error: 0.0113 45/126 [=========>....................] - ETA: 0s - loss: 2.7345e-04 - mean\_absolute\_error: 0.0118 67/126 [==============>...............] - ETA: 0s - loss: 2.7369e-04 - mean\_absolute\_error: 0.0118 89/126 [====================>.........] - ETA: 0s - loss: 2.6552e-04 - mean\_absolute\_error: 0.0117111/126 [=========================>....] - ETA: 0s - loss: 2.6145e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5612e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.2929e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6215e-04 - mean\_absolute\_error: 0.0103 24/126 [====>.........................] - ETA: 0s - loss: 3.3708e-04 - mean\_absolute\_error: 0.0127 47/126 [==========>...................] - ETA: 0s - loss: 2.7748e-04 - mean\_absolute\_error: 0.0118 69/126 [===============>..............] - ETA: 0s - loss: 2.6597e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.5835e-04 - mean\_absolute\_error: 0.0117112/126 [=========================>....] - ETA: 0s - loss: 2.6583e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6914e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.8644e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9026e-04 - mean\_absolute\_error: 0.0132 24/126 [====>.........................] - ETA: 0s - loss: 3.2776e-04 - mean\_absolute\_error: 0.0128 46/126 [=========>....................] - ETA: 0s - loss: 3.0383e-04 - mean\_absolute\_error: 0.0122 68/126 [===============>..............] - ETA: 0s - loss: 2.8477e-04 - mean\_absolute\_error: 0.0121 90/126 [====================>.........] - ETA: 0s - loss: 2.8037e-04 - mean\_absolute\_error: 0.0121112/126 [=========================>....] - ETA: 0s - loss: 2.6762e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.7124e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.3479e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8334e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 3.3757e-04 - mean\_absolute\_error: 0.0129 45/126 [=========>....................] - ETA: 0s - loss: 3.3825e-04 - mean\_absolute\_error: 0.0135 67/126 [==============>...............] - ETA: 0s - loss: 3.3218e-04 - mean\_absolute\_error: 0.0135 89/126 [====================>.........] - ETA: 0s - loss: 3.1252e-04 - mean\_absolute\_error: 0.0130111/126 [=========================>....] - ETA: 0s - loss: 2.9400e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.9904e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 2.3176e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 4.3680e-04 - mean\_absolute\_error: 0.0149 24/126 [====>.........................] - ETA: 0s - loss: 3.1317e-04 - mean\_absolute\_error: 0.0124 46/126 [=========>....................] - ETA: 0s - loss: 2.9638e-04 - mean\_absolute\_error: 0.0121 68/126 [===============>..............] - ETA: 0s - loss: 2.7480e-04 - mean\_absolute\_error: 0.0119 89/126 [====================>.........] - ETA: 0s - loss: 2.6141e-04 - mean\_absolute\_error: 0.0116111/126 [=========================>....] - ETA: 0s - loss: 2.6139e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5745e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.2398e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1777e-04 - mean\_absolute\_error: 0.0120 23/126 [====>.........................] - ETA: 0s - loss: 2.0730e-04 - mean\_absolute\_error: 0.0106 45/126 [=========>....................] - ETA: 0s - loss: 2.4057e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.5147e-04 - mean\_absolute\_error: 0.0116 90/126 [====================>.........] - ETA: 0s - loss: 2.6190e-04 - mean\_absolute\_error: 0.0117112/126 [=========================>....] - ETA: 0s - loss: 2.6383e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5946e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.3987e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9753e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 2.8110e-04 - mean\_absolute\_error: 0.0118 42/126 [=========>....................] - ETA: 0s - loss: 2.5995e-04 - mean\_absolute\_error: 0.0117 63/126 [==============>...............] - ETA: 0s - loss: 2.6767e-04 - mean\_absolute\_error: 0.0118 83/126 [==================>...........] - ETA: 0s - loss: 2.7412e-04 - mean\_absolute\_error: 0.0120104/126 [=======================>......] - ETA: 0s - loss: 2.6653e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - ETA: 0s - loss: 2.6952e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6952e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.8160e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4403e-04 - mean\_absolute\_error: 0.0129 23/126 [====>.........................] - ETA: 0s - loss: 2.7070e-04 - mean\_absolute\_error: 0.0121 45/126 [=========>....................] - ETA: 0s - loss: 2.6840e-04 - mean\_absolute\_error: 0.0122 66/126 [==============>...............] - ETA: 0s - loss: 2.6272e-04 - mean\_absolute\_error: 0.0119 87/126 [===================>..........] - ETA: 0s - loss: 2.6340e-04 - mean\_absolute\_error: 0.0119109/126 [========================>.....] - ETA: 0s - loss: 2.6415e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6773e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.4278e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5009e-04 - mean\_absolute\_error: 0.0118 24/126 [====>.........................] - ETA: 0s - loss: 2.6233e-04 - mean\_absolute\_error: 0.0116 46/126 [=========>....................] - ETA: 0s - loss: 3.0308e-04 - mean\_absolute\_error: 0.0121 68/126 [===============>..............] - ETA: 0s - loss: 2.8471e-04 - mean\_absolute\_error: 0.0121 90/126 [====================>.........] - ETA: 0s - loss: 2.7761e-04 - mean\_absolute\_error: 0.0120112/126 [=========================>....] - ETA: 0s - loss: 2.7850e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.7319e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.2231e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9957e-04 - mean\_absolute\_error: 0.0113 23/126 [====>.........................] - ETA: 0s - loss: 3.0284e-04 - mean\_absolute\_error: 0.0126 44/126 [=========>....................] - ETA: 0s - loss: 2.7812e-04 - mean\_absolute\_error: 0.0122 66/126 [==============>...............] - ETA: 0s - loss: 2.6756e-04 - mean\_absolute\_error: 0.0119 88/126 [===================>..........] - ETA: 0s - loss: 2.6931e-04 - mean\_absolute\_error: 0.0121110/126 [=========================>....] - ETA: 0s - loss: 2.8262e-04 - mean\_absolute\_error: 0.0122126/126 [==============================] - 0s 3ms/step - loss: 2.7893e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.2579e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1209e-04 - mean\_absolute\_error: 0.0083 24/126 [====>.........................] - ETA: 0s - loss: 2.8180e-04 - mean\_absolute\_error: 0.0122 46/126 [=========>....................] - ETA: 0s - loss: 2.6572e-04 - mean\_absolute\_error: 0.0120 68/126 [===============>..............] - ETA: 0s - loss: 2.8476e-04 - mean\_absolute\_error: 0.0122 90/126 [====================>.........] - ETA: 0s - loss: 2.9061e-04 - mean\_absolute\_error: 0.0125112/126 [=========================>....] - ETA: 0s - loss: 2.8823e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 3ms/step - loss: 2.8596e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 2.0691e-04 - val\_mean\_absolute\_error: 0.0119  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3410e-04 - mean\_absolute\_error: 0.0124 24/126 [====>.........................] - ETA: 0s - loss: 2.7943e-04 - mean\_absolute\_error: 0.0121 47/126 [==========>...................] - ETA: 0s - loss: 2.8248e-04 - mean\_absolute\_error: 0.0121 68/126 [===============>..............] - ETA: 0s - loss: 2.7531e-04 - mean\_absolute\_error: 0.0122 90/126 [====================>.........] - ETA: 0s - loss: 2.9279e-04 - mean\_absolute\_error: 0.0125112/126 [=========================>....] - ETA: 0s - loss: 3.0893e-04 - mean\_absolute\_error: 0.0129126/126 [==============================] - 0s 3ms/step - loss: 3.0903e-04 - mean\_absolute\_error: 0.0129 - val\_loss: 1.3595e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5116e-04 - mean\_absolute\_error: 0.0094 24/126 [====>.........................] - ETA: 0s - loss: 2.3239e-04 - mean\_absolute\_error: 0.0108 46/126 [=========>....................] - ETA: 0s - loss: 2.9535e-04 - mean\_absolute\_error: 0.0127 68/126 [===============>..............] - ETA: 0s - loss: 2.9713e-04 - mean\_absolute\_error: 0.0127 90/126 [====================>.........] - ETA: 0s - loss: 2.8875e-04 - mean\_absolute\_error: 0.0125113/126 [=========================>....] - ETA: 0s - loss: 2.7953e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 3ms/step - loss: 2.8295e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 1.4288e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8001e-04 - mean\_absolute\_error: 0.0094 23/126 [====>.........................] - ETA: 0s - loss: 2.9862e-04 - mean\_absolute\_error: 0.0125 45/126 [=========>....................] - ETA: 0s - loss: 2.8016e-04 - mean\_absolute\_error: 0.0120 66/126 [==============>...............] - ETA: 0s - loss: 2.8598e-04 - mean\_absolute\_error: 0.0121 88/126 [===================>..........] - ETA: 0s - loss: 2.7362e-04 - mean\_absolute\_error: 0.0120110/126 [=========================>....] - ETA: 0s - loss: 2.7598e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.7470e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.2412e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9190e-04 - mean\_absolute\_error: 0.0115 23/126 [====>.........................] - ETA: 0s - loss: 2.6044e-04 - mean\_absolute\_error: 0.0116 46/126 [=========>....................] - ETA: 0s - loss: 2.5872e-04 - mean\_absolute\_error: 0.0118 68/126 [===============>..............] - ETA: 0s - loss: 2.6536e-04 - mean\_absolute\_error: 0.0121 90/126 [====================>.........] - ETA: 0s - loss: 2.6276e-04 - mean\_absolute\_error: 0.0120112/126 [=========================>....] - ETA: 0s - loss: 2.7018e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.7576e-04 - mean\_absolute\_error: 0.0121 - val\_loss: 1.2038e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4892e-04 - mean\_absolute\_error: 0.0142 23/126 [====>.........................] - ETA: 0s - loss: 2.5949e-04 - mean\_absolute\_error: 0.0121 45/126 [=========>....................] - ETA: 0s - loss: 2.5632e-04 - mean\_absolute\_error: 0.0121 67/126 [==============>...............] - ETA: 0s - loss: 2.5303e-04 - mean\_absolute\_error: 0.0120 89/126 [====================>.........] - ETA: 0s - loss: 2.5547e-04 - mean\_absolute\_error: 0.0118111/126 [=========================>....] - ETA: 0s - loss: 2.6557e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.6390e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.1989e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6700e-04 - mean\_absolute\_error: 0.0110 24/126 [====>.........................] - ETA: 0s - loss: 2.3127e-04 - mean\_absolute\_error: 0.0111 46/126 [=========>....................] - ETA: 0s - loss: 2.4288e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.5219e-04 - mean\_absolute\_error: 0.0114 90/126 [====================>.........] - ETA: 0s - loss: 2.6145e-04 - mean\_absolute\_error: 0.0118111/126 [=========================>....] - ETA: 0s - loss: 2.5929e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5522e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.1908e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0083e-04 - mean\_absolute\_error: 0.0114 24/126 [====>.........................] - ETA: 0s - loss: 2.3858e-04 - mean\_absolute\_error: 0.0110 46/126 [=========>....................] - ETA: 0s - loss: 2.6458e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.4912e-04 - mean\_absolute\_error: 0.0114 90/126 [====================>.........] - ETA: 0s - loss: 2.5365e-04 - mean\_absolute\_error: 0.0113109/126 [========================>.....] - ETA: 0s - loss: 2.5329e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4701e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1961e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7772e-04 - mean\_absolute\_error: 0.0106 23/126 [====>.........................] - ETA: 0s - loss: 2.2294e-04 - mean\_absolute\_error: 0.0110 45/126 [=========>....................] - ETA: 0s - loss: 2.6475e-04 - mean\_absolute\_error: 0.0116 66/126 [==============>...............] - ETA: 0s - loss: 2.6199e-04 - mean\_absolute\_error: 0.0117 88/126 [===================>..........] - ETA: 0s - loss: 2.6336e-04 - mean\_absolute\_error: 0.0117110/126 [=========================>....] - ETA: 0s - loss: 2.6192e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.6233e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 4.2041e-04 - val\_mean\_absolute\_error: 0.0180  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7244e-04 - mean\_absolute\_error: 0.0229 24/126 [====>.........................] - ETA: 0s - loss: 3.5437e-04 - mean\_absolute\_error: 0.0143 45/126 [=========>....................] - ETA: 0s - loss: 3.7710e-04 - mean\_absolute\_error: 0.0145 67/126 [==============>...............] - ETA: 0s - loss: 3.6284e-04 - mean\_absolute\_error: 0.0143 89/126 [====================>.........] - ETA: 0s - loss: 3.5990e-04 - mean\_absolute\_error: 0.0140111/126 [=========================>....] - ETA: 0s - loss: 3.3214e-04 - mean\_absolute\_error: 0.0134126/126 [==============================] - 0s 3ms/step - loss: 3.1936e-04 - mean\_absolute\_error: 0.0132 - val\_loss: 1.1960e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9261e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 3.0058e-04 - mean\_absolute\_error: 0.0134 45/126 [=========>....................] - ETA: 0s - loss: 2.8392e-04 - mean\_absolute\_error: 0.0126 68/126 [===============>..............] - ETA: 0s - loss: 2.8567e-04 - mean\_absolute\_error: 0.0124 90/126 [====================>.........] - ETA: 0s - loss: 2.9976e-04 - mean\_absolute\_error: 0.0128112/126 [=========================>....] - ETA: 0s - loss: 2.8694e-04 - mean\_absolute\_error: 0.0125126/126 [==============================] - 0s 3ms/step - loss: 2.8115e-04 - mean\_absolute\_error: 0.0124 - val\_loss: 1.4077e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5880e-05 - mean\_absolute\_error: 0.0071 23/126 [====>.........................] - ETA: 0s - loss: 2.9757e-04 - mean\_absolute\_error: 0.0127 45/126 [=========>....................] - ETA: 0s - loss: 3.1222e-04 - mean\_absolute\_error: 0.0128 67/126 [==============>...............] - ETA: 0s - loss: 2.8387e-04 - mean\_absolute\_error: 0.0123 89/126 [====================>.........] - ETA: 0s - loss: 2.8223e-04 - mean\_absolute\_error: 0.0121111/126 [=========================>....] - ETA: 0s - loss: 2.6968e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.7247e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.8956e-04 - val\_mean\_absolute\_error: 0.0110  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7270e-04 - mean\_absolute\_error: 0.0137 24/126 [====>.........................] - ETA: 0s - loss: 2.2467e-04 - mean\_absolute\_error: 0.0109 46/126 [=========>....................] - ETA: 0s - loss: 2.3610e-04 - mean\_absolute\_error: 0.0111 68/126 [===============>..............] - ETA: 0s - loss: 2.4606e-04 - mean\_absolute\_error: 0.0114 90/126 [====================>.........] - ETA: 0s - loss: 2.6145e-04 - mean\_absolute\_error: 0.0116112/126 [=========================>....] - ETA: 0s - loss: 2.6555e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.6529e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 1.6229e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7478e-04 - mean\_absolute\_error: 0.0161 23/126 [====>.........................] - ETA: 0s - loss: 3.1396e-04 - mean\_absolute\_error: 0.0124 45/126 [=========>....................] - ETA: 0s - loss: 3.9648e-04 - mean\_absolute\_error: 0.0148 67/126 [==============>...............] - ETA: 0s - loss: 4.0543e-04 - mean\_absolute\_error: 0.0150 89/126 [====================>.........] - ETA: 0s - loss: 3.8579e-04 - mean\_absolute\_error: 0.0148112/126 [=========================>....] - ETA: 0s - loss: 3.6025e-04 - mean\_absolute\_error: 0.0144126/126 [==============================] - 0s 3ms/step - loss: 3.4282e-04 - mean\_absolute\_error: 0.0140 - val\_loss: 1.3999e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2517e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 2.4188e-04 - mean\_absolute\_error: 0.0112 46/126 [=========>....................] - ETA: 0s - loss: 2.6820e-04 - mean\_absolute\_error: 0.0121 68/126 [===============>..............] - ETA: 0s - loss: 2.7711e-04 - mean\_absolute\_error: 0.0122 90/126 [====================>.........] - ETA: 0s - loss: 2.7070e-04 - mean\_absolute\_error: 0.0120112/126 [=========================>....] - ETA: 0s - loss: 2.6666e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.7208e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.2816e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9528e-04 - mean\_absolute\_error: 0.0110 24/126 [====>.........................] - ETA: 0s - loss: 2.7355e-04 - mean\_absolute\_error: 0.0118 45/126 [=========>....................] - ETA: 0s - loss: 2.4520e-04 - mean\_absolute\_error: 0.0116 66/126 [==============>...............] - ETA: 0s - loss: 2.5439e-04 - mean\_absolute\_error: 0.0116 88/126 [===================>..........] - ETA: 0s - loss: 2.5300e-04 - mean\_absolute\_error: 0.0115110/126 [=========================>....] - ETA: 0s - loss: 2.5764e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5965e-04 - mean\_absolute\_error: 0.0118 - val\_loss: 3.0122e-04 - val\_mean\_absolute\_error: 0.0148  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3503e-04 - mean\_absolute\_error: 0.0150 23/126 [====>.........................] - ETA: 0s - loss: 3.2431e-04 - mean\_absolute\_error: 0.0130 45/126 [=========>....................] - ETA: 0s - loss: 3.0216e-04 - mean\_absolute\_error: 0.0129 67/126 [==============>...............] - ETA: 0s - loss: 2.7121e-04 - mean\_absolute\_error: 0.0122 89/126 [====================>.........] - ETA: 0s - loss: 2.7351e-04 - mean\_absolute\_error: 0.0121112/126 [=========================>....] - ETA: 0s - loss: 2.6615e-04 - mean\_absolute\_error: 0.0120126/126 [==============================] - 0s 3ms/step - loss: 2.6639e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 1.1751e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6789e-04 - mean\_absolute\_error: 0.0102 24/126 [====>.........................] - ETA: 0s - loss: 2.2548e-04 - mean\_absolute\_error: 0.0110 46/126 [=========>....................] - ETA: 0s - loss: 3.3493e-04 - mean\_absolute\_error: 0.0133 68/126 [===============>..............] - ETA: 0s - loss: 3.0468e-04 - mean\_absolute\_error: 0.0128 90/126 [====================>.........] - ETA: 0s - loss: 2.8495e-04 - mean\_absolute\_error: 0.0124112/126 [=========================>....] - ETA: 0s - loss: 2.7810e-04 - mean\_absolute\_error: 0.0124126/126 [==============================] - 0s 3ms/step - loss: 2.7469e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 3.1431e-04 - val\_mean\_absolute\_error: 0.0150  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9332e-04 - mean\_absolute\_error: 0.0142 23/126 [====>.........................] - ETA: 0s - loss: 3.4484e-04 - mean\_absolute\_error: 0.0139 42/126 [=========>....................] - ETA: 0s - loss: 3.5777e-04 - mean\_absolute\_error: 0.0143 63/126 [==============>...............] - ETA: 0s - loss: 3.2930e-04 - mean\_absolute\_error: 0.0136 84/126 [===================>..........] - ETA: 0s - loss: 3.2350e-04 - mean\_absolute\_error: 0.0133106/126 [========================>.....] - ETA: 0s - loss: 3.0985e-04 - mean\_absolute\_error: 0.0129126/126 [==============================] - 0s 3ms/step - loss: 2.9492e-04 - mean\_absolute\_error: 0.0126 - val\_loss: 1.5464e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7322e-04 - mean\_absolute\_error: 0.0108 23/126 [====>.........................] - ETA: 0s - loss: 2.0200e-04 - mean\_absolute\_error: 0.0107 45/126 [=========>....................] - ETA: 0s - loss: 2.5987e-04 - mean\_absolute\_error: 0.0119 66/126 [==============>...............] - ETA: 0s - loss: 2.5203e-04 - mean\_absolute\_error: 0.0117 89/126 [====================>.........] - ETA: 0s - loss: 2.7099e-04 - mean\_absolute\_error: 0.0119111/126 [=========================>....] - ETA: 0s - loss: 2.6757e-04 - mean\_absolute\_error: 0.0119126/126 [==============================] - 0s 3ms/step - loss: 2.5663e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.5311e-04 - val\_mean\_absolute\_error: 0.0097  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5770e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 2.5874e-04 - mean\_absolute\_error: 0.0116 45/126 [=========>....................] - ETA: 0s - loss: 2.5691e-04 - mean\_absolute\_error: 0.0112 67/126 [==============>...............] - ETA: 0s - loss: 2.5023e-04 - mean\_absolute\_error: 0.0113 89/126 [====================>.........] - ETA: 0s - loss: 2.4693e-04 - mean\_absolute\_error: 0.0113111/126 [=========================>....] - ETA: 0s - loss: 2.5163e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.5171e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.7753e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8972e-04 - mean\_absolute\_error: 0.0106 22/126 [====>.........................] - ETA: 0s - loss: 2.2414e-04 - mean\_absolute\_error: 0.0109 43/126 [=========>....................] - ETA: 0s - loss: 2.3616e-04 - mean\_absolute\_error: 0.0110 65/126 [==============>...............] - ETA: 0s - loss: 2.7769e-04 - mean\_absolute\_error: 0.0122 87/126 [===================>..........] - ETA: 0s - loss: 2.7470e-04 - mean\_absolute\_error: 0.0120108/126 [========================>.....] - ETA: 0s - loss: 2.8244e-04 - mean\_absolute\_error: 0.0123126/126 [==============================] - 0s 3ms/step - loss: 2.8204e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 2.4301e-04 - val\_mean\_absolute\_error: 0.0128  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3912e-04 - mean\_absolute\_error: 0.0118 23/126 [====>.........................] - ETA: 0s - loss: 3.2161e-04 - mean\_absolute\_error: 0.0130 45/126 [=========>....................] - ETA: 0s - loss: 2.8437e-04 - mean\_absolute\_error: 0.0123 66/126 [==============>...............] - ETA: 0s - loss: 2.6168e-04 - mean\_absolute\_error: 0.0117 88/126 [===================>..........] - ETA: 0s - loss: 2.5560e-04 - mean\_absolute\_error: 0.0116109/126 [========================>.....] - ETA: 0s - loss: 2.6611e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5693e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 2.5299e-04 - val\_mean\_absolute\_error: 0.0134  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3274e-04 - mean\_absolute\_error: 0.0129 23/126 [====>.........................] - ETA: 0s - loss: 2.7640e-04 - mean\_absolute\_error: 0.0122 45/126 [=========>....................] - ETA: 0s - loss: 2.6112e-04 - mean\_absolute\_error: 0.0116 67/126 [==============>...............] - ETA: 0s - loss: 2.6550e-04 - mean\_absolute\_error: 0.0118 89/126 [====================>.........] - ETA: 0s - loss: 2.5895e-04 - mean\_absolute\_error: 0.0117111/126 [=========================>....] - ETA: 0s - loss: 2.5739e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5786e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 3.8538e-04 - val\_mean\_absolute\_error: 0.0170  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1194e-04 - mean\_absolute\_error: 0.0166 24/126 [====>.........................] - ETA: 0s - loss: 3.1067e-04 - mean\_absolute\_error: 0.0134 46/126 [=========>....................] - ETA: 0s - loss: 2.9459e-04 - mean\_absolute\_error: 0.0126 68/126 [===============>..............] - ETA: 0s - loss: 2.8493e-04 - mean\_absolute\_error: 0.0124 90/126 [====================>.........] - ETA: 0s - loss: 2.7595e-04 - mean\_absolute\_error: 0.0121111/126 [=========================>....] - ETA: 0s - loss: 2.6897e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.7365e-04 - mean\_absolute\_error: 0.0122 - val\_loss: 1.3759e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1636e-04 - mean\_absolute\_error: 0.0120 24/126 [====>.........................] - ETA: 0s - loss: 3.5308e-04 - mean\_absolute\_error: 0.0146 45/126 [=========>....................] - ETA: 0s - loss: 3.1997e-04 - mean\_absolute\_error: 0.0137 67/126 [==============>...............] - ETA: 0s - loss: 3.0462e-04 - mean\_absolute\_error: 0.0128 89/126 [====================>.........] - ETA: 0s - loss: 2.8904e-04 - mean\_absolute\_error: 0.0124111/126 [=========================>....] - ETA: 0s - loss: 2.7135e-04 - mean\_absolute\_error: 0.0121126/126 [==============================] - 0s 3ms/step - loss: 2.6354e-04 - mean\_absolute\_error: 0.0119 - val\_loss: 1.1354e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7367e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 2.3643e-04 - mean\_absolute\_error: 0.0108 47/126 [==========>...................] - ETA: 0s - loss: 2.4384e-04 - mean\_absolute\_error: 0.0110 70/126 [===============>..............] - ETA: 0s - loss: 2.3457e-04 - mean\_absolute\_error: 0.0110 92/126 [====================>.........] - ETA: 0s - loss: 2.3563e-04 - mean\_absolute\_error: 0.0111114/126 [==========================>...] - ETA: 0s - loss: 2.4769e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.5853e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 2.1141e-04 - val\_mean\_absolute\_error: 0.0118  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5118e-04 - mean\_absolute\_error: 0.0122 22/126 [====>.........................] - ETA: 0s - loss: 3.9554e-04 - mean\_absolute\_error: 0.0148 44/126 [=========>....................] - ETA: 0s - loss: 3.4475e-04 - mean\_absolute\_error: 0.0138 66/126 [==============>...............] - ETA: 0s - loss: 3.0828e-04 - mean\_absolute\_error: 0.0130 87/126 [===================>..........] - ETA: 0s - loss: 3.0400e-04 - mean\_absolute\_error: 0.0129110/126 [=========================>....] - ETA: 0s - loss: 2.8920e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.8146e-04 - mean\_absolute\_error: 0.0125 - val\_loss: 1.3279e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7136e-04 - mean\_absolute\_error: 0.0112 24/126 [====>.........................] - ETA: 0s - loss: 2.2327e-04 - mean\_absolute\_error: 0.0112 47/126 [==========>...................] - ETA: 0s - loss: 2.6027e-04 - mean\_absolute\_error: 0.0114 69/126 [===============>..............] - ETA: 0s - loss: 2.5285e-04 - mean\_absolute\_error: 0.0114 92/126 [====================>.........] - ETA: 0s - loss: 2.4434e-04 - mean\_absolute\_error: 0.0113114/126 [==========================>...] - ETA: 0s - loss: 2.4696e-04 - mean\_absolute\_error: 0.0114126/126 [==============================] - 0s 3ms/step - loss: 2.4651e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1635e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2043e-04 - mean\_absolute\_error: 0.0117 24/126 [====>.........................] - ETA: 0s - loss: 3.2604e-04 - mean\_absolute\_error: 0.0131 46/126 [=========>....................] - ETA: 0s - loss: 2.6669e-04 - mean\_absolute\_error: 0.0120 68/126 [===============>..............] - ETA: 0s - loss: 2.6320e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.4545e-04 - mean\_absolute\_error: 0.0114112/126 [=========================>....] - ETA: 0s - loss: 2.4151e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4583e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.1811e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7613e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 2.4666e-04 - mean\_absolute\_error: 0.0118 46/126 [=========>....................] - ETA: 0s - loss: 2.6218e-04 - mean\_absolute\_error: 0.0119 68/126 [===============>..............] - ETA: 0s - loss: 2.5783e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.4967e-04 - mean\_absolute\_error: 0.0115112/126 [=========================>....] - ETA: 0s - loss: 2.5008e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4230e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.9853e-04 - val\_mean\_absolute\_error: 0.0116  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5637e-04 - mean\_absolute\_error: 0.0132 24/126 [====>.........................] - ETA: 0s - loss: 3.0147e-04 - mean\_absolute\_error: 0.0132 46/126 [=========>....................] - ETA: 0s - loss: 3.5840e-04 - mean\_absolute\_error: 0.0143 68/126 [===============>..............] - ETA: 0s - loss: 3.3557e-04 - mean\_absolute\_error: 0.0137 90/126 [====================>.........] - ETA: 0s - loss: 3.0185e-04 - mean\_absolute\_error: 0.0130112/126 [=========================>....] - ETA: 0s - loss: 2.9584e-04 - mean\_absolute\_error: 0.0128126/126 [==============================] - 0s 3ms/step - loss: 2.9650e-04 - mean\_absolute\_error: 0.0128 - val\_loss: 2.4785e-04 - val\_mean\_absolute\_error: 0.0130  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2645e-04 - mean\_absolute\_error: 0.0123 24/126 [====>.........................] - ETA: 0s - loss: 4.0895e-04 - mean\_absolute\_error: 0.0155 46/126 [=========>....................] - ETA: 0s - loss: 3.6527e-04 - mean\_absolute\_error: 0.0143 68/126 [===============>..............] - ETA: 0s - loss: 3.1197e-04 - mean\_absolute\_error: 0.0131 90/126 [====================>.........] - ETA: 0s - loss: 2.9936e-04 - mean\_absolute\_error: 0.0127113/126 [=========================>....] - ETA: 0s - loss: 2.8925e-04 - mean\_absolute\_error: 0.0125126/126 [==============================] - 0s 3ms/step - loss: 2.8437e-04 - mean\_absolute\_error: 0.0124 - val\_loss: 1.3197e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3363e-04 - mean\_absolute\_error: 0.0126 22/126 [====>.........................] - ETA: 0s - loss: 2.3148e-04 - mean\_absolute\_error: 0.0111 44/126 [=========>....................] - ETA: 0s - loss: 2.6904e-04 - mean\_absolute\_error: 0.0121 63/126 [==============>...............] - ETA: 0s - loss: 2.7113e-04 - mean\_absolute\_error: 0.0121 85/126 [===================>..........] - ETA: 0s - loss: 2.6558e-04 - mean\_absolute\_error: 0.0120107/126 [========================>.....] - ETA: 0s - loss: 2.5912e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5205e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 2.5859e-04 - val\_mean\_absolute\_error: 0.0137  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2349e-04 - mean\_absolute\_error: 0.0151 23/126 [====>.........................] - ETA: 0s - loss: 3.1651e-04 - mean\_absolute\_error: 0.0128 45/126 [=========>....................] - ETA: 0s - loss: 2.7108e-04 - mean\_absolute\_error: 0.0121 67/126 [==============>...............] - ETA: 0s - loss: 2.5288e-04 - mean\_absolute\_error: 0.0116 89/126 [====================>.........] - ETA: 0s - loss: 2.6411e-04 - mean\_absolute\_error: 0.0117111/126 [=========================>....] - ETA: 0s - loss: 2.5086e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4430e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.0708e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7880e-04 - mean\_absolute\_error: 0.0112 24/126 [====>.........................] - ETA: 0s - loss: 2.3002e-04 - mean\_absolute\_error: 0.0108 46/126 [=========>....................] - ETA: 0s - loss: 2.5752e-04 - mean\_absolute\_error: 0.0116 68/126 [===============>..............] - ETA: 0s - loss: 2.6916e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.5109e-04 - mean\_absolute\_error: 0.0115112/126 [=========================>....] - ETA: 0s - loss: 2.3983e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.4298e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 2.7833e-04 - val\_mean\_absolute\_error: 0.0140  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4437e-04 - mean\_absolute\_error: 0.0163 24/126 [====>.........................] - ETA: 0s - loss: 2.7774e-04 - mean\_absolute\_error: 0.0122 46/126 [=========>....................] - ETA: 0s - loss: 2.4421e-04 - mean\_absolute\_error: 0.0118 68/126 [===============>..............] - ETA: 0s - loss: 2.5057e-04 - mean\_absolute\_error: 0.0118 90/126 [====================>.........] - ETA: 0s - loss: 2.5716e-04 - mean\_absolute\_error: 0.0119111/126 [=========================>....] - ETA: 0s - loss: 2.5550e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.4998e-04 - mean\_absolute\_error: 0.0117 - val\_loss: 1.2157e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7914e-04 - mean\_absolute\_error: 0.0131 24/126 [====>.........................] - ETA: 0s - loss: 1.9357e-04 - mean\_absolute\_error: 0.0098 47/126 [==========>...................] - ETA: 0s - loss: 2.0486e-04 - mean\_absolute\_error: 0.0102 69/126 [===============>..............] - ETA: 0s - loss: 2.1493e-04 - mean\_absolute\_error: 0.0106 90/126 [====================>.........] - ETA: 0s - loss: 2.2394e-04 - mean\_absolute\_error: 0.0110112/126 [=========================>....] - ETA: 0s - loss: 2.3651e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3678e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.9054e-04 - val\_mean\_absolute\_error: 0.0111  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7173e-04 - mean\_absolute\_error: 0.0153 23/126 [====>.........................] - ETA: 0s - loss: 2.4419e-04 - mean\_absolute\_error: 0.0116 45/126 [=========>....................] - ETA: 0s - loss: 2.3159e-04 - mean\_absolute\_error: 0.0111 67/126 [==============>...............] - ETA: 0s - loss: 2.4094e-04 - mean\_absolute\_error: 0.0115 89/126 [====================>.........] - ETA: 0s - loss: 2.4584e-04 - mean\_absolute\_error: 0.0114111/126 [=========================>....] - ETA: 0s - loss: 2.4284e-04 - mean\_absolute\_error: 0.0113126/126 [==============================] - 0s 3ms/step - loss: 2.3440e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.1583e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9745e-04 - mean\_absolute\_error: 0.0121 23/126 [====>.........................] - ETA: 0s - loss: 2.1255e-04 - mean\_absolute\_error: 0.0100 45/126 [=========>....................] - ETA: 0s - loss: 2.2622e-04 - mean\_absolute\_error: 0.0105 67/126 [==============>...............] - ETA: 0s - loss: 2.2196e-04 - mean\_absolute\_error: 0.0105 89/126 [====================>.........] - ETA: 0s - loss: 2.1322e-04 - mean\_absolute\_error: 0.0105111/126 [=========================>....] - ETA: 0s - loss: 2.2369e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.2354e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.1579e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0124e-04 - mean\_absolute\_error: 0.0151 24/126 [====>.........................] - ETA: 0s - loss: 2.5633e-04 - mean\_absolute\_error: 0.0109 46/126 [=========>....................] - ETA: 0s - loss: 2.7750e-04 - mean\_absolute\_error: 0.0117 68/126 [===============>..............] - ETA: 0s - loss: 3.0198e-04 - mean\_absolute\_error: 0.0124 90/126 [====================>.........] - ETA: 0s - loss: 2.9316e-04 - mean\_absolute\_error: 0.0124112/126 [=========================>....] - ETA: 0s - loss: 2.6588e-04 - mean\_absolute\_error: 0.0118126/126 [==============================] - 0s 3ms/step - loss: 2.5663e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.0406e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9544e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 2.3325e-04 - mean\_absolute\_error: 0.0104 46/126 [=========>....................] - ETA: 0s - loss: 2.1572e-04 - mean\_absolute\_error: 0.0104 68/126 [===============>..............] - ETA: 0s - loss: 2.1492e-04 - mean\_absolute\_error: 0.0104 90/126 [====================>.........] - ETA: 0s - loss: 2.2544e-04 - mean\_absolute\_error: 0.0110112/126 [=========================>....] - ETA: 0s - loss: 2.2813e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.3008e-04 - mean\_absolute\_error: 0.0111 - val\_loss: 1.0601e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5737e-04 - mean\_absolute\_error: 0.0110 24/126 [====>.........................] - ETA: 0s - loss: 1.9537e-04 - mean\_absolute\_error: 0.0100 47/126 [==========>...................] - ETA: 0s - loss: 2.2882e-04 - mean\_absolute\_error: 0.0110 69/126 [===============>..............] - ETA: 0s - loss: 2.4080e-04 - mean\_absolute\_error: 0.0111 91/126 [====================>.........] - ETA: 0s - loss: 2.3785e-04 - mean\_absolute\_error: 0.0112112/126 [=========================>....] - ETA: 0s - loss: 2.6030e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.5345e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.0653e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3418e-04 - mean\_absolute\_error: 0.0092 24/126 [====>.........................] - ETA: 0s - loss: 2.0029e-04 - mean\_absolute\_error: 0.0100 46/126 [=========>....................] - ETA: 0s - loss: 1.9608e-04 - mean\_absolute\_error: 0.0102 68/126 [===============>..............] - ETA: 0s - loss: 2.1022e-04 - mean\_absolute\_error: 0.0105 90/126 [====================>.........] - ETA: 0s - loss: 2.1794e-04 - mean\_absolute\_error: 0.0106113/126 [=========================>....] - ETA: 0s - loss: 2.2649e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2857e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.0953e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5144e-04 - mean\_absolute\_error: 0.0102 23/126 [====>.........................] - ETA: 0s - loss: 1.9218e-04 - mean\_absolute\_error: 0.0106 45/126 [=========>....................] - ETA: 0s - loss: 2.1900e-04 - mean\_absolute\_error: 0.0110 67/126 [==============>...............] - ETA: 0s - loss: 2.3755e-04 - mean\_absolute\_error: 0.0114 89/126 [====================>.........] - ETA: 0s - loss: 2.3941e-04 - mean\_absolute\_error: 0.0114111/126 [=========================>....] - ETA: 0s - loss: 2.3079e-04 - mean\_absolute\_error: 0.0112126/126 [==============================] - 0s 3ms/step - loss: 2.3251e-04 - mean\_absolute\_error: 0.0112 - val\_loss: 1.8611e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1073e-04 - mean\_absolute\_error: 0.0111 24/126 [====>.........................] - ETA: 0s - loss: 2.0488e-04 - mean\_absolute\_error: 0.0105 46/126 [=========>....................] - ETA: 0s - loss: 1.9637e-04 - mean\_absolute\_error: 0.0103 68/126 [===============>..............] - ETA: 0s - loss: 2.2465e-04 - mean\_absolute\_error: 0.0110 90/126 [====================>.........] - ETA: 0s - loss: 2.3055e-04 - mean\_absolute\_error: 0.0111112/126 [=========================>....] - ETA: 0s - loss: 2.2713e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2400e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.0206e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1232e-04 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 1.8870e-04 - mean\_absolute\_error: 0.0103 46/126 [=========>....................] - ETA: 0s - loss: 1.9257e-04 - mean\_absolute\_error: 0.0102 68/126 [===============>..............] - ETA: 0s - loss: 2.0999e-04 - mean\_absolute\_error: 0.0107 90/126 [====================>.........] - ETA: 0s - loss: 2.4749e-04 - mean\_absolute\_error: 0.0117112/126 [=========================>....] - ETA: 0s - loss: 2.4589e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4127e-04 - mean\_absolute\_error: 0.0114 - val\_loss: 1.5663e-04 - val\_mean\_absolute\_error: 0.0102  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2893e-04 - mean\_absolute\_error: 0.0137 24/126 [====>.........................] - ETA: 0s - loss: 2.2116e-04 - mean\_absolute\_error: 0.0105 46/126 [=========>....................] - ETA: 0s - loss: 2.4384e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.9558e-04 - mean\_absolute\_error: 0.0127 90/126 [====================>.........] - ETA: 0s - loss: 2.8768e-04 - mean\_absolute\_error: 0.0124112/126 [=========================>....] - ETA: 0s - loss: 2.8635e-04 - mean\_absolute\_error: 0.0126126/126 [==============================] - 0s 3ms/step - loss: 2.8429e-04 - mean\_absolute\_error: 0.0125 - val\_loss: 1.0039e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7936e-04 - mean\_absolute\_error: 0.0117 24/126 [====>.........................] - ETA: 0s - loss: 2.3057e-04 - mean\_absolute\_error: 0.0115 46/126 [=========>....................] - ETA: 0s - loss: 2.7637e-04 - mean\_absolute\_error: 0.0123 68/126 [===============>..............] - ETA: 0s - loss: 2.7895e-04 - mean\_absolute\_error: 0.0124 90/126 [====================>.........] - ETA: 0s - loss: 2.5803e-04 - mean\_absolute\_error: 0.0117112/126 [=========================>....] - ETA: 0s - loss: 2.5414e-04 - mean\_absolute\_error: 0.0117126/126 [==============================] - 0s 3ms/step - loss: 2.4872e-04 - mean\_absolute\_error: 0.0115 - val\_loss: 1.2657e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7452e-05 - mean\_absolute\_error: 0.0085 24/126 [====>.........................] - ETA: 0s - loss: 1.9486e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 2.1115e-04 - mean\_absolute\_error: 0.0109 68/126 [===============>..............] - ETA: 0s - loss: 2.1524e-04 - mean\_absolute\_error: 0.0108 87/126 [===================>..........] - ETA: 0s - loss: 2.1523e-04 - mean\_absolute\_error: 0.0106108/126 [========================>.....] - ETA: 0s - loss: 2.1680e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.2002e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.4715e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3430e-04 - mean\_absolute\_error: 0.0095 23/126 [====>.........................] - ETA: 0s - loss: 2.4426e-04 - mean\_absolute\_error: 0.0110 45/126 [=========>....................] - ETA: 0s - loss: 2.3159e-04 - mean\_absolute\_error: 0.0109 67/126 [==============>...............] - ETA: 0s - loss: 2.2587e-04 - mean\_absolute\_error: 0.0107 89/126 [====================>.........] - ETA: 0s - loss: 2.1660e-04 - mean\_absolute\_error: 0.0106111/126 [=========================>....] - ETA: 0s - loss: 2.1389e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.0935e-04 - mean\_absolute\_error: 0.0105 - val\_loss: 1.7876e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1723e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 2.0198e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 2.0324e-04 - mean\_absolute\_error: 0.0106 68/126 [===============>..............] - ETA: 0s - loss: 2.1026e-04 - mean\_absolute\_error: 0.0107 90/126 [====================>.........] - ETA: 0s - loss: 2.1287e-04 - mean\_absolute\_error: 0.0108112/126 [=========================>....] - ETA: 0s - loss: 2.1450e-04 - mean\_absolute\_error: 0.0107126/126 [==============================] - 0s 3ms/step - loss: 2.1316e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 9.8068e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5431e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 1.7978e-04 - mean\_absolute\_error: 0.0100 45/126 [=========>....................] - ETA: 0s - loss: 1.9563e-04 - mean\_absolute\_error: 0.0101 67/126 [==============>...............] - ETA: 0s - loss: 2.0020e-04 - mean\_absolute\_error: 0.0104 89/126 [====================>.........] - ETA: 0s - loss: 2.1460e-04 - mean\_absolute\_error: 0.0108111/126 [=========================>....] - ETA: 0s - loss: 2.2488e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.3484e-04 - mean\_absolute\_error: 0.0113 - val\_loss: 1.1581e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3440e-04 - mean\_absolute\_error: 0.0096 24/126 [====>.........................] - ETA: 0s - loss: 2.4259e-04 - mean\_absolute\_error: 0.0117 46/126 [=========>....................] - ETA: 0s - loss: 2.1775e-04 - mean\_absolute\_error: 0.0109 68/126 [===============>..............] - ETA: 0s - loss: 2.5115e-04 - mean\_absolute\_error: 0.0114 90/126 [====================>.........] - ETA: 0s - loss: 2.3274e-04 - mean\_absolute\_error: 0.0111112/126 [=========================>....] - ETA: 0s - loss: 2.2537e-04 - mean\_absolute\_error: 0.0109126/126 [==============================] - 0s 3ms/step - loss: 2.2208e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.8632e-04 - val\_mean\_absolute\_error: 0.0113  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1314e-04 - mean\_absolute\_error: 0.0134 24/126 [====>.........................] - ETA: 0s - loss: 2.7154e-04 - mean\_absolute\_error: 0.0125 46/126 [=========>....................] - ETA: 0s - loss: 2.4899e-04 - mean\_absolute\_error: 0.0116 68/126 [===============>..............] - ETA: 0s - loss: 2.4288e-04 - mean\_absolute\_error: 0.0112 90/126 [====================>.........] - ETA: 0s - loss: 2.2973e-04 - mean\_absolute\_error: 0.0109111/126 [=========================>....] - ETA: 0s - loss: 2.3067e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 2.2561e-04 - mean\_absolute\_error: 0.0109 - val\_loss: 1.2844e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4355e-04 - mean\_absolute\_error: 0.0128 24/126 [====>.........................] - ETA: 0s - loss: 1.7458e-04 - mean\_absolute\_error: 0.0098 47/126 [==========>...................] - ETA: 0s - loss: 2.1034e-04 - mean\_absolute\_error: 0.0104 69/126 [===============>..............] - ETA: 0s - loss: 2.1297e-04 - mean\_absolute\_error: 0.0106 91/126 [====================>.........] - ETA: 0s - loss: 2.2951e-04 - mean\_absolute\_error: 0.0112113/126 [=========================>....] - ETA: 0s - loss: 2.4157e-04 - mean\_absolute\_error: 0.0115126/126 [==============================] - 0s 3ms/step - loss: 2.4388e-04 - mean\_absolute\_error: 0.0116 - val\_loss: 1.8872e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4127e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 1.7310e-04 - mean\_absolute\_error: 0.0101 47/126 [==========>...................] - ETA: 0s - loss: 2.1008e-04 - mean\_absolute\_error: 0.0107 69/126 [===============>..............] - ETA: 0s - loss: 2.0591e-04 - mean\_absolute\_error: 0.0104 91/126 [====================>.........] - ETA: 0s - loss: 2.1330e-04 - mean\_absolute\_error: 0.0104113/126 [=========================>....] - ETA: 0s - loss: 2.0954e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0661e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 9.6931e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8274e-04 - mean\_absolute\_error: 0.0120 23/126 [====>.........................] - ETA: 0s - loss: 1.9232e-04 - mean\_absolute\_error: 0.0104 45/126 [=========>....................] - ETA: 0s - loss: 2.2110e-04 - mean\_absolute\_error: 0.0106 67/126 [==============>...............] - ETA: 0s - loss: 2.1178e-04 - mean\_absolute\_error: 0.0104 90/126 [====================>.........] - ETA: 0s - loss: 1.9971e-04 - mean\_absolute\_error: 0.0102112/126 [=========================>....] - ETA: 0s - loss: 1.9989e-04 - mean\_absolute\_error: 0.0101126/126 [==============================] - 0s 3ms/step - loss: 1.9838e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 9.4367e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2500e-04 - mean\_absolute\_error: 0.0083 24/126 [====>.........................] - ETA: 0s - loss: 2.0864e-04 - mean\_absolute\_error: 0.0109 47/126 [==========>...................] - ETA: 0s - loss: 2.1488e-04 - mean\_absolute\_error: 0.0108 69/126 [===============>..............] - ETA: 0s - loss: 2.0996e-04 - mean\_absolute\_error: 0.0105 91/126 [====================>.........] - ETA: 0s - loss: 2.1589e-04 - mean\_absolute\_error: 0.0107113/126 [=========================>....] - ETA: 0s - loss: 2.1036e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.1311e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 1.4639e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9246e-04 - mean\_absolute\_error: 0.0133 24/126 [====>.........................] - ETA: 0s - loss: 2.1982e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 1.9905e-04 - mean\_absolute\_error: 0.0103 69/126 [===============>..............] - ETA: 0s - loss: 2.1227e-04 - mean\_absolute\_error: 0.0106 91/126 [====================>.........] - ETA: 0s - loss: 2.0742e-04 - mean\_absolute\_error: 0.0103113/126 [=========================>....] - ETA: 0s - loss: 1.9978e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 1.9674e-04 - mean\_absolute\_error: 0.0101 - val\_loss: 1.0783e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6991e-04 - mean\_absolute\_error: 0.0094 24/126 [====>.........................] - ETA: 0s - loss: 1.5024e-04 - mean\_absolute\_error: 0.0094 46/126 [=========>....................] - ETA: 0s - loss: 2.1063e-04 - mean\_absolute\_error: 0.0106 69/126 [===============>..............] - ETA: 0s - loss: 2.1535e-04 - mean\_absolute\_error: 0.0105 92/126 [====================>.........] - ETA: 0s - loss: 2.1523e-04 - mean\_absolute\_error: 0.0106114/126 [==========================>...] - ETA: 0s - loss: 2.1781e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 2.2376e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 1.4539e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5433e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 1.8464e-04 - mean\_absolute\_error: 0.0099 45/126 [=========>....................] - ETA: 0s - loss: 2.0429e-04 - mean\_absolute\_error: 0.0100 67/126 [==============>...............] - ETA: 0s - loss: 2.2306e-04 - mean\_absolute\_error: 0.0106 89/126 [====================>.........] - ETA: 0s - loss: 2.1650e-04 - mean\_absolute\_error: 0.0106111/126 [=========================>....] - ETA: 0s - loss: 2.0953e-04 - mean\_absolute\_error: 0.0105126/126 [==============================] - 0s 3ms/step - loss: 2.0649e-04 - mean\_absolute\_error: 0.0104 - val\_loss: 1.2429e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7196e-04 - mean\_absolute\_error: 0.0104 23/126 [====>.........................] - ETA: 0s - loss: 1.9858e-04 - mean\_absolute\_error: 0.0096 45/126 [=========>....................] - ETA: 0s - loss: 1.9214e-04 - mean\_absolute\_error: 0.0096 67/126 [==============>...............] - ETA: 0s - loss: 1.8570e-04 - mean\_absolute\_error: 0.0097 89/126 [====================>.........] - ETA: 0s - loss: 1.9637e-04 - mean\_absolute\_error: 0.0099111/126 [=========================>....] - ETA: 0s - loss: 2.0154e-04 - mean\_absolute\_error: 0.0102126/126 [==============================] - 0s 3ms/step - loss: 2.0201e-04 - mean\_absolute\_error: 0.0103 - val\_loss: 1.1807e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6958e-04 - mean\_absolute\_error: 0.0122 24/126 [====>.........................] - ETA: 0s - loss: 1.9994e-04 - mean\_absolute\_error: 0.0104 46/126 [=========>....................] - ETA: 0s - loss: 2.3107e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 2.5408e-04 - mean\_absolute\_error: 0.0117 90/126 [====================>.........] - ETA: 0s - loss: 2.4730e-04 - mean\_absolute\_error: 0.0116112/126 [=========================>....] - ETA: 0s - loss: 2.4796e-04 - mean\_absolute\_error: 0.0116126/126 [==============================] - 0s 3ms/step - loss: 2.5913e-04 - mean\_absolute\_error: 0.0120 - val\_loss: 3.5464e-04 - val\_mean\_absolute\_error: 0.0167  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1110e-04 - mean\_absolute\_error: 0.0169 22/126 [====>.........................] - ETA: 0s - loss: 2.2504e-04 - mean\_absolute\_error: 0.0111 44/126 [=========>....................] - ETA: 0s - loss: 2.3376e-04 - mean\_absolute\_error: 0.0112 66/126 [==============>...............] - ETA: 0s - loss: 2.2826e-04 - mean\_absolute\_error: 0.0110 88/126 [===================>..........] - ETA: 0s - loss: 2.3618e-04 - mean\_absolute\_error: 0.0112110/126 [=========================>....] - ETA: 0s - loss: 2.3254e-04 - mean\_absolute\_error: 0.0111126/126 [==============================] - 0s 3ms/step - loss: 2.2797e-04 - mean\_absolute\_error: 0.0110 - val\_loss: 1.0470e-04 - val\_mean\_absolute\_error: 0.0080

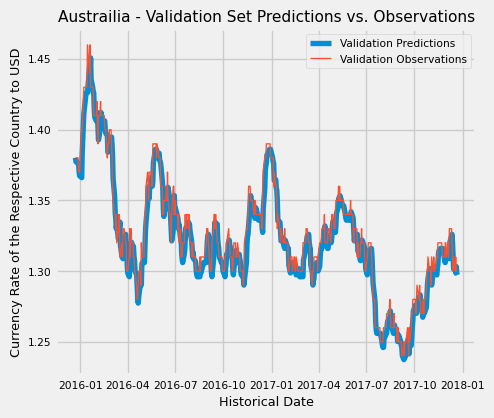
<keras.src.callbacks.History at 0x1b9a30d1050>

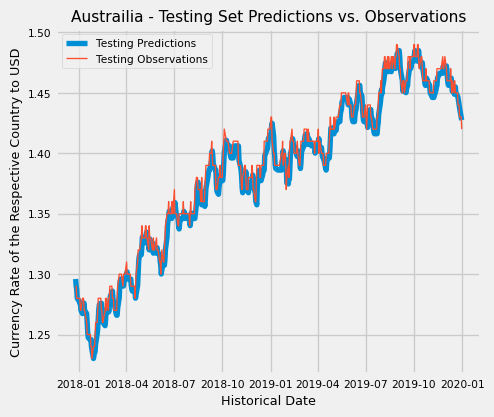
After the training and fitting of the Machine Learning model for Austrailia, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 44s 43/126 [=========>....................] - ETA: 0s 86/126 [===================>..........] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

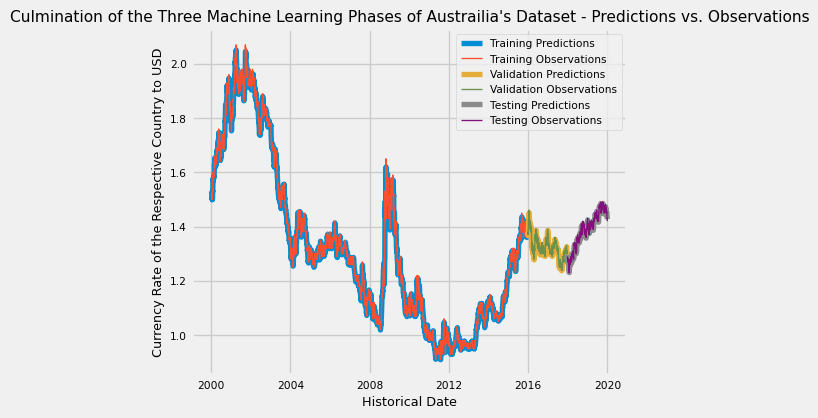






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

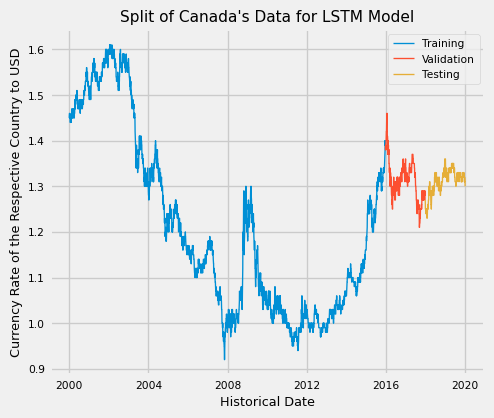
```{python}  
# Plotting Austrailia's observational (reference) data with the predictions of   
# its Machine Learning Model (as a way to visually inspect the effectiveness of   
# the model)   
plt.plot(dates\_austrailia\_train, austrailia\_train\_pred, linewidth=4)  
plt.plot(dates\_austrailia\_train,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



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

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

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



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

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

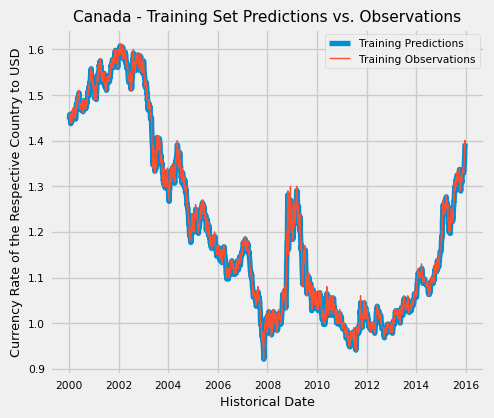
Epoch 1/100  
 1/126 [..............................] - ETA: 3:46 - loss: 1.6327 - mean\_absolute\_error: 1.2597 24/126 [====>.........................] - ETA: 0s - loss: 1.0351 - mean\_absolute\_error: 0.9861 49/126 [==========>...................] - ETA: 0s - loss: 0.5456 - mean\_absolute\_error: 0.5971 73/126 [================>.............] - ETA: 0s - loss: 0.3684 - mean\_absolute\_error: 0.4209 98/126 [======================>.......] - ETA: 0s - loss: 0.2754 - mean\_absolute\_error: 0.3271122/126 [============================>.] - ETA: 0s - loss: 0.2218 - mean\_absolute\_error: 0.2724126/126 [==============================] - 3s 6ms/step - loss: 0.2159 - mean\_absolute\_error: 0.2665 - val\_loss: 0.0010 - val\_mean\_absolute\_error: 0.0290  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0024 - mean\_absolute\_error: 0.0414 26/126 [=====>........................] - ETA: 0s - loss: 0.0026 - mean\_absolute\_error: 0.0439 49/126 [==========>...................] - ETA: 0s - loss: 0.0024 - mean\_absolute\_error: 0.0425 72/126 [================>.............] - ETA: 0s - loss: 0.0023 - mean\_absolute\_error: 0.0417 95/126 [=====================>........] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0401117/126 [==========================>...] - ETA: 0s - loss: 0.0020 - mean\_absolute\_error: 0.0389126/126 [==============================] - 0s 3ms/step - loss: 0.0020 - mean\_absolute\_error: 0.0383 - val\_loss: 3.5321e-04 - val\_mean\_absolute\_error: 0.0157  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0013 - mean\_absolute\_error: 0.0333 24/126 [====>.........................] - ETA: 0s - loss: 0.0011 - mean\_absolute\_error: 0.0286 46/126 [=========>....................] - ETA: 0s - loss: 9.8084e-04 - mean\_absolute\_error: 0.0273 69/126 [===============>..............] - ETA: 0s - loss: 8.9769e-04 - mean\_absolute\_error: 0.0259 91/126 [====================>.........] - ETA: 0s - loss: 8.2444e-04 - mean\_absolute\_error: 0.0247113/126 [=========================>....] - ETA: 0s - loss: 7.5557e-04 - mean\_absolute\_error: 0.0236126/126 [==============================] - 0s 3ms/step - loss: 7.2076e-04 - mean\_absolute\_error: 0.0230 - val\_loss: 1.8295e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 4.4054e-04 - mean\_absolute\_error: 0.0171 22/126 [====>.........................] - ETA: 0s - loss: 3.4370e-04 - mean\_absolute\_error: 0.0159 44/126 [=========>....................] - ETA: 0s - loss: 3.0633e-04 - mean\_absolute\_error: 0.0149 66/126 [==============>...............] - ETA: 0s - loss: 2.7362e-04 - mean\_absolute\_error: 0.0140 88/126 [===================>..........] - ETA: 0s - loss: 2.5390e-04 - mean\_absolute\_error: 0.0134111/126 [=========================>....] - ETA: 0s - loss: 2.3891e-04 - mean\_absolute\_error: 0.0128126/126 [==============================] - 0s 3ms/step - loss: 2.2724e-04 - mean\_absolute\_error: 0.0124 - val\_loss: 1.2867e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5381e-05 - mean\_absolute\_error: 0.0073 24/126 [====>.........................] - ETA: 0s - loss: 1.3522e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.2639e-04 - mean\_absolute\_error: 0.0088 68/126 [===============>..............] - ETA: 0s - loss: 1.1782e-04 - mean\_absolute\_error: 0.0086 86/126 [===================>..........] - ETA: 0s - loss: 1.1741e-04 - mean\_absolute\_error: 0.0085108/126 [========================>.....] - ETA: 0s - loss: 1.1479e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1302e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.1010e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0733e-04 - mean\_absolute\_error: 0.0084 24/126 [====>.........................] - ETA: 0s - loss: 1.0653e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.1046e-04 - mean\_absolute\_error: 0.0079 68/126 [===============>..............] - ETA: 0s - loss: 1.0779e-04 - mean\_absolute\_error: 0.0078 90/126 [====================>.........] - ETA: 0s - loss: 1.0517e-04 - mean\_absolute\_error: 0.0077112/126 [=========================>....] - ETA: 0s - loss: 1.0380e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0188e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.1575e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7869e-05 - mean\_absolute\_error: 0.0074 23/126 [====>.........................] - ETA: 0s - loss: 1.0638e-04 - mean\_absolute\_error: 0.0077 45/126 [=========>....................] - ETA: 0s - loss: 9.6621e-05 - mean\_absolute\_error: 0.0075 67/126 [==============>...............] - ETA: 0s - loss: 9.5257e-05 - mean\_absolute\_error: 0.0074 89/126 [====================>.........] - ETA: 0s - loss: 9.8335e-05 - mean\_absolute\_error: 0.0075111/126 [=========================>....] - ETA: 0s - loss: 9.9825e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9654e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2253e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6543e-05 - mean\_absolute\_error: 0.0054 24/126 [====>.........................] - ETA: 0s - loss: 9.5907e-05 - mean\_absolute\_error: 0.0073 47/126 [==========>...................] - ETA: 0s - loss: 9.4531e-05 - mean\_absolute\_error: 0.0073 69/126 [===============>..............] - ETA: 0s - loss: 9.5082e-05 - mean\_absolute\_error: 0.0074 91/126 [====================>.........] - ETA: 0s - loss: 9.8304e-05 - mean\_absolute\_error: 0.0074113/126 [=========================>....] - ETA: 0s - loss: 9.8062e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.8549e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2840e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 7.4592e-05 - mean\_absolute\_error: 0.0066 24/126 [====>.........................] - ETA: 0s - loss: 1.1006e-04 - mean\_absolute\_error: 0.0079 47/126 [==========>...................] - ETA: 0s - loss: 1.0377e-04 - mean\_absolute\_error: 0.0077 70/126 [===============>..............] - ETA: 0s - loss: 1.0181e-04 - mean\_absolute\_error: 0.0076 93/126 [=====================>........] - ETA: 0s - loss: 1.0155e-04 - mean\_absolute\_error: 0.0076116/126 [==========================>...] - ETA: 0s - loss: 9.9800e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9680e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.2313e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7296e-05 - mean\_absolute\_error: 0.0060 23/126 [====>.........................] - ETA: 0s - loss: 1.0156e-04 - mean\_absolute\_error: 0.0076 45/126 [=========>....................] - ETA: 0s - loss: 1.0376e-04 - mean\_absolute\_error: 0.0076 67/126 [==============>...............] - ETA: 0s - loss: 9.7185e-05 - mean\_absolute\_error: 0.0075 90/126 [====================>.........] - ETA: 0s - loss: 1.0020e-04 - mean\_absolute\_error: 0.0076112/126 [=========================>....] - ETA: 0s - loss: 1.0047e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0163e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0815e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9179e-05 - mean\_absolute\_error: 0.0077 24/126 [====>.........................] - ETA: 0s - loss: 9.4345e-05 - mean\_absolute\_error: 0.0073 46/126 [=========>....................] - ETA: 0s - loss: 1.0053e-04 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 9.9635e-05 - mean\_absolute\_error: 0.0075 91/126 [====================>.........] - ETA: 0s - loss: 1.0061e-04 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 1.0245e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0259e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0944e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8967e-04 - mean\_absolute\_error: 0.0110 22/126 [====>.........................] - ETA: 0s - loss: 1.1082e-04 - mean\_absolute\_error: 0.0080 44/126 [=========>....................] - ETA: 0s - loss: 1.0213e-04 - mean\_absolute\_error: 0.0077 66/126 [==============>...............] - ETA: 0s - loss: 1.0307e-04 - mean\_absolute\_error: 0.0078 89/126 [====================>.........] - ETA: 0s - loss: 1.0355e-04 - mean\_absolute\_error: 0.0078111/126 [=========================>....] - ETA: 0s - loss: 1.0179e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0159e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0808e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1856e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 1.0210e-04 - mean\_absolute\_error: 0.0079 47/126 [==========>...................] - ETA: 0s - loss: 9.7541e-05 - mean\_absolute\_error: 0.0078 70/126 [===============>..............] - ETA: 0s - loss: 9.8168e-05 - mean\_absolute\_error: 0.0076 91/126 [====================>.........] - ETA: 0s - loss: 9.9782e-05 - mean\_absolute\_error: 0.0076113/126 [=========================>....] - ETA: 0s - loss: 1.0617e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0777e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1428e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7212e-05 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 1.1718e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 1.1364e-04 - mean\_absolute\_error: 0.0082 69/126 [===============>..............] - ETA: 0s - loss: 1.1035e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0757e-04 - mean\_absolute\_error: 0.0080113/126 [=========================>....] - ETA: 0s - loss: 1.0635e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0522e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.2200e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0852e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 1.0612e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.0276e-04 - mean\_absolute\_error: 0.0077 69/126 [===============>..............] - ETA: 0s - loss: 1.0173e-04 - mean\_absolute\_error: 0.0077 92/126 [====================>.........] - ETA: 0s - loss: 1.0102e-04 - mean\_absolute\_error: 0.0076115/126 [==========================>...] - ETA: 0s - loss: 1.0131e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0186e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.1103e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3575e-05 - mean\_absolute\_error: 0.0067 23/126 [====>.........................] - ETA: 0s - loss: 8.7553e-05 - mean\_absolute\_error: 0.0072 45/126 [=========>....................] - ETA: 0s - loss: 9.2768e-05 - mean\_absolute\_error: 0.0073 67/126 [==============>...............] - ETA: 0s - loss: 9.4981e-05 - mean\_absolute\_error: 0.0074 90/126 [====================>.........] - ETA: 0s - loss: 9.9897e-05 - mean\_absolute\_error: 0.0076112/126 [=========================>....] - ETA: 0s - loss: 1.0166e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0100e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 1.0756e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0780e-05 - mean\_absolute\_error: 0.0066 24/126 [====>.........................] - ETA: 0s - loss: 1.0678e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.0525e-04 - mean\_absolute\_error: 0.0078 68/126 [===============>..............] - ETA: 0s - loss: 1.0839e-04 - mean\_absolute\_error: 0.0079 90/126 [====================>.........] - ETA: 0s - loss: 1.1119e-04 - mean\_absolute\_error: 0.0080112/126 [=========================>....] - ETA: 0s - loss: 1.0917e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0612e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.2235e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0088e-04 - mean\_absolute\_error: 0.0077 24/126 [====>.........................] - ETA: 0s - loss: 1.0004e-04 - mean\_absolute\_error: 0.0075 46/126 [=========>....................] - ETA: 0s - loss: 9.9884e-05 - mean\_absolute\_error: 0.0075 69/126 [===============>..............] - ETA: 0s - loss: 1.0132e-04 - mean\_absolute\_error: 0.0075 91/126 [====================>.........] - ETA: 0s - loss: 1.0192e-04 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 1.0048e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9929e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1308e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 7.8592e-05 - mean\_absolute\_error: 0.0070 25/126 [====>.........................] - ETA: 0s - loss: 1.1114e-04 - mean\_absolute\_error: 0.0078 47/126 [==========>...................] - ETA: 0s - loss: 1.0585e-04 - mean\_absolute\_error: 0.0077 70/126 [===============>..............] - ETA: 0s - loss: 1.0223e-04 - mean\_absolute\_error: 0.0076 93/126 [=====================>........] - ETA: 0s - loss: 1.0140e-04 - mean\_absolute\_error: 0.0076116/126 [==========================>...] - ETA: 0s - loss: 9.9642e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.9744e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.0738e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 5.5911e-05 - mean\_absolute\_error: 0.0063 24/126 [====>.........................] - ETA: 0s - loss: 8.6762e-05 - mean\_absolute\_error: 0.0071 46/126 [=========>....................] - ETA: 0s - loss: 9.9771e-05 - mean\_absolute\_error: 0.0076 68/126 [===============>..............] - ETA: 0s - loss: 1.0260e-04 - mean\_absolute\_error: 0.0077 89/126 [====================>.........] - ETA: 0s - loss: 1.0031e-04 - mean\_absolute\_error: 0.0077109/126 [========================>.....] - ETA: 0s - loss: 1.0266e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0260e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0869e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7546e-05 - mean\_absolute\_error: 0.0065 24/126 [====>.........................] - ETA: 0s - loss: 1.1239e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.0416e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.0318e-04 - mean\_absolute\_error: 0.0078 92/126 [====================>.........] - ETA: 0s - loss: 1.0064e-04 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 1.0201e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0436e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1632e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2805e-04 - mean\_absolute\_error: 0.0095 22/126 [====>.........................] - ETA: 0s - loss: 1.1126e-04 - mean\_absolute\_error: 0.0082 45/126 [=========>....................] - ETA: 0s - loss: 1.1235e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.1228e-04 - mean\_absolute\_error: 0.0081 91/126 [====================>.........] - ETA: 0s - loss: 1.0741e-04 - mean\_absolute\_error: 0.0080114/126 [==========================>...] - ETA: 0s - loss: 1.0575e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0633e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1222e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2454e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 9.8931e-05 - mean\_absolute\_error: 0.0076 47/126 [==========>...................] - ETA: 0s - loss: 1.0219e-04 - mean\_absolute\_error: 0.0077 70/126 [===============>..............] - ETA: 0s - loss: 1.0160e-04 - mean\_absolute\_error: 0.0077 92/126 [====================>.........] - ETA: 0s - loss: 1.0455e-04 - mean\_absolute\_error: 0.0078114/126 [==========================>...] - ETA: 0s - loss: 1.0537e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0569e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1101e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3436e-05 - mean\_absolute\_error: 0.0079 24/126 [====>.........................] - ETA: 0s - loss: 1.0810e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1624e-04 - mean\_absolute\_error: 0.0081 69/126 [===============>..............] - ETA: 0s - loss: 1.1044e-04 - mean\_absolute\_error: 0.0080 92/126 [====================>.........] - ETA: 0s - loss: 1.1264e-04 - mean\_absolute\_error: 0.0081115/126 [==========================>...] - ETA: 0s - loss: 1.1103e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0931e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.2517e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3486e-04 - mean\_absolute\_error: 0.0084 24/126 [====>.........................] - ETA: 0s - loss: 1.1362e-04 - mean\_absolute\_error: 0.0081 47/126 [==========>...................] - ETA: 0s - loss: 1.1172e-04 - mean\_absolute\_error: 0.0081 70/126 [===============>..............] - ETA: 0s - loss: 1.0623e-04 - mean\_absolute\_error: 0.0078 93/126 [=====================>........] - ETA: 0s - loss: 1.0320e-04 - mean\_absolute\_error: 0.0077116/126 [==========================>...] - ETA: 0s - loss: 1.0393e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0384e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.0634e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1353e-04 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 1.1692e-04 - mean\_absolute\_error: 0.0082 46/126 [=========>....................] - ETA: 0s - loss: 1.3332e-04 - mean\_absolute\_error: 0.0089 68/126 [===============>..............] - ETA: 0s - loss: 1.2883e-04 - mean\_absolute\_error: 0.0088 91/126 [====================>.........] - ETA: 0s - loss: 1.2186e-04 - mean\_absolute\_error: 0.0085113/126 [=========================>....] - ETA: 0s - loss: 1.1771e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1357e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.3138e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9212e-05 - mean\_absolute\_error: 0.0068 24/126 [====>.........................] - ETA: 0s - loss: 1.1246e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1804e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.1464e-04 - mean\_absolute\_error: 0.0082 91/126 [====================>.........] - ETA: 0s - loss: 1.1099e-04 - mean\_absolute\_error: 0.0081113/126 [=========================>....] - ETA: 0s - loss: 1.0964e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0937e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1021e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9866e-05 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 1.1006e-04 - mean\_absolute\_error: 0.0082 45/126 [=========>....................] - ETA: 0s - loss: 1.1301e-04 - mean\_absolute\_error: 0.0083 67/126 [==============>...............] - ETA: 0s - loss: 1.1381e-04 - mean\_absolute\_error: 0.0082 89/126 [====================>.........] - ETA: 0s - loss: 1.0919e-04 - mean\_absolute\_error: 0.0080111/126 [=========================>....] - ETA: 0s - loss: 1.0681e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0663e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0828e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0829e-05 - mean\_absolute\_error: 0.0080 24/126 [====>.........................] - ETA: 0s - loss: 1.1685e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.1830e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.1202e-04 - mean\_absolute\_error: 0.0081 90/126 [====================>.........] - ETA: 0s - loss: 1.1075e-04 - mean\_absolute\_error: 0.0081112/126 [=========================>....] - ETA: 0s - loss: 1.1240e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1439e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0971e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9729e-05 - mean\_absolute\_error: 0.0074 24/126 [====>.........................] - ETA: 0s - loss: 1.1313e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1856e-04 - mean\_absolute\_error: 0.0084 68/126 [===============>..............] - ETA: 0s - loss: 1.2112e-04 - mean\_absolute\_error: 0.0085 91/126 [====================>.........] - ETA: 0s - loss: 1.1876e-04 - mean\_absolute\_error: 0.0084114/126 [==========================>...] - ETA: 0s - loss: 1.2311e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2221e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.3134e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3236e-04 - mean\_absolute\_error: 0.0093 24/126 [====>.........................] - ETA: 0s - loss: 1.0236e-04 - mean\_absolute\_error: 0.0078 47/126 [==========>...................] - ETA: 0s - loss: 1.0881e-04 - mean\_absolute\_error: 0.0080 69/126 [===============>..............] - ETA: 0s - loss: 1.0748e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0824e-04 - mean\_absolute\_error: 0.0080114/126 [==========================>...] - ETA: 0s - loss: 1.0429e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0635e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.1477e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0622e-04 - mean\_absolute\_error: 0.0085 24/126 [====>.........................] - ETA: 0s - loss: 9.3526e-05 - mean\_absolute\_error: 0.0075 46/126 [=========>....................] - ETA: 0s - loss: 9.8319e-05 - mean\_absolute\_error: 0.0075 68/126 [===============>..............] - ETA: 0s - loss: 1.0041e-04 - mean\_absolute\_error: 0.0076 91/126 [====================>.........] - ETA: 0s - loss: 1.0115e-04 - mean\_absolute\_error: 0.0076113/126 [=========================>....] - ETA: 0s - loss: 1.0082e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0346e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.8186e-04 - val\_mean\_absolute\_error: 0.0108  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1398e-04 - mean\_absolute\_error: 0.0118 24/126 [====>.........................] - ETA: 0s - loss: 1.2124e-04 - mean\_absolute\_error: 0.0086 46/126 [=========>....................] - ETA: 0s - loss: 1.0997e-04 - mean\_absolute\_error: 0.0081 68/126 [===============>..............] - ETA: 0s - loss: 1.0821e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0882e-04 - mean\_absolute\_error: 0.0080114/126 [==========================>...] - ETA: 0s - loss: 1.0713e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0869e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 3.2163e-04 - val\_mean\_absolute\_error: 0.0156  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0955e-04 - mean\_absolute\_error: 0.0127 22/126 [====>.........................] - ETA: 0s - loss: 1.3414e-04 - mean\_absolute\_error: 0.0089 44/126 [=========>....................] - ETA: 0s - loss: 1.1999e-04 - mean\_absolute\_error: 0.0085 66/126 [==============>...............] - ETA: 0s - loss: 1.1545e-04 - mean\_absolute\_error: 0.0083 88/126 [===================>..........] - ETA: 0s - loss: 1.1924e-04 - mean\_absolute\_error: 0.0084110/126 [=========================>....] - ETA: 0s - loss: 1.1172e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1136e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.1200e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1419e-05 - mean\_absolute\_error: 0.0058 24/126 [====>.........................] - ETA: 0s - loss: 1.2568e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.1366e-04 - mean\_absolute\_error: 0.0081 68/126 [===============>..............] - ETA: 0s - loss: 1.1064e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0776e-04 - mean\_absolute\_error: 0.0079113/126 [=========================>....] - ETA: 0s - loss: 1.0725e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0932e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.3199e-04 - val\_mean\_absolute\_error: 0.0128  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7032e-04 - mean\_absolute\_error: 0.0106 24/126 [====>.........................] - ETA: 0s - loss: 1.1104e-04 - mean\_absolute\_error: 0.0079 47/126 [==========>...................] - ETA: 0s - loss: 1.2049e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.1848e-04 - mean\_absolute\_error: 0.0083 91/126 [====================>.........] - ETA: 0s - loss: 1.1338e-04 - mean\_absolute\_error: 0.0082113/126 [=========================>....] - ETA: 0s - loss: 1.1453e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1539e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0492e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3720e-05 - mean\_absolute\_error: 0.0077 21/126 [====>.........................] - ETA: 0s - loss: 9.1405e-05 - mean\_absolute\_error: 0.0074 44/126 [=========>....................] - ETA: 0s - loss: 1.0638e-04 - mean\_absolute\_error: 0.0078 66/126 [==============>...............] - ETA: 0s - loss: 1.0291e-04 - mean\_absolute\_error: 0.0077 89/126 [====================>.........] - ETA: 0s - loss: 1.0231e-04 - mean\_absolute\_error: 0.0077110/126 [=========================>....] - ETA: 0s - loss: 1.0550e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0794e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.9198e-04 - val\_mean\_absolute\_error: 0.0114  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4082e-04 - mean\_absolute\_error: 0.0100 21/126 [====>.........................] - ETA: 0s - loss: 1.2435e-04 - mean\_absolute\_error: 0.0084 41/126 [========>.....................] - ETA: 0s - loss: 1.0984e-04 - mean\_absolute\_error: 0.0078 61/126 [=============>................] - ETA: 0s - loss: 1.0494e-04 - mean\_absolute\_error: 0.0078 81/126 [==================>...........] - ETA: 0s - loss: 1.0230e-04 - mean\_absolute\_error: 0.0077100/126 [======================>.......] - ETA: 0s - loss: 1.0143e-04 - mean\_absolute\_error: 0.0077119/126 [===========================>..] - ETA: 0s - loss: 1.0480e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0542e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0735e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9109e-05 - mean\_absolute\_error: 0.0060 18/126 [===>..........................] - ETA: 0s - loss: 1.0703e-04 - mean\_absolute\_error: 0.0081 35/126 [=======>......................] - ETA: 0s - loss: 1.0244e-04 - mean\_absolute\_error: 0.0078 51/126 [===========>..................] - ETA: 0s - loss: 1.1120e-04 - mean\_absolute\_error: 0.0082 69/126 [===============>..............] - ETA: 0s - loss: 1.0996e-04 - mean\_absolute\_error: 0.0080 86/126 [===================>..........] - ETA: 0s - loss: 1.1173e-04 - mean\_absolute\_error: 0.0081103/126 [=======================>......] - ETA: 0s - loss: 1.0919e-04 - mean\_absolute\_error: 0.0080118/126 [===========================>..] - ETA: 0s - loss: 1.0846e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 4ms/step - loss: 1.0707e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0787e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 8.5339e-05 - mean\_absolute\_error: 0.0075 18/126 [===>..........................] - ETA: 0s - loss: 9.6364e-05 - mean\_absolute\_error: 0.0075 35/126 [=======>......................] - ETA: 0s - loss: 9.3310e-05 - mean\_absolute\_error: 0.0074 53/126 [===========>..................] - ETA: 0s - loss: 1.0422e-04 - mean\_absolute\_error: 0.0079 72/126 [================>.............] - ETA: 0s - loss: 1.0604e-04 - mean\_absolute\_error: 0.0079 92/126 [====================>.........] - ETA: 0s - loss: 1.0898e-04 - mean\_absolute\_error: 0.0080112/126 [=========================>....] - ETA: 0s - loss: 1.1408e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1258e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0900e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1712e-05 - mean\_absolute\_error: 0.0052 21/126 [====>.........................] - ETA: 0s - loss: 1.1749e-04 - mean\_absolute\_error: 0.0083 41/126 [========>.....................] - ETA: 0s - loss: 1.1733e-04 - mean\_absolute\_error: 0.0084 61/126 [=============>................] - ETA: 0s - loss: 1.1476e-04 - mean\_absolute\_error: 0.0083 81/126 [==================>...........] - ETA: 0s - loss: 1.1910e-04 - mean\_absolute\_error: 0.0084101/126 [=======================>......] - ETA: 0s - loss: 1.1785e-04 - mean\_absolute\_error: 0.0084121/126 [===========================>..] - ETA: 0s - loss: 1.1511e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1564e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.2244e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3901e-04 - mean\_absolute\_error: 0.0090 22/126 [====>.........................] - ETA: 0s - loss: 1.2260e-04 - mean\_absolute\_error: 0.0084 42/126 [=========>....................] - ETA: 0s - loss: 1.2220e-04 - mean\_absolute\_error: 0.0083 63/126 [==============>...............] - ETA: 0s - loss: 1.2577e-04 - mean\_absolute\_error: 0.0085 83/126 [==================>...........] - ETA: 0s - loss: 1.3494e-04 - mean\_absolute\_error: 0.0090103/126 [=======================>......] - ETA: 0s - loss: 1.3995e-04 - mean\_absolute\_error: 0.0091122/126 [============================>.] - ETA: 0s - loss: 1.3326e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.3200e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.1726e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0406e-04 - mean\_absolute\_error: 0.0080 21/126 [====>.........................] - ETA: 0s - loss: 1.2082e-04 - mean\_absolute\_error: 0.0083 41/126 [========>.....................] - ETA: 0s - loss: 1.1917e-04 - mean\_absolute\_error: 0.0083 61/126 [=============>................] - ETA: 0s - loss: 1.1632e-04 - mean\_absolute\_error: 0.0081 82/126 [==================>...........] - ETA: 0s - loss: 1.1722e-04 - mean\_absolute\_error: 0.0083103/126 [=======================>......] - ETA: 0s - loss: 1.1238e-04 - mean\_absolute\_error: 0.0081124/126 [============================>.] - ETA: 0s - loss: 1.0860e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0873e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.2828e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3661e-05 - mean\_absolute\_error: 0.0081 21/126 [====>.........................] - ETA: 0s - loss: 1.0950e-04 - mean\_absolute\_error: 0.0084 42/126 [=========>....................] - ETA: 0s - loss: 1.0897e-04 - mean\_absolute\_error: 0.0081 62/126 [=============>................] - ETA: 0s - loss: 1.0152e-04 - mean\_absolute\_error: 0.0078 82/126 [==================>...........] - ETA: 0s - loss: 1.0259e-04 - mean\_absolute\_error: 0.0078102/126 [=======================>......] - ETA: 0s - loss: 1.0992e-04 - mean\_absolute\_error: 0.0081122/126 [============================>.] - ETA: 0s - loss: 1.1092e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1122e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0744e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 7.0323e-05 - mean\_absolute\_error: 0.0064 21/126 [====>.........................] - ETA: 0s - loss: 9.8727e-05 - mean\_absolute\_error: 0.0076 42/126 [=========>....................] - ETA: 0s - loss: 1.0924e-04 - mean\_absolute\_error: 0.0080 64/126 [==============>...............] - ETA: 0s - loss: 1.1321e-04 - mean\_absolute\_error: 0.0081 86/126 [===================>..........] - ETA: 0s - loss: 1.1233e-04 - mean\_absolute\_error: 0.0081106/126 [========================>.....] - ETA: 0s - loss: 1.1037e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0940e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.1515e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9449e-05 - mean\_absolute\_error: 0.0063 24/126 [====>.........................] - ETA: 0s - loss: 9.9946e-05 - mean\_absolute\_error: 0.0076 46/126 [=========>....................] - ETA: 0s - loss: 1.0119e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.1320e-04 - mean\_absolute\_error: 0.0081 91/126 [====================>.........] - ETA: 0s - loss: 1.1739e-04 - mean\_absolute\_error: 0.0083114/126 [==========================>...] - ETA: 0s - loss: 1.1557e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1236e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.2742e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1939e-04 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 1.1637e-04 - mean\_absolute\_error: 0.0083 47/126 [==========>...................] - ETA: 0s - loss: 1.2038e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.3488e-04 - mean\_absolute\_error: 0.0089 92/126 [====================>.........] - ETA: 0s - loss: 1.2996e-04 - mean\_absolute\_error: 0.0088115/126 [==========================>...] - ETA: 0s - loss: 1.3000e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2760e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.2185e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5052e-05 - mean\_absolute\_error: 0.0073 24/126 [====>.........................] - ETA: 0s - loss: 1.1462e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1697e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.1017e-04 - mean\_absolute\_error: 0.0081 91/126 [====================>.........] - ETA: 0s - loss: 1.1072e-04 - mean\_absolute\_error: 0.0080113/126 [=========================>....] - ETA: 0s - loss: 1.1582e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1523e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 2.3413e-04 - val\_mean\_absolute\_error: 0.0129  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5032e-04 - mean\_absolute\_error: 0.0096 24/126 [====>.........................] - ETA: 0s - loss: 1.0345e-04 - mean\_absolute\_error: 0.0079 46/126 [=========>....................] - ETA: 0s - loss: 1.1409e-04 - mean\_absolute\_error: 0.0084 69/126 [===============>..............] - ETA: 0s - loss: 1.1929e-04 - mean\_absolute\_error: 0.0084 92/126 [====================>.........] - ETA: 0s - loss: 1.2323e-04 - mean\_absolute\_error: 0.0086114/126 [==========================>...] - ETA: 0s - loss: 1.2097e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.1887e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.3247e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0526e-04 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.0284e-04 - mean\_absolute\_error: 0.0074 45/126 [=========>....................] - ETA: 0s - loss: 9.4422e-05 - mean\_absolute\_error: 0.0073 68/126 [===============>..............] - ETA: 0s - loss: 9.9205e-05 - mean\_absolute\_error: 0.0076 90/126 [====================>.........] - ETA: 0s - loss: 1.1765e-04 - mean\_absolute\_error: 0.0082113/126 [=========================>....] - ETA: 0s - loss: 1.1712e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1578e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0997e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0666e-04 - mean\_absolute\_error: 0.0074 22/126 [====>.........................] - ETA: 0s - loss: 1.0252e-04 - mean\_absolute\_error: 0.0076 45/126 [=========>....................] - ETA: 0s - loss: 9.9716e-05 - mean\_absolute\_error: 0.0076 68/126 [===============>..............] - ETA: 0s - loss: 1.0402e-04 - mean\_absolute\_error: 0.0079 90/126 [====================>.........] - ETA: 0s - loss: 1.0837e-04 - mean\_absolute\_error: 0.0080113/126 [=========================>....] - ETA: 0s - loss: 1.0872e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0923e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.1071e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2083e-04 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 1.1633e-04 - mean\_absolute\_error: 0.0083 45/126 [=========>....................] - ETA: 0s - loss: 1.0971e-04 - mean\_absolute\_error: 0.0082 68/126 [===============>..............] - ETA: 0s - loss: 1.0729e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0381e-04 - mean\_absolute\_error: 0.0079113/126 [=========================>....] - ETA: 0s - loss: 1.0455e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0456e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0708e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3659e-05 - mean\_absolute\_error: 0.0065 24/126 [====>.........................] - ETA: 0s - loss: 1.6240e-04 - mean\_absolute\_error: 0.0098 47/126 [==========>...................] - ETA: 0s - loss: 1.4261e-04 - mean\_absolute\_error: 0.0092 67/126 [==============>...............] - ETA: 0s - loss: 1.2599e-04 - mean\_absolute\_error: 0.0086 89/126 [====================>.........] - ETA: 0s - loss: 1.1884e-04 - mean\_absolute\_error: 0.0083112/126 [=========================>....] - ETA: 0s - loss: 1.1099e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0960e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.9624e-04 - val\_mean\_absolute\_error: 0.0116  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5380e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 1.1683e-04 - mean\_absolute\_error: 0.0083 47/126 [==========>...................] - ETA: 0s - loss: 1.1227e-04 - mean\_absolute\_error: 0.0082 70/126 [===============>..............] - ETA: 0s - loss: 1.2582e-04 - mean\_absolute\_error: 0.0087 93/126 [=====================>........] - ETA: 0s - loss: 1.2769e-04 - mean\_absolute\_error: 0.0088116/126 [==========================>...] - ETA: 0s - loss: 1.2373e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2251e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.1318e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 9.0118e-05 - mean\_absolute\_error: 0.0063 24/126 [====>.........................] - ETA: 0s - loss: 9.4708e-05 - mean\_absolute\_error: 0.0072 46/126 [=========>....................] - ETA: 0s - loss: 9.1340e-05 - mean\_absolute\_error: 0.0072 68/126 [===============>..............] - ETA: 0s - loss: 9.4761e-05 - mean\_absolute\_error: 0.0074 90/126 [====================>.........] - ETA: 0s - loss: 9.4187e-05 - mean\_absolute\_error: 0.0074113/126 [=========================>....] - ETA: 0s - loss: 1.0813e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0829e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.3392e-04 - val\_mean\_absolute\_error: 0.0093  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0895e-04 - mean\_absolute\_error: 0.0082 23/126 [====>.........................] - ETA: 0s - loss: 1.0410e-04 - mean\_absolute\_error: 0.0077 46/126 [=========>....................] - ETA: 0s - loss: 1.0451e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.0174e-04 - mean\_absolute\_error: 0.0077 91/126 [====================>.........] - ETA: 0s - loss: 1.1281e-04 - mean\_absolute\_error: 0.0081114/126 [==========================>...] - ETA: 0s - loss: 1.2905e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.2867e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 1.1421e-04 - val\_mean\_absolute\_error: 0.0083  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3739e-05 - mean\_absolute\_error: 0.0070 23/126 [====>.........................] - ETA: 0s - loss: 9.2852e-05 - mean\_absolute\_error: 0.0076 45/126 [=========>....................] - ETA: 0s - loss: 1.0878e-04 - mean\_absolute\_error: 0.0080 67/126 [==============>...............] - ETA: 0s - loss: 1.1396e-04 - mean\_absolute\_error: 0.0083 89/126 [====================>.........] - ETA: 0s - loss: 1.1272e-04 - mean\_absolute\_error: 0.0082111/126 [=========================>....] - ETA: 0s - loss: 1.1144e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1017e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0334e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 7.5822e-05 - mean\_absolute\_error: 0.0074 24/126 [====>.........................] - ETA: 0s - loss: 1.2724e-04 - mean\_absolute\_error: 0.0087 47/126 [==========>...................] - ETA: 0s - loss: 1.1116e-04 - mean\_absolute\_error: 0.0082 69/126 [===============>..............] - ETA: 0s - loss: 1.1101e-04 - mean\_absolute\_error: 0.0082 90/126 [====================>.........] - ETA: 0s - loss: 1.1481e-04 - mean\_absolute\_error: 0.0083112/126 [=========================>....] - ETA: 0s - loss: 1.1216e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1439e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.2213e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3311e-04 - mean\_absolute\_error: 0.0082 24/126 [====>.........................] - ETA: 0s - loss: 1.0244e-04 - mean\_absolute\_error: 0.0075 47/126 [==========>...................] - ETA: 0s - loss: 1.0389e-04 - mean\_absolute\_error: 0.0077 70/126 [===============>..............] - ETA: 0s - loss: 1.0294e-04 - mean\_absolute\_error: 0.0078 93/126 [=====================>........] - ETA: 0s - loss: 1.0711e-04 - mean\_absolute\_error: 0.0080116/126 [==========================>...] - ETA: 0s - loss: 1.0893e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0985e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 1.3308e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1533e-05 - mean\_absolute\_error: 0.0070 24/126 [====>.........................] - ETA: 0s - loss: 1.0392e-04 - mean\_absolute\_error: 0.0077 46/126 [=========>....................] - ETA: 0s - loss: 1.0220e-04 - mean\_absolute\_error: 0.0076 69/126 [===============>..............] - ETA: 0s - loss: 1.0087e-04 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 1.1394e-04 - mean\_absolute\_error: 0.0082114/126 [==========================>...] - ETA: 0s - loss: 1.1968e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1957e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.0582e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8828e-05 - mean\_absolute\_error: 0.0074 24/126 [====>.........................] - ETA: 0s - loss: 1.1663e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 1.2257e-04 - mean\_absolute\_error: 0.0087 70/126 [===============>..............] - ETA: 0s - loss: 1.1616e-04 - mean\_absolute\_error: 0.0083 93/126 [=====================>........] - ETA: 0s - loss: 1.1525e-04 - mean\_absolute\_error: 0.0082115/126 [==========================>...] - ETA: 0s - loss: 1.0858e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0920e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0571e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6164e-05 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 9.2422e-05 - mean\_absolute\_error: 0.0072 47/126 [==========>...................] - ETA: 0s - loss: 1.0960e-04 - mean\_absolute\_error: 0.0079 69/126 [===============>..............] - ETA: 0s - loss: 1.0765e-04 - mean\_absolute\_error: 0.0079 92/126 [====================>.........] - ETA: 0s - loss: 1.2670e-04 - mean\_absolute\_error: 0.0087115/126 [==========================>...] - ETA: 0s - loss: 1.2912e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.2722e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 1.9403e-04 - val\_mean\_absolute\_error: 0.0116  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4129e-04 - mean\_absolute\_error: 0.0103 23/126 [====>.........................] - ETA: 0s - loss: 1.2007e-04 - mean\_absolute\_error: 0.0087 45/126 [=========>....................] - ETA: 0s - loss: 1.1650e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.2175e-04 - mean\_absolute\_error: 0.0085 91/126 [====================>.........] - ETA: 0s - loss: 1.1334e-04 - mean\_absolute\_error: 0.0082114/126 [==========================>...] - ETA: 0s - loss: 1.1570e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1666e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 1.0600e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 8.0749e-05 - mean\_absolute\_error: 0.0067 24/126 [====>.........................] - ETA: 0s - loss: 1.1480e-04 - mean\_absolute\_error: 0.0080 47/126 [==========>...................] - ETA: 0s - loss: 1.2412e-04 - mean\_absolute\_error: 0.0084 70/126 [===============>..............] - ETA: 0s - loss: 1.2963e-04 - mean\_absolute\_error: 0.0087 92/126 [====================>.........] - ETA: 0s - loss: 1.2613e-04 - mean\_absolute\_error: 0.0087114/126 [==========================>...] - ETA: 0s - loss: 1.2121e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.1940e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.2996e-04 - val\_mean\_absolute\_error: 0.0091  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9167e-05 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 1.0857e-04 - mean\_absolute\_error: 0.0079 46/126 [=========>....................] - ETA: 0s - loss: 1.1585e-04 - mean\_absolute\_error: 0.0082 67/126 [==============>...............] - ETA: 0s - loss: 1.0943e-04 - mean\_absolute\_error: 0.0081 89/126 [====================>.........] - ETA: 0s - loss: 1.1077e-04 - mean\_absolute\_error: 0.0081112/126 [=========================>....] - ETA: 0s - loss: 1.1700e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.1513e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.0208e-04 - val\_mean\_absolute\_error: 0.0079  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8670e-05 - mean\_absolute\_error: 0.0054 23/126 [====>.........................] - ETA: 0s - loss: 1.0506e-04 - mean\_absolute\_error: 0.0077 45/126 [=========>....................] - ETA: 0s - loss: 9.9906e-05 - mean\_absolute\_error: 0.0076 68/126 [===============>..............] - ETA: 0s - loss: 9.7507e-05 - mean\_absolute\_error: 0.0075 90/126 [====================>.........] - ETA: 0s - loss: 9.5028e-05 - mean\_absolute\_error: 0.0073113/126 [=========================>....] - ETA: 0s - loss: 1.0450e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0346e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.3315e-04 - val\_mean\_absolute\_error: 0.0092  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3077e-05 - mean\_absolute\_error: 0.0079 24/126 [====>.........................] - ETA: 0s - loss: 1.1288e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.1673e-04 - mean\_absolute\_error: 0.0081 69/126 [===============>..............] - ETA: 0s - loss: 1.1648e-04 - mean\_absolute\_error: 0.0082 91/126 [====================>.........] - ETA: 0s - loss: 1.1811e-04 - mean\_absolute\_error: 0.0083114/126 [==========================>...] - ETA: 0s - loss: 1.1516e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1277e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 1.2024e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4536e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 1.0397e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1203e-04 - mean\_absolute\_error: 0.0082 68/126 [===============>..............] - ETA: 0s - loss: 1.0518e-04 - mean\_absolute\_error: 0.0079 90/126 [====================>.........] - ETA: 0s - loss: 1.0630e-04 - mean\_absolute\_error: 0.0079113/126 [=========================>....] - ETA: 0s - loss: 1.0421e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0275e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.2500e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7743e-05 - mean\_absolute\_error: 0.0083 22/126 [====>.........................] - ETA: 0s - loss: 1.2722e-04 - mean\_absolute\_error: 0.0085 44/126 [=========>....................] - ETA: 0s - loss: 1.1374e-04 - mean\_absolute\_error: 0.0081 67/126 [==============>...............] - ETA: 0s - loss: 1.1470e-04 - mean\_absolute\_error: 0.0082 90/126 [====================>.........] - ETA: 0s - loss: 1.1030e-04 - mean\_absolute\_error: 0.0080112/126 [=========================>....] - ETA: 0s - loss: 1.0822e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0897e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 2.8645e-04 - val\_mean\_absolute\_error: 0.0147  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7688e-04 - mean\_absolute\_error: 0.0148 24/126 [====>.........................] - ETA: 0s - loss: 1.1360e-04 - mean\_absolute\_error: 0.0083 46/126 [=========>....................] - ETA: 0s - loss: 1.0343e-04 - mean\_absolute\_error: 0.0078 69/126 [===============>..............] - ETA: 0s - loss: 1.0122e-04 - mean\_absolute\_error: 0.0076 91/126 [====================>.........] - ETA: 0s - loss: 1.0122e-04 - mean\_absolute\_error: 0.0076114/126 [==========================>...] - ETA: 0s - loss: 9.8116e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.7996e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.1710e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0647e-04 - mean\_absolute\_error: 0.0079 24/126 [====>.........................] - ETA: 0s - loss: 9.7161e-05 - mean\_absolute\_error: 0.0077 45/126 [=========>....................] - ETA: 0s - loss: 1.0126e-04 - mean\_absolute\_error: 0.0078 68/126 [===============>..............] - ETA: 0s - loss: 1.0074e-04 - mean\_absolute\_error: 0.0078 90/126 [====================>.........] - ETA: 0s - loss: 1.1186e-04 - mean\_absolute\_error: 0.0082113/126 [=========================>....] - ETA: 0s - loss: 1.1545e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1541e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 2.1217e-04 - val\_mean\_absolute\_error: 0.0123  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7005e-04 - mean\_absolute\_error: 0.0117 24/126 [====>.........................] - ETA: 0s - loss: 1.3021e-04 - mean\_absolute\_error: 0.0086 47/126 [==========>...................] - ETA: 0s - loss: 1.1659e-04 - mean\_absolute\_error: 0.0082 69/126 [===============>..............] - ETA: 0s - loss: 1.1151e-04 - mean\_absolute\_error: 0.0081 91/126 [====================>.........] - ETA: 0s - loss: 1.0716e-04 - mean\_absolute\_error: 0.0079113/126 [=========================>....] - ETA: 0s - loss: 1.0717e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1043e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.0061e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0142e-04 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 1.3214e-04 - mean\_absolute\_error: 0.0089 47/126 [==========>...................] - ETA: 0s - loss: 1.2733e-04 - mean\_absolute\_error: 0.0087 70/126 [===============>..............] - ETA: 0s - loss: 1.1622e-04 - mean\_absolute\_error: 0.0083 93/126 [=====================>........] - ETA: 0s - loss: 1.1930e-04 - mean\_absolute\_error: 0.0084115/126 [==========================>...] - ETA: 0s - loss: 1.2039e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.1896e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.0524e-04 - val\_mean\_absolute\_error: 0.0081  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0678e-04 - mean\_absolute\_error: 0.0067 24/126 [====>.........................] - ETA: 0s - loss: 9.5182e-05 - mean\_absolute\_error: 0.0072 46/126 [=========>....................] - ETA: 0s - loss: 9.0572e-05 - mean\_absolute\_error: 0.0072 68/126 [===============>..............] - ETA: 0s - loss: 9.3886e-05 - mean\_absolute\_error: 0.0073 90/126 [====================>.........] - ETA: 0s - loss: 9.3240e-05 - mean\_absolute\_error: 0.0073113/126 [=========================>....] - ETA: 0s - loss: 9.4526e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.7464e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.9805e-04 - val\_mean\_absolute\_error: 0.0115  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0770e-04 - mean\_absolute\_error: 0.0119 24/126 [====>.........................] - ETA: 0s - loss: 1.2358e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.1318e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.0958e-04 - mean\_absolute\_error: 0.0081 90/126 [====================>.........] - ETA: 0s - loss: 1.2094e-04 - mean\_absolute\_error: 0.0086113/126 [=========================>....] - ETA: 0s - loss: 1.1560e-04 - mean\_absolute\_error: 0.0083126/126 [==============================] - 0s 3ms/step - loss: 1.1666e-04 - mean\_absolute\_error: 0.0084 - val\_loss: 1.0439e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 5.8707e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 1.2643e-04 - mean\_absolute\_error: 0.0089 45/126 [=========>....................] - ETA: 0s - loss: 1.1948e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.3185e-04 - mean\_absolute\_error: 0.0089 91/126 [====================>.........] - ETA: 0s - loss: 1.2327e-04 - mean\_absolute\_error: 0.0086114/126 [==========================>...] - ETA: 0s - loss: 1.1492e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1433e-04 - mean\_absolute\_error: 0.0082 - val\_loss: 9.5550e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0120e-04 - mean\_absolute\_error: 0.0078 24/126 [====>.........................] - ETA: 0s - loss: 1.3974e-04 - mean\_absolute\_error: 0.0089 47/126 [==========>...................] - ETA: 0s - loss: 1.3415e-04 - mean\_absolute\_error: 0.0090 69/126 [===============>..............] - ETA: 0s - loss: 1.2113e-04 - mean\_absolute\_error: 0.0085 92/126 [====================>.........] - ETA: 0s - loss: 1.1744e-04 - mean\_absolute\_error: 0.0083114/126 [==========================>...] - ETA: 0s - loss: 1.1294e-04 - mean\_absolute\_error: 0.0082126/126 [==============================] - 0s 3ms/step - loss: 1.1120e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 9.9460e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4679e-04 - mean\_absolute\_error: 0.0077 24/126 [====>.........................] - ETA: 0s - loss: 1.1229e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.0008e-04 - mean\_absolute\_error: 0.0077 68/126 [===============>..............] - ETA: 0s - loss: 1.0369e-04 - mean\_absolute\_error: 0.0078 90/126 [====================>.........] - ETA: 0s - loss: 9.9460e-05 - mean\_absolute\_error: 0.0076113/126 [=========================>....] - ETA: 0s - loss: 1.0048e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0057e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 3.0946e-04 - val\_mean\_absolute\_error: 0.0151  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1679e-04 - mean\_absolute\_error: 0.0156 24/126 [====>.........................] - ETA: 0s - loss: 2.0981e-04 - mean\_absolute\_error: 0.0116 46/126 [=========>....................] - ETA: 0s - loss: 1.6895e-04 - mean\_absolute\_error: 0.0103 69/126 [===============>..............] - ETA: 0s - loss: 1.4812e-04 - mean\_absolute\_error: 0.0095 92/126 [====================>.........] - ETA: 0s - loss: 1.3346e-04 - mean\_absolute\_error: 0.0089115/126 [==========================>...] - ETA: 0s - loss: 1.2493e-04 - mean\_absolute\_error: 0.0085126/126 [==============================] - 0s 3ms/step - loss: 1.2384e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 9.9539e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3571e-05 - mean\_absolute\_error: 0.0066 24/126 [====>.........................] - ETA: 0s - loss: 1.2403e-04 - mean\_absolute\_error: 0.0088 47/126 [==========>...................] - ETA: 0s - loss: 1.1209e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.0624e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0592e-04 - mean\_absolute\_error: 0.0080114/126 [==========================>...] - ETA: 0s - loss: 1.0709e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.0525e-04 - mean\_absolute\_error: 0.0080 - val\_loss: 9.5295e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7520e-05 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 1.0211e-04 - mean\_absolute\_error: 0.0079 45/126 [=========>....................] - ETA: 0s - loss: 1.1327e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.1655e-04 - mean\_absolute\_error: 0.0084 90/126 [====================>.........] - ETA: 0s - loss: 1.1868e-04 - mean\_absolute\_error: 0.0085113/126 [=========================>....] - ETA: 0s - loss: 1.2200e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.1977e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 1.6480e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7547e-04 - mean\_absolute\_error: 0.0112 24/126 [====>.........................] - ETA: 0s - loss: 1.0574e-04 - mean\_absolute\_error: 0.0081 47/126 [==========>...................] - ETA: 0s - loss: 1.1037e-04 - mean\_absolute\_error: 0.0081 69/126 [===============>..............] - ETA: 0s - loss: 1.0823e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0333e-04 - mean\_absolute\_error: 0.0078114/126 [==========================>...] - ETA: 0s - loss: 1.0053e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0044e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.6048e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2942e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 1.0383e-04 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 1.0019e-04 - mean\_absolute\_error: 0.0075 69/126 [===============>..............] - ETA: 0s - loss: 1.2533e-04 - mean\_absolute\_error: 0.0085 91/126 [====================>.........] - ETA: 0s - loss: 1.2460e-04 - mean\_absolute\_error: 0.0086113/126 [=========================>....] - ETA: 0s - loss: 1.2505e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3040e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 2.9620e-04 - val\_mean\_absolute\_error: 0.0148  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3433e-04 - mean\_absolute\_error: 0.0155 24/126 [====>.........................] - ETA: 0s - loss: 1.4359e-04 - mean\_absolute\_error: 0.0094 46/126 [=========>....................] - ETA: 0s - loss: 1.1992e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.1493e-04 - mean\_absolute\_error: 0.0082 91/126 [====================>.........] - ETA: 0s - loss: 1.0680e-04 - mean\_absolute\_error: 0.0079114/126 [==========================>...] - ETA: 0s - loss: 1.0106e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0132e-04 - mean\_absolute\_error: 0.0076 - val\_loss: 9.7810e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2151e-05 - mean\_absolute\_error: 0.0066 24/126 [====>.........................] - ETA: 0s - loss: 9.6607e-05 - mean\_absolute\_error: 0.0076 47/126 [==========>...................] - ETA: 0s - loss: 1.0291e-04 - mean\_absolute\_error: 0.0077 69/126 [===============>..............] - ETA: 0s - loss: 9.6290e-05 - mean\_absolute\_error: 0.0074 91/126 [====================>.........] - ETA: 0s - loss: 9.6095e-05 - mean\_absolute\_error: 0.0074112/126 [=========================>....] - ETA: 0s - loss: 9.4015e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.1863e-05 - mean\_absolute\_error: 0.0072 - val\_loss: 9.7867e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0387e-04 - mean\_absolute\_error: 0.0081 23/126 [====>.........................] - ETA: 0s - loss: 9.2418e-05 - mean\_absolute\_error: 0.0075 46/126 [=========>....................] - ETA: 0s - loss: 1.1335e-04 - mean\_absolute\_error: 0.0083 69/126 [===============>..............] - ETA: 0s - loss: 1.1522e-04 - mean\_absolute\_error: 0.0083 91/126 [====================>.........] - ETA: 0s - loss: 1.1100e-04 - mean\_absolute\_error: 0.0081114/126 [==========================>...] - ETA: 0s - loss: 1.0647e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0983e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 1.6526e-04 - val\_mean\_absolute\_error: 0.0106  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2523e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 1.0578e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 1.1907e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.1033e-04 - mean\_absolute\_error: 0.0082 90/126 [====================>.........] - ETA: 0s - loss: 1.1057e-04 - mean\_absolute\_error: 0.0081113/126 [=========================>....] - ETA: 0s - loss: 1.1072e-04 - mean\_absolute\_error: 0.0081126/126 [==============================] - 0s 3ms/step - loss: 1.1514e-04 - mean\_absolute\_error: 0.0083 - val\_loss: 9.6622e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1135e-04 - mean\_absolute\_error: 0.0089 23/126 [====>.........................] - ETA: 0s - loss: 1.3208e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.2318e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.1575e-04 - mean\_absolute\_error: 0.0083 91/126 [====================>.........] - ETA: 0s - loss: 1.1093e-04 - mean\_absolute\_error: 0.0081114/126 [==========================>...] - ETA: 0s - loss: 1.0955e-04 - mean\_absolute\_error: 0.0080126/126 [==============================] - 0s 3ms/step - loss: 1.1098e-04 - mean\_absolute\_error: 0.0081 - val\_loss: 9.8923e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4728e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 8.0772e-05 - mean\_absolute\_error: 0.0070 46/126 [=========>....................] - ETA: 0s - loss: 9.0663e-05 - mean\_absolute\_error: 0.0072 68/126 [===============>..............] - ETA: 0s - loss: 9.2055e-05 - mean\_absolute\_error: 0.0073 90/126 [====================>.........] - ETA: 0s - loss: 9.8118e-05 - mean\_absolute\_error: 0.0076112/126 [=========================>....] - ETA: 0s - loss: 9.9398e-05 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 9.9931e-05 - mean\_absolute\_error: 0.0077 - val\_loss: 9.3428e-05 - val\_mean\_absolute\_error: 0.0074  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4666e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 1.2183e-04 - mean\_absolute\_error: 0.0084 47/126 [==========>...................] - ETA: 0s - loss: 1.2197e-04 - mean\_absolute\_error: 0.0084 69/126 [===============>..............] - ETA: 0s - loss: 1.2014e-04 - mean\_absolute\_error: 0.0084 91/126 [====================>.........] - ETA: 0s - loss: 1.1053e-04 - mean\_absolute\_error: 0.0080113/126 [=========================>....] - ETA: 0s - loss: 1.0454e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0486e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 2.0359e-04 - val\_mean\_absolute\_error: 0.0117  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6665e-04 - mean\_absolute\_error: 0.0116 24/126 [====>.........................] - ETA: 0s - loss: 1.0461e-04 - mean\_absolute\_error: 0.0080 47/126 [==========>...................] - ETA: 0s - loss: 1.0246e-04 - mean\_absolute\_error: 0.0077 69/126 [===============>..............] - ETA: 0s - loss: 9.5125e-05 - mean\_absolute\_error: 0.0074 91/126 [====================>.........] - ETA: 0s - loss: 9.3203e-05 - mean\_absolute\_error: 0.0073114/126 [==========================>...] - ETA: 0s - loss: 9.2692e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.1966e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 9.2519e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0496e-04 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 1.0517e-04 - mean\_absolute\_error: 0.0077 47/126 [==========>...................] - ETA: 0s - loss: 1.1281e-04 - mean\_absolute\_error: 0.0080 69/126 [===============>..............] - ETA: 0s - loss: 1.0730e-04 - mean\_absolute\_error: 0.0079 91/126 [====================>.........] - ETA: 0s - loss: 1.0476e-04 - mean\_absolute\_error: 0.0078113/126 [=========================>....] - ETA: 0s - loss: 1.0222e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0422e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 9.1670e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6850e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 9.5631e-05 - mean\_absolute\_error: 0.0073 46/126 [=========>....................] - ETA: 0s - loss: 9.1974e-05 - mean\_absolute\_error: 0.0072 68/126 [===============>..............] - ETA: 0s - loss: 9.4811e-05 - mean\_absolute\_error: 0.0073 90/126 [====================>.........] - ETA: 0s - loss: 9.1188e-05 - mean\_absolute\_error: 0.0072112/126 [=========================>....] - ETA: 0s - loss: 9.8809e-05 - mean\_absolute\_error: 0.0075126/126 [==============================] - 0s 3ms/step - loss: 9.7757e-05 - mean\_absolute\_error: 0.0075 - val\_loss: 1.9516e-04 - val\_mean\_absolute\_error: 0.0114  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5088e-04 - mean\_absolute\_error: 0.0100 25/126 [====>.........................] - ETA: 0s - loss: 1.4220e-04 - mean\_absolute\_error: 0.0093 47/126 [==========>...................] - ETA: 0s - loss: 1.2532e-04 - mean\_absolute\_error: 0.0086 70/126 [===============>..............] - ETA: 0s - loss: 1.1433e-04 - mean\_absolute\_error: 0.0083 93/126 [=====================>........] - ETA: 0s - loss: 1.0754e-04 - mean\_absolute\_error: 0.0080116/126 [==========================>...] - ETA: 0s - loss: 1.0641e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0653e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0974e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4224e-05 - mean\_absolute\_error: 0.0076 25/126 [====>.........................] - ETA: 0s - loss: 8.4151e-05 - mean\_absolute\_error: 0.0071 47/126 [==========>...................] - ETA: 0s - loss: 8.9701e-05 - mean\_absolute\_error: 0.0072 69/126 [===============>..............] - ETA: 0s - loss: 1.0313e-04 - mean\_absolute\_error: 0.0077 92/126 [====================>.........] - ETA: 0s - loss: 1.0313e-04 - mean\_absolute\_error: 0.0077115/126 [==========================>...] - ETA: 0s - loss: 1.0467e-04 - mean\_absolute\_error: 0.0078126/126 [==============================] - 0s 3ms/step - loss: 1.0518e-04 - mean\_absolute\_error: 0.0079 - val\_loss: 1.0549e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 5.6362e-05 - mean\_absolute\_error: 0.0062 23/126 [====>.........................] - ETA: 0s - loss: 1.0354e-04 - mean\_absolute\_error: 0.0080 46/126 [=========>....................] - ETA: 0s - loss: 9.9985e-05 - mean\_absolute\_error: 0.0076 69/126 [===============>..............] - ETA: 0s - loss: 1.0911e-04 - mean\_absolute\_error: 0.0080 91/126 [====================>.........] - ETA: 0s - loss: 1.0622e-04 - mean\_absolute\_error: 0.0078113/126 [=========================>....] - ETA: 0s - loss: 1.0288e-04 - mean\_absolute\_error: 0.0077126/126 [==============================] - 0s 3ms/step - loss: 1.0548e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 1.0176e-04 - val\_mean\_absolute\_error: 0.0078  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9253e-05 - mean\_absolute\_error: 0.0076 24/126 [====>.........................] - ETA: 0s - loss: 8.7706e-05 - mean\_absolute\_error: 0.0071 46/126 [=========>....................] - ETA: 0s - loss: 9.3226e-05 - mean\_absolute\_error: 0.0073 68/126 [===============>..............] - ETA: 0s - loss: 9.1915e-05 - mean\_absolute\_error: 0.0073 90/126 [====================>.........] - ETA: 0s - loss: 8.8613e-05 - mean\_absolute\_error: 0.0072112/126 [=========================>....] - ETA: 0s - loss: 9.1967e-05 - mean\_absolute\_error: 0.0073126/126 [==============================] - 0s 3ms/step - loss: 9.1561e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.2459e-04 - val\_mean\_absolute\_error: 0.0088  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1001e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 9.0053e-05 - mean\_absolute\_error: 0.0072 47/126 [==========>...................] - ETA: 0s - loss: 8.8655e-05 - mean\_absolute\_error: 0.0071 69/126 [===============>..............] - ETA: 0s - loss: 9.9677e-05 - mean\_absolute\_error: 0.0076 92/126 [====================>.........] - ETA: 0s - loss: 1.0415e-04 - mean\_absolute\_error: 0.0078114/126 [==========================>...] - ETA: 0s - loss: 1.0071e-04 - mean\_absolute\_error: 0.0076126/126 [==============================] - 0s 3ms/step - loss: 1.0179e-04 - mean\_absolute\_error: 0.0077 - val\_loss: 1.3437e-04 - val\_mean\_absolute\_error: 0.0094  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2556e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 9.0171e-05 - mean\_absolute\_error: 0.0072 45/126 [=========>....................] - ETA: 0s - loss: 9.0303e-05 - mean\_absolute\_error: 0.0074 68/126 [===============>..............] - ETA: 0s - loss: 9.1354e-05 - mean\_absolute\_error: 0.0073 91/126 [====================>.........] - ETA: 0s - loss: 9.4342e-05 - mean\_absolute\_error: 0.0074114/126 [==========================>...] - ETA: 0s - loss: 9.2721e-05 - mean\_absolute\_error: 0.0074126/126 [==============================] - 0s 3ms/step - loss: 9.1230e-05 - mean\_absolute\_error: 0.0073 - val\_loss: 1.0101e-04 - val\_mean\_absolute\_error: 0.0080  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7664e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 9.0711e-05 - mean\_absolute\_error: 0.0072 46/126 [=========>....................] - ETA: 0s - loss: 9.7192e-05 - mean\_absolute\_error: 0.0076 69/126 [===============>..............] - ETA: 0s - loss: 9.9700e-05 - mean\_absolute\_error: 0.0077 92/126 [====================>.........] - ETA: 0s - loss: 9.5692e-05 - mean\_absolute\_error: 0.0076115/126 [==========================>...] - ETA: 0s - loss: 1.0440e-04 - mean\_absolute\_error: 0.0079126/126 [==============================] - 0s 3ms/step - loss: 1.0310e-04 - mean\_absolute\_error: 0.0078 - val\_loss: 9.6589e-05 - val\_mean\_absolute\_error: 0.0077

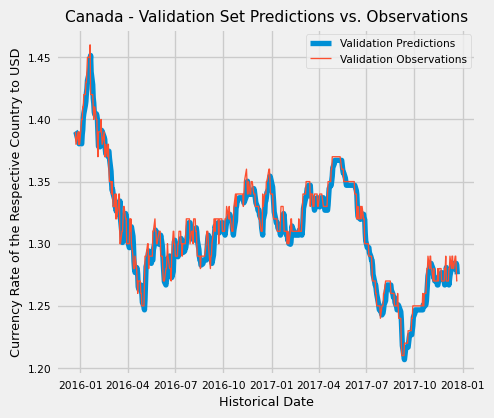
<keras.src.callbacks.History at 0x1b9cf56d990>

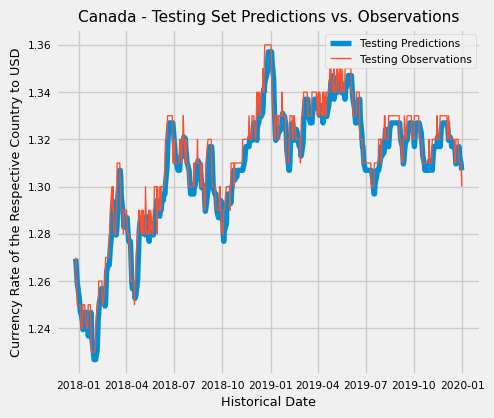
After the training and fitting of the Machine Learning model for Canada, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker blue 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: 43s 45/126 [=========>....................] - ETA: 0s 89/126 [====================>.........] - ETA: 0s126/126 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

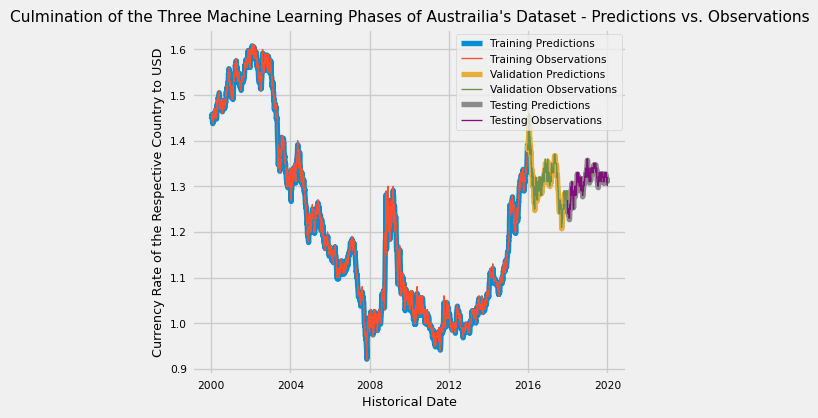






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

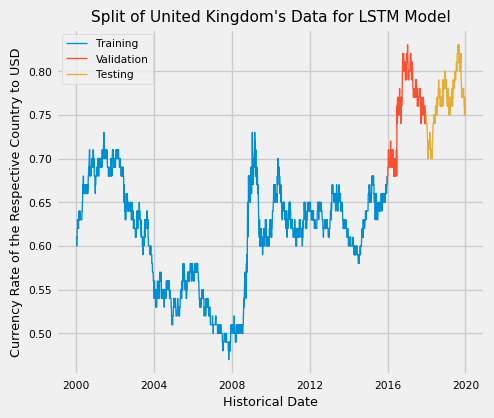
```{python}  
# Plotting Canada's observational (reference) data with the predictions of its   
# Machine Learning Model (as a way to visually inspect the effectiveness of the   
# model)   
plt.plot(dates\_canada\_train, canada\_train\_pred, linewidth=4)  
plt.plot(dates\_canada\_train, y\_canada\_train,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



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

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

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



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

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

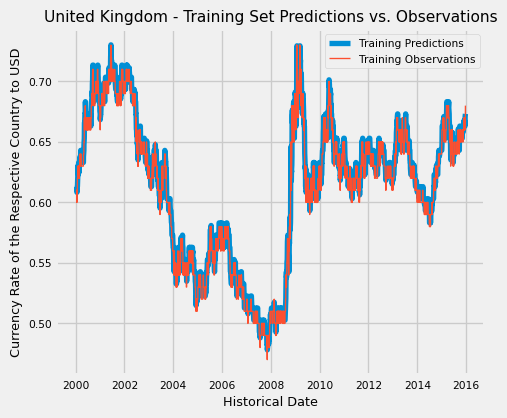
Epoch 1/100  
 1/126 [..............................] - ETA: 3:49 - loss: 0.3703 - mean\_absolute\_error: 0.6057 24/126 [====>.........................] - ETA: 0s - loss: 0.1779 - mean\_absolute\_error: 0.3939 47/126 [==========>...................] - ETA: 0s - loss: 0.0935 - mean\_absolute\_error: 0.2321 70/126 [===============>..............] - ETA: 0s - loss: 0.0633 - mean\_absolute\_error: 0.1663 92/126 [====================>.........] - ETA: 0s - loss: 0.0483 - mean\_absolute\_error: 0.1316115/126 [==========================>...] - ETA: 0s - loss: 0.0388 - mean\_absolute\_error: 0.1094126/126 [==============================] - 3s 6ms/step - loss: 0.0356 - mean\_absolute\_error: 0.1019 - val\_loss: 0.0026 - val\_mean\_absolute\_error: 0.0484  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 5.7615e-04 - mean\_absolute\_error: 0.0197 27/126 [=====>........................] - ETA: 0s - loss: 5.9776e-04 - mean\_absolute\_error: 0.0197 51/126 [===========>..................] - ETA: 0s - loss: 5.8787e-04 - mean\_absolute\_error: 0.0196 74/126 [================>.............] - ETA: 0s - loss: 5.7513e-04 - mean\_absolute\_error: 0.0193 97/126 [======================>.......] - ETA: 0s - loss: 5.5764e-04 - mean\_absolute\_error: 0.0191120/126 [===========================>..] - ETA: 0s - loss: 5.4724e-04 - mean\_absolute\_error: 0.0190126/126 [==============================] - 0s 3ms/step - loss: 5.3960e-04 - mean\_absolute\_error: 0.0188 - val\_loss: 0.0029 - val\_mean\_absolute\_error: 0.0515  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1183e-04 - mean\_absolute\_error: 0.0166 24/126 [====>.........................] - ETA: 0s - loss: 4.6633e-04 - mean\_absolute\_error: 0.0177 46/126 [=========>....................] - ETA: 0s - loss: 4.3105e-04 - mean\_absolute\_error: 0.0169 68/126 [===============>..............] - ETA: 0s - loss: 4.0813e-04 - mean\_absolute\_error: 0.0163 90/126 [====================>.........] - ETA: 0s - loss: 4.0196e-04 - mean\_absolute\_error: 0.0162112/126 [=========================>....] - ETA: 0s - loss: 3.8933e-04 - mean\_absolute\_error: 0.0160126/126 [==============================] - 0s 3ms/step - loss: 3.8321e-04 - mean\_absolute\_error: 0.0158 - val\_loss: 0.0017 - val\_mean\_absolute\_error: 0.0387  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9451e-04 - mean\_absolute\_error: 0.0138 24/126 [====>.........................] - ETA: 0s - loss: 2.8846e-04 - mean\_absolute\_error: 0.0138 45/126 [=========>....................] - ETA: 0s - loss: 2.8327e-04 - mean\_absolute\_error: 0.0137 67/126 [==============>...............] - ETA: 0s - loss: 2.7148e-04 - mean\_absolute\_error: 0.0134 88/126 [===================>..........] - ETA: 0s - loss: 2.5713e-04 - mean\_absolute\_error: 0.0130110/126 [=========================>....] - ETA: 0s - loss: 2.4041e-04 - mean\_absolute\_error: 0.0125126/126 [==============================] - 0s 3ms/step - loss: 2.3300e-04 - mean\_absolute\_error: 0.0123 - val\_loss: 7.2339e-04 - val\_mean\_absolute\_error: 0.0250  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6418e-04 - mean\_absolute\_error: 0.0104 23/126 [====>.........................] - ETA: 0s - loss: 1.5541e-04 - mean\_absolute\_error: 0.0100 45/126 [=========>....................] - ETA: 0s - loss: 1.4503e-04 - mean\_absolute\_error: 0.0097 67/126 [==============>...............] - ETA: 0s - loss: 1.3995e-04 - mean\_absolute\_error: 0.0095 89/126 [====================>.........] - ETA: 0s - loss: 1.3297e-04 - mean\_absolute\_error: 0.0092111/126 [=========================>....] - ETA: 0s - loss: 1.2426e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.2030e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 3.5008e-04 - val\_mean\_absolute\_error: 0.0168  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1211e-04 - mean\_absolute\_error: 0.0087 24/126 [====>.........................] - ETA: 0s - loss: 7.9705e-05 - mean\_absolute\_error: 0.0071 45/126 [=========>....................] - ETA: 0s - loss: 7.3698e-05 - mean\_absolute\_error: 0.0068 67/126 [==============>...............] - ETA: 0s - loss: 6.9166e-05 - mean\_absolute\_error: 0.0066 90/126 [====================>.........] - ETA: 0s - loss: 6.4327e-05 - mean\_absolute\_error: 0.0063112/126 [=========================>....] - ETA: 0s - loss: 6.2269e-05 - mean\_absolute\_error: 0.0062126/126 [==============================] - 0s 3ms/step - loss: 6.1990e-05 - mean\_absolute\_error: 0.0061 - val\_loss: 8.4367e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 6.8136e-05 - mean\_absolute\_error: 0.0055 23/126 [====>.........................] - ETA: 0s - loss: 4.1728e-05 - mean\_absolute\_error: 0.0050 45/126 [=========>....................] - ETA: 0s - loss: 4.4722e-05 - mean\_absolute\_error: 0.0051 67/126 [==============>...............] - ETA: 0s - loss: 4.2934e-05 - mean\_absolute\_error: 0.0049 89/126 [====================>.........] - ETA: 0s - loss: 4.0831e-05 - mean\_absolute\_error: 0.0048111/126 [=========================>....] - ETA: 0s - loss: 4.0103e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.9733e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.8472e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1524e-05 - mean\_absolute\_error: 0.0059 25/126 [====>.........................] - ETA: 0s - loss: 3.7015e-05 - mean\_absolute\_error: 0.0044 48/126 [==========>...................] - ETA: 0s - loss: 3.4919e-05 - mean\_absolute\_error: 0.0043 70/126 [===============>..............] - ETA: 0s - loss: 3.5356e-05 - mean\_absolute\_error: 0.0043 92/126 [====================>.........] - ETA: 0s - loss: 3.5256e-05 - mean\_absolute\_error: 0.0043115/126 [==========================>...] - ETA: 0s - loss: 3.5437e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5126e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.7305e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0081e-05 - mean\_absolute\_error: 0.0033 24/126 [====>.........................] - ETA: 0s - loss: 3.4835e-05 - mean\_absolute\_error: 0.0042 46/126 [=========>....................] - ETA: 0s - loss: 3.4079e-05 - mean\_absolute\_error: 0.0042 68/126 [===============>..............] - ETA: 0s - loss: 3.5187e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.4644e-05 - mean\_absolute\_error: 0.0042111/126 [=========================>....] - ETA: 0s - loss: 3.5023e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5349e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 8.9381e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4251e-05 - mean\_absolute\_error: 0.0039 24/126 [====>.........................] - ETA: 0s - loss: 3.2503e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 3.4143e-05 - mean\_absolute\_error: 0.0043 68/126 [===============>..............] - ETA: 0s - loss: 3.4326e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.4976e-05 - mean\_absolute\_error: 0.0042112/126 [=========================>....] - ETA: 0s - loss: 3.5986e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5557e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 8.3691e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9377e-05 - mean\_absolute\_error: 0.0035 24/126 [====>.........................] - ETA: 0s - loss: 4.0163e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 3.8101e-05 - mean\_absolute\_error: 0.0044 69/126 [===============>..............] - ETA: 0s - loss: 3.6304e-05 - mean\_absolute\_error: 0.0043 91/126 [====================>.........] - ETA: 0s - loss: 3.5456e-05 - mean\_absolute\_error: 0.0043113/126 [=========================>....] - ETA: 0s - loss: 3.5447e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5190e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 7.7864e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0049e-05 - mean\_absolute\_error: 0.0056 23/126 [====>.........................] - ETA: 0s - loss: 3.9334e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.5765e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.8222e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.7408e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.7638e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7638e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 1.1657e-04 - val\_mean\_absolute\_error: 0.0087  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7195e-05 - mean\_absolute\_error: 0.0045 24/126 [====>.........................] - ETA: 0s - loss: 3.4601e-05 - mean\_absolute\_error: 0.0042 47/126 [==========>...................] - ETA: 0s - loss: 3.8705e-05 - mean\_absolute\_error: 0.0046 69/126 [===============>..............] - ETA: 0s - loss: 3.8673e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.7759e-05 - mean\_absolute\_error: 0.0045113/126 [=========================>....] - ETA: 0s - loss: 3.6740e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6512e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.5360e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1867e-05 - mean\_absolute\_error: 0.0060 23/126 [====>.........................] - ETA: 0s - loss: 4.0445e-05 - mean\_absolute\_error: 0.0046 43/126 [=========>....................] - ETA: 0s - loss: 3.6565e-05 - mean\_absolute\_error: 0.0044 65/126 [==============>...............] - ETA: 0s - loss: 3.7358e-05 - mean\_absolute\_error: 0.0044 87/126 [===================>..........] - ETA: 0s - loss: 3.6614e-05 - mean\_absolute\_error: 0.0044109/126 [========================>.....] - ETA: 0s - loss: 3.6441e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6050e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 8.1182e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 4.1153e-05 - mean\_absolute\_error: 0.0044 23/126 [====>.........................] - ETA: 0s - loss: 3.7249e-05 - mean\_absolute\_error: 0.0044 45/126 [=========>....................] - ETA: 0s - loss: 3.6487e-05 - mean\_absolute\_error: 0.0043 68/126 [===============>..............] - ETA: 0s - loss: 3.5029e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.5053e-05 - mean\_absolute\_error: 0.0042112/126 [=========================>....] - ETA: 0s - loss: 3.4933e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.4769e-05 - mean\_absolute\_error: 0.0042 - val\_loss: 8.4254e-05 - val\_mean\_absolute\_error: 0.0069  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5322e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 3.1060e-05 - mean\_absolute\_error: 0.0039 45/126 [=========>....................] - ETA: 0s - loss: 3.3700e-05 - mean\_absolute\_error: 0.0042 67/126 [==============>...............] - ETA: 0s - loss: 3.6681e-05 - mean\_absolute\_error: 0.0044 89/126 [====================>.........] - ETA: 0s - loss: 3.6556e-05 - mean\_absolute\_error: 0.0044111/126 [=========================>....] - ETA: 0s - loss: 3.6363e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.7018e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.5951e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4051e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 3.3351e-05 - mean\_absolute\_error: 0.0042 47/126 [==========>...................] - ETA: 0s - loss: 3.4065e-05 - mean\_absolute\_error: 0.0042 69/126 [===============>..............] - ETA: 0s - loss: 3.4994e-05 - mean\_absolute\_error: 0.0042 92/126 [====================>.........] - ETA: 0s - loss: 3.5927e-05 - mean\_absolute\_error: 0.0043114/126 [==========================>...] - ETA: 0s - loss: 3.5325e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.5529e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 1.4061e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 6.0757e-05 - mean\_absolute\_error: 0.0068 23/126 [====>.........................] - ETA: 0s - loss: 4.4706e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 4.1539e-05 - mean\_absolute\_error: 0.0049 69/126 [===============>..............] - ETA: 0s - loss: 4.0294e-05 - mean\_absolute\_error: 0.0048 92/126 [====================>.........] - ETA: 0s - loss: 3.9511e-05 - mean\_absolute\_error: 0.0047114/126 [==========================>...] - ETA: 0s - loss: 3.9125e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8713e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2952e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9657e-05 - mean\_absolute\_error: 0.0049 24/126 [====>.........................] - ETA: 0s - loss: 3.3274e-05 - mean\_absolute\_error: 0.0041 47/126 [==========>...................] - ETA: 0s - loss: 3.4312e-05 - mean\_absolute\_error: 0.0042 69/126 [===============>..............] - ETA: 0s - loss: 3.5985e-05 - mean\_absolute\_error: 0.0043 91/126 [====================>.........] - ETA: 0s - loss: 3.6230e-05 - mean\_absolute\_error: 0.0043113/126 [=========================>....] - ETA: 0s - loss: 3.6469e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6663e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.1082e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7346e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.6410e-05 - mean\_absolute\_error: 0.0047 46/126 [=========>....................] - ETA: 0s - loss: 3.6144e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.7964e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.7649e-05 - mean\_absolute\_error: 0.0046113/126 [=========================>....] - ETA: 0s - loss: 3.7350e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8748e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.2055e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9978e-05 - mean\_absolute\_error: 0.0042 23/126 [====>.........................] - ETA: 0s - loss: 4.4860e-05 - mean\_absolute\_error: 0.0051 45/126 [=========>....................] - ETA: 0s - loss: 4.5841e-05 - mean\_absolute\_error: 0.0052 67/126 [==============>...............] - ETA: 0s - loss: 4.2903e-05 - mean\_absolute\_error: 0.0050 90/126 [====================>.........] - ETA: 0s - loss: 4.0168e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.9137e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9014e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 8.2201e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7407e-05 - mean\_absolute\_error: 0.0030 24/126 [====>.........................] - ETA: 0s - loss: 3.4634e-05 - mean\_absolute\_error: 0.0043 47/126 [==========>...................] - ETA: 0s - loss: 3.3956e-05 - mean\_absolute\_error: 0.0043 68/126 [===============>..............] - ETA: 0s - loss: 3.3241e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.6367e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.9618e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9800e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.1082e-04 - val\_mean\_absolute\_error: 0.0084  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8745e-05 - mean\_absolute\_error: 0.0050 24/126 [====>.........................] - ETA: 0s - loss: 4.8414e-05 - mean\_absolute\_error: 0.0053 46/126 [=========>....................] - ETA: 0s - loss: 4.5196e-05 - mean\_absolute\_error: 0.0052 68/126 [===============>..............] - ETA: 0s - loss: 4.1870e-05 - mean\_absolute\_error: 0.0049 90/126 [====================>.........] - ETA: 0s - loss: 3.9861e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 3.9794e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9571e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.2094e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5008e-05 - mean\_absolute\_error: 0.0052 24/126 [====>.........................] - ETA: 0s - loss: 4.2569e-05 - mean\_absolute\_error: 0.0048 47/126 [==========>...................] - ETA: 0s - loss: 4.3678e-05 - mean\_absolute\_error: 0.0050 70/126 [===============>..............] - ETA: 0s - loss: 4.3440e-05 - mean\_absolute\_error: 0.0051 93/126 [=====================>........] - ETA: 0s - loss: 4.3844e-05 - mean\_absolute\_error: 0.0050115/126 [==========================>...] - ETA: 0s - loss: 4.1713e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0986e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.3482e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9496e-05 - mean\_absolute\_error: 0.0040 24/126 [====>.........................] - ETA: 0s - loss: 3.9174e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 3.9149e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.7900e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.7342e-05 - mean\_absolute\_error: 0.0045113/126 [=========================>....] - ETA: 0s - loss: 3.8126e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8825e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.1622e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9086e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 4.7408e-05 - mean\_absolute\_error: 0.0054 46/126 [=========>....................] - ETA: 0s - loss: 4.2106e-05 - mean\_absolute\_error: 0.0050 69/126 [===============>..............] - ETA: 0s - loss: 4.0718e-05 - mean\_absolute\_error: 0.0048 91/126 [====================>.........] - ETA: 0s - loss: 4.0213e-05 - mean\_absolute\_error: 0.0048114/126 [==========================>...] - ETA: 0s - loss: 3.9795e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0182e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.5986e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2475e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 4.9288e-05 - mean\_absolute\_error: 0.0053 46/126 [=========>....................] - ETA: 0s - loss: 4.7750e-05 - mean\_absolute\_error: 0.0053 67/126 [==============>...............] - ETA: 0s - loss: 4.3718e-05 - mean\_absolute\_error: 0.0051 89/126 [====================>.........] - ETA: 0s - loss: 4.4797e-05 - mean\_absolute\_error: 0.0051111/126 [=========================>....] - ETA: 0s - loss: 4.2929e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.5528e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.9569e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1491e-05 - mean\_absolute\_error: 0.0052 24/126 [====>.........................] - ETA: 0s - loss: 4.1706e-05 - mean\_absolute\_error: 0.0045 47/126 [==========>...................] - ETA: 0s - loss: 4.0855e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.8269e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.8267e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.8487e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7866e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.1724e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9081e-05 - mean\_absolute\_error: 0.0044 23/126 [====>.........................] - ETA: 0s - loss: 4.3232e-05 - mean\_absolute\_error: 0.0049 46/126 [=========>....................] - ETA: 0s - loss: 3.9045e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.8769e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.9341e-05 - mean\_absolute\_error: 0.0046114/126 [==========================>...] - ETA: 0s - loss: 3.9491e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9493e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.2157e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6716e-05 - mean\_absolute\_error: 0.0057 24/126 [====>.........................] - ETA: 0s - loss: 4.1602e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 3.8111e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.9194e-05 - mean\_absolute\_error: 0.0048 91/126 [====================>.........] - ETA: 0s - loss: 4.0240e-05 - mean\_absolute\_error: 0.0049113/126 [=========================>....] - ETA: 0s - loss: 4.0919e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0357e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 1.0520e-04 - val\_mean\_absolute\_error: 0.0082  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1149e-05 - mean\_absolute\_error: 0.0054 24/126 [====>.........................] - ETA: 0s - loss: 3.9772e-05 - mean\_absolute\_error: 0.0045 47/126 [==========>...................] - ETA: 0s - loss: 4.0307e-05 - mean\_absolute\_error: 0.0045 70/126 [===============>..............] - ETA: 0s - loss: 3.7671e-05 - mean\_absolute\_error: 0.0044 91/126 [====================>.........] - ETA: 0s - loss: 4.0282e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 4.1046e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1532e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.8861e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3483e-05 - mean\_absolute\_error: 0.0046 24/126 [====>.........................] - ETA: 0s - loss: 5.6840e-05 - mean\_absolute\_error: 0.0061 46/126 [=========>....................] - ETA: 0s - loss: 5.1411e-05 - mean\_absolute\_error: 0.0057 68/126 [===============>..............] - ETA: 0s - loss: 4.7771e-05 - mean\_absolute\_error: 0.0053 90/126 [====================>.........] - ETA: 0s - loss: 4.4828e-05 - mean\_absolute\_error: 0.0051112/126 [=========================>....] - ETA: 0s - loss: 4.3787e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.3513e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 7.0987e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8555e-05 - mean\_absolute\_error: 0.0040 24/126 [====>.........................] - ETA: 0s - loss: 4.1433e-05 - mean\_absolute\_error: 0.0050 47/126 [==========>...................] - ETA: 0s - loss: 4.1503e-05 - mean\_absolute\_error: 0.0049 69/126 [===============>..............] - ETA: 0s - loss: 4.1095e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 3.9933e-05 - mean\_absolute\_error: 0.0048113/126 [=========================>....] - ETA: 0s - loss: 4.3117e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2038e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 8.9247e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3897e-05 - mean\_absolute\_error: 0.0045 24/126 [====>.........................] - ETA: 0s - loss: 3.4618e-05 - mean\_absolute\_error: 0.0042 47/126 [==========>...................] - ETA: 0s - loss: 3.2736e-05 - mean\_absolute\_error: 0.0041 68/126 [===============>..............] - ETA: 0s - loss: 3.6226e-05 - mean\_absolute\_error: 0.0044 90/126 [====================>.........] - ETA: 0s - loss: 3.7654e-05 - mean\_absolute\_error: 0.0046112/126 [=========================>....] - ETA: 0s - loss: 4.0234e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9912e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.8296e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6056e-05 - mean\_absolute\_error: 0.0047 24/126 [====>.........................] - ETA: 0s - loss: 3.7693e-05 - mean\_absolute\_error: 0.0046 47/126 [==========>...................] - ETA: 0s - loss: 4.3301e-05 - mean\_absolute\_error: 0.0050 69/126 [===============>..............] - ETA: 0s - loss: 4.3404e-05 - mean\_absolute\_error: 0.0050 91/126 [====================>.........] - ETA: 0s - loss: 4.3017e-05 - mean\_absolute\_error: 0.0050114/126 [==========================>...] - ETA: 0s - loss: 4.2117e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1077e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.4119e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 7.6924e-05 - mean\_absolute\_error: 0.0063 24/126 [====>.........................] - ETA: 0s - loss: 4.5494e-05 - mean\_absolute\_error: 0.0052 47/126 [==========>...................] - ETA: 0s - loss: 4.6544e-05 - mean\_absolute\_error: 0.0052 69/126 [===============>..............] - ETA: 0s - loss: 4.2562e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.1150e-05 - mean\_absolute\_error: 0.0048113/126 [=========================>....] - ETA: 0s - loss: 3.9848e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9863e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.8366e-05 - val\_mean\_absolute\_error: 0.0066  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 8.3085e-05 - mean\_absolute\_error: 0.0064 24/126 [====>.........................] - ETA: 0s - loss: 3.6788e-05 - mean\_absolute\_error: 0.0044 47/126 [==========>...................] - ETA: 0s - loss: 4.2576e-05 - mean\_absolute\_error: 0.0048 69/126 [===============>..............] - ETA: 0s - loss: 4.0050e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 4.0501e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 4.0357e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0284e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.0034e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1714e-05 - mean\_absolute\_error: 0.0041 24/126 [====>.........................] - ETA: 0s - loss: 3.8988e-05 - mean\_absolute\_error: 0.0045 46/126 [=========>....................] - ETA: 0s - loss: 3.8824e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.9188e-05 - mean\_absolute\_error: 0.0047 89/126 [====================>.........] - ETA: 0s - loss: 3.9128e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.8498e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7921e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 1.1207e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 9.3763e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 3.7151e-05 - mean\_absolute\_error: 0.0045 46/126 [=========>....................] - ETA: 0s - loss: 4.1888e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.9579e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 4.0925e-05 - mean\_absolute\_error: 0.0048112/126 [=========================>....] - ETA: 0s - loss: 4.5879e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.7032e-05 - mean\_absolute\_error: 0.0053 - val\_loss: 8.3397e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1737e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 4.3760e-05 - mean\_absolute\_error: 0.0052 47/126 [==========>...................] - ETA: 0s - loss: 4.5450e-05 - mean\_absolute\_error: 0.0053 68/126 [===============>..............] - ETA: 0s - loss: 4.5369e-05 - mean\_absolute\_error: 0.0053 89/126 [====================>.........] - ETA: 0s - loss: 4.3720e-05 - mean\_absolute\_error: 0.0051111/126 [=========================>....] - ETA: 0s - loss: 4.4901e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.4550e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 7.4965e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5939e-05 - mean\_absolute\_error: 0.0035 24/126 [====>.........................] - ETA: 0s - loss: 3.2755e-05 - mean\_absolute\_error: 0.0041 46/126 [=========>....................] - ETA: 0s - loss: 3.6405e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 4.1376e-05 - mean\_absolute\_error: 0.0049 90/126 [====================>.........] - ETA: 0s - loss: 4.1005e-05 - mean\_absolute\_error: 0.0048113/126 [=========================>....] - ETA: 0s - loss: 4.0943e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0517e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.9863e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8609e-05 - mean\_absolute\_error: 0.0031 23/126 [====>.........................] - ETA: 0s - loss: 3.4335e-05 - mean\_absolute\_error: 0.0045 46/126 [=========>....................] - ETA: 0s - loss: 3.8701e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.8020e-05 - mean\_absolute\_error: 0.0047 91/126 [====================>.........] - ETA: 0s - loss: 3.8644e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 3.9985e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 4.0611e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 9.2729e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2995e-04 - mean\_absolute\_error: 0.0082 24/126 [====>.........................] - ETA: 0s - loss: 4.0905e-05 - mean\_absolute\_error: 0.0048 47/126 [==========>...................] - ETA: 0s - loss: 3.7502e-05 - mean\_absolute\_error: 0.0046 70/126 [===============>..............] - ETA: 0s - loss: 3.6845e-05 - mean\_absolute\_error: 0.0045 92/126 [====================>.........] - ETA: 0s - loss: 3.5906e-05 - mean\_absolute\_error: 0.0045114/126 [==========================>...] - ETA: 0s - loss: 3.7205e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7682e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.5481e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6178e-05 - mean\_absolute\_error: 0.0045 24/126 [====>.........................] - ETA: 0s - loss: 4.6679e-05 - mean\_absolute\_error: 0.0053 46/126 [=========>....................] - ETA: 0s - loss: 4.7191e-05 - mean\_absolute\_error: 0.0054 68/126 [===============>..............] - ETA: 0s - loss: 4.9691e-05 - mean\_absolute\_error: 0.0055 90/126 [====================>.........] - ETA: 0s - loss: 4.7512e-05 - mean\_absolute\_error: 0.0053112/126 [=========================>....] - ETA: 0s - loss: 4.5781e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.5026e-05 - mean\_absolute\_error: 0.0052 - val\_loss: 8.3639e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 5.3862e-05 - mean\_absolute\_error: 0.0053 23/126 [====>.........................] - ETA: 0s - loss: 3.3164e-05 - mean\_absolute\_error: 0.0042 45/126 [=========>....................] - ETA: 0s - loss: 3.3684e-05 - mean\_absolute\_error: 0.0043 67/126 [==============>...............] - ETA: 0s - loss: 3.5510e-05 - mean\_absolute\_error: 0.0044 89/126 [====================>.........] - ETA: 0s - loss: 3.4860e-05 - mean\_absolute\_error: 0.0043111/126 [=========================>....] - ETA: 0s - loss: 3.5197e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6309e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 7.2604e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6433e-05 - mean\_absolute\_error: 0.0035 24/126 [====>.........................] - ETA: 0s - loss: 4.5941e-05 - mean\_absolute\_error: 0.0053 47/126 [==========>...................] - ETA: 0s - loss: 4.1728e-05 - mean\_absolute\_error: 0.0049 70/126 [===============>..............] - ETA: 0s - loss: 4.2112e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.1761e-05 - mean\_absolute\_error: 0.0049113/126 [=========================>....] - ETA: 0s - loss: 4.1409e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0611e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 1.3025e-04 - val\_mean\_absolute\_error: 0.0095  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6830e-05 - mean\_absolute\_error: 0.0058 23/126 [====>.........................] - ETA: 0s - loss: 3.7508e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 4.7644e-05 - mean\_absolute\_error: 0.0054 67/126 [==============>...............] - ETA: 0s - loss: 4.7991e-05 - mean\_absolute\_error: 0.0054 90/126 [====================>.........] - ETA: 0s - loss: 4.6860e-05 - mean\_absolute\_error: 0.0053112/126 [=========================>....] - ETA: 0s - loss: 4.9916e-05 - mean\_absolute\_error: 0.0055126/126 [==============================] - 0s 3ms/step - loss: 4.9372e-05 - mean\_absolute\_error: 0.0055 - val\_loss: 6.7336e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 3.8143e-05 - mean\_absolute\_error: 0.0047 24/126 [====>.........................] - ETA: 0s - loss: 3.8764e-05 - mean\_absolute\_error: 0.0048 46/126 [=========>....................] - ETA: 0s - loss: 3.8204e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.9213e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.8970e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 4.0259e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0439e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.0016e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0503e-05 - mean\_absolute\_error: 0.0030 24/126 [====>.........................] - ETA: 0s - loss: 3.3504e-05 - mean\_absolute\_error: 0.0043 47/126 [==========>...................] - ETA: 0s - loss: 3.9851e-05 - mean\_absolute\_error: 0.0048 69/126 [===============>..............] - ETA: 0s - loss: 4.5551e-05 - mean\_absolute\_error: 0.0051 91/126 [====================>.........] - ETA: 0s - loss: 4.3626e-05 - mean\_absolute\_error: 0.0050113/126 [=========================>....] - ETA: 0s - loss: 4.1961e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1888e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.9709e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3729e-05 - mean\_absolute\_error: 0.0033 24/126 [====>.........................] - ETA: 0s - loss: 4.2181e-05 - mean\_absolute\_error: 0.0049 47/126 [==========>...................] - ETA: 0s - loss: 4.0214e-05 - mean\_absolute\_error: 0.0048 69/126 [===============>..............] - ETA: 0s - loss: 4.1311e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.1202e-05 - mean\_absolute\_error: 0.0049112/126 [=========================>....] - ETA: 0s - loss: 4.0741e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0301e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.7661e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1479e-05 - mean\_absolute\_error: 0.0035 24/126 [====>.........................] - ETA: 0s - loss: 3.3322e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 3.2463e-05 - mean\_absolute\_error: 0.0042 68/126 [===============>..............] - ETA: 0s - loss: 3.4042e-05 - mean\_absolute\_error: 0.0043 91/126 [====================>.........] - ETA: 0s - loss: 3.4550e-05 - mean\_absolute\_error: 0.0043114/126 [==========================>...] - ETA: 0s - loss: 3.6892e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6523e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.7807e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5202e-05 - mean\_absolute\_error: 0.0038 22/126 [====>.........................] - ETA: 0s - loss: 5.0714e-05 - mean\_absolute\_error: 0.0054 44/126 [=========>....................] - ETA: 0s - loss: 4.6058e-05 - mean\_absolute\_error: 0.0053 67/126 [==============>...............] - ETA: 0s - loss: 4.3695e-05 - mean\_absolute\_error: 0.0051 88/126 [===================>..........] - ETA: 0s - loss: 4.5782e-05 - mean\_absolute\_error: 0.0052110/126 [=========================>....] - ETA: 0s - loss: 4.5324e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.4203e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 6.8367e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5977e-05 - mean\_absolute\_error: 0.0045 20/126 [===>..........................] - ETA: 0s - loss: 3.0738e-05 - mean\_absolute\_error: 0.0041 41/126 [========>.....................] - ETA: 0s - loss: 3.3463e-05 - mean\_absolute\_error: 0.0042 63/126 [==============>...............] - ETA: 0s - loss: 3.8418e-05 - mean\_absolute\_error: 0.0046 85/126 [===================>..........] - ETA: 0s - loss: 3.8822e-05 - mean\_absolute\_error: 0.0046107/126 [========================>.....] - ETA: 0s - loss: 3.9829e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9420e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.4327e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5476e-05 - mean\_absolute\_error: 0.0051 23/126 [====>.........................] - ETA: 0s - loss: 3.5120e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 3.5356e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.7926e-05 - mean\_absolute\_error: 0.0046 90/126 [====================>.........] - ETA: 0s - loss: 3.8088e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.8797e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9270e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 9.6196e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 6.4946e-05 - mean\_absolute\_error: 0.0070 24/126 [====>.........................] - ETA: 0s - loss: 6.1925e-05 - mean\_absolute\_error: 0.0063 47/126 [==========>...................] - ETA: 0s - loss: 5.9905e-05 - mean\_absolute\_error: 0.0062 69/126 [===============>..............] - ETA: 0s - loss: 5.7644e-05 - mean\_absolute\_error: 0.0061 91/126 [====================>.........] - ETA: 0s - loss: 5.3469e-05 - mean\_absolute\_error: 0.0058113/126 [=========================>....] - ETA: 0s - loss: 5.0971e-05 - mean\_absolute\_error: 0.0056126/126 [==============================] - 0s 3ms/step - loss: 5.1169e-05 - mean\_absolute\_error: 0.0056 - val\_loss: 6.2722e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 4.7564e-05 - mean\_absolute\_error: 0.0056 24/126 [====>.........................] - ETA: 0s - loss: 4.8315e-05 - mean\_absolute\_error: 0.0054 47/126 [==========>...................] - ETA: 0s - loss: 4.1856e-05 - mean\_absolute\_error: 0.0049 69/126 [===============>..............] - ETA: 0s - loss: 4.0701e-05 - mean\_absolute\_error: 0.0048 91/126 [====================>.........] - ETA: 0s - loss: 4.1710e-05 - mean\_absolute\_error: 0.0049113/126 [=========================>....] - ETA: 0s - loss: 4.2430e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1787e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 9.1252e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 4.5932e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 3.1718e-05 - mean\_absolute\_error: 0.0042 46/126 [=========>....................] - ETA: 0s - loss: 4.1237e-05 - mean\_absolute\_error: 0.0050 68/126 [===============>..............] - ETA: 0s - loss: 4.2761e-05 - mean\_absolute\_error: 0.0051 90/126 [====================>.........] - ETA: 0s - loss: 4.3973e-05 - mean\_absolute\_error: 0.0051112/126 [=========================>....] - ETA: 0s - loss: 4.2729e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.2680e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 8.8743e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5383e-05 - mean\_absolute\_error: 0.0030 23/126 [====>.........................] - ETA: 0s - loss: 4.1925e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.8764e-05 - mean\_absolute\_error: 0.0047 67/126 [==============>...............] - ETA: 0s - loss: 4.0143e-05 - mean\_absolute\_error: 0.0049 89/126 [====================>.........] - ETA: 0s - loss: 4.0411e-05 - mean\_absolute\_error: 0.0048111/126 [=========================>....] - ETA: 0s - loss: 3.9299e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8221e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.1938e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7637e-05 - mean\_absolute\_error: 0.0051 24/126 [====>.........................] - ETA: 0s - loss: 4.7986e-05 - mean\_absolute\_error: 0.0055 46/126 [=========>....................] - ETA: 0s - loss: 4.2189e-05 - mean\_absolute\_error: 0.0051 68/126 [===============>..............] - ETA: 0s - loss: 4.1409e-05 - mean\_absolute\_error: 0.0050 90/126 [====================>.........] - ETA: 0s - loss: 3.9463e-05 - mean\_absolute\_error: 0.0048112/126 [=========================>....] - ETA: 0s - loss: 3.8587e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9085e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 7.1940e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2940e-05 - mean\_absolute\_error: 0.0037 23/126 [====>.........................] - ETA: 0s - loss: 3.6461e-05 - mean\_absolute\_error: 0.0046 46/126 [=========>....................] - ETA: 0s - loss: 3.6766e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.8808e-05 - mean\_absolute\_error: 0.0048 91/126 [====================>.........] - ETA: 0s - loss: 3.8551e-05 - mean\_absolute\_error: 0.0047114/126 [==========================>...] - ETA: 0s - loss: 3.8172e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8381e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.0991e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6139e-05 - mean\_absolute\_error: 0.0036 22/126 [====>.........................] - ETA: 0s - loss: 4.7322e-05 - mean\_absolute\_error: 0.0053 44/126 [=========>....................] - ETA: 0s - loss: 4.2216e-05 - mean\_absolute\_error: 0.0048 66/126 [==============>...............] - ETA: 0s - loss: 4.1583e-05 - mean\_absolute\_error: 0.0048 89/126 [====================>.........] - ETA: 0s - loss: 3.9624e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.7887e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.8317e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.9096e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4825e-05 - mean\_absolute\_error: 0.0040 23/126 [====>.........................] - ETA: 0s - loss: 4.0963e-05 - mean\_absolute\_error: 0.0048 45/126 [=========>....................] - ETA: 0s - loss: 3.8210e-05 - mean\_absolute\_error: 0.0047 68/126 [===============>..............] - ETA: 0s - loss: 3.7336e-05 - mean\_absolute\_error: 0.0046 90/126 [====================>.........] - ETA: 0s - loss: 3.8412e-05 - mean\_absolute\_error: 0.0046112/126 [=========================>....] - ETA: 0s - loss: 4.0567e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.1395e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.2296e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 3.2827e-05 - mean\_absolute\_error: 0.0038 23/126 [====>.........................] - ETA: 0s - loss: 2.9353e-05 - mean\_absolute\_error: 0.0040 45/126 [=========>....................] - ETA: 0s - loss: 3.1484e-05 - mean\_absolute\_error: 0.0041 67/126 [==============>...............] - ETA: 0s - loss: 3.3680e-05 - mean\_absolute\_error: 0.0042 89/126 [====================>.........] - ETA: 0s - loss: 3.5319e-05 - mean\_absolute\_error: 0.0044111/126 [=========================>....] - ETA: 0s - loss: 3.5567e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.7102e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.0152e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5153e-05 - mean\_absolute\_error: 0.0044 24/126 [====>.........................] - ETA: 0s - loss: 3.8064e-05 - mean\_absolute\_error: 0.0046 45/126 [=========>....................] - ETA: 0s - loss: 4.4461e-05 - mean\_absolute\_error: 0.0051 66/126 [==============>...............] - ETA: 0s - loss: 4.1536e-05 - mean\_absolute\_error: 0.0048 88/126 [===================>..........] - ETA: 0s - loss: 4.2563e-05 - mean\_absolute\_error: 0.0049110/126 [=========================>....] - ETA: 0s - loss: 4.3931e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.3906e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 1.1504e-04 - val\_mean\_absolute\_error: 0.0085  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3197e-05 - mean\_absolute\_error: 0.0064 23/126 [====>.........................] - ETA: 0s - loss: 4.8919e-05 - mean\_absolute\_error: 0.0055 43/126 [=========>....................] - ETA: 0s - loss: 4.2463e-05 - mean\_absolute\_error: 0.0051 65/126 [==============>...............] - ETA: 0s - loss: 4.3726e-05 - mean\_absolute\_error: 0.0051 86/126 [===================>..........] - ETA: 0s - loss: 4.2653e-05 - mean\_absolute\_error: 0.0050109/126 [========================>.....] - ETA: 0s - loss: 4.1515e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.1034e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 6.4919e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 3.4864e-05 - mean\_absolute\_error: 0.0047 23/126 [====>.........................] - ETA: 0s - loss: 5.4930e-05 - mean\_absolute\_error: 0.0059 45/126 [=========>....................] - ETA: 0s - loss: 5.5278e-05 - mean\_absolute\_error: 0.0059 67/126 [==============>...............] - ETA: 0s - loss: 5.4243e-05 - mean\_absolute\_error: 0.0058 90/126 [====================>.........] - ETA: 0s - loss: 4.8855e-05 - mean\_absolute\_error: 0.0054112/126 [=========================>....] - ETA: 0s - loss: 4.8649e-05 - mean\_absolute\_error: 0.0054126/126 [==============================] - 0s 3ms/step - loss: 4.7836e-05 - mean\_absolute\_error: 0.0054 - val\_loss: 6.0298e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6974e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 3.3343e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 4.0490e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 3.8852e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.8238e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 4.0771e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0795e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 7.0638e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5444e-05 - mean\_absolute\_error: 0.0033 23/126 [====>.........................] - ETA: 0s - loss: 3.3577e-05 - mean\_absolute\_error: 0.0041 44/126 [=========>....................] - ETA: 0s - loss: 3.7626e-05 - mean\_absolute\_error: 0.0043 66/126 [==============>...............] - ETA: 0s - loss: 3.8041e-05 - mean\_absolute\_error: 0.0045 88/126 [===================>..........] - ETA: 0s - loss: 4.0009e-05 - mean\_absolute\_error: 0.0047111/126 [=========================>....] - ETA: 0s - loss: 3.7773e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.7321e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.4701e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8243e-05 - mean\_absolute\_error: 0.0058 23/126 [====>.........................] - ETA: 0s - loss: 4.0645e-05 - mean\_absolute\_error: 0.0047 45/126 [=========>....................] - ETA: 0s - loss: 3.8307e-05 - mean\_absolute\_error: 0.0045 67/126 [==============>...............] - ETA: 0s - loss: 3.7157e-05 - mean\_absolute\_error: 0.0045 89/126 [====================>.........] - ETA: 0s - loss: 3.7632e-05 - mean\_absolute\_error: 0.0046110/126 [=========================>....] - ETA: 0s - loss: 3.8903e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8741e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 6.8351e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 2.8569e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 3.9157e-05 - mean\_absolute\_error: 0.0047 47/126 [==========>...................] - ETA: 0s - loss: 3.6851e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.8840e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.8768e-05 - mean\_absolute\_error: 0.0047113/126 [=========================>....] - ETA: 0s - loss: 3.8161e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.9172e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.6919e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 7.7535e-05 - mean\_absolute\_error: 0.0075 23/126 [====>.........................] - ETA: 0s - loss: 5.2926e-05 - mean\_absolute\_error: 0.0059 45/126 [=========>....................] - ETA: 0s - loss: 5.7749e-05 - mean\_absolute\_error: 0.0061 66/126 [==============>...............] - ETA: 0s - loss: 5.4233e-05 - mean\_absolute\_error: 0.0059 88/126 [===================>..........] - ETA: 0s - loss: 4.9819e-05 - mean\_absolute\_error: 0.0055109/126 [========================>.....] - ETA: 0s - loss: 4.7139e-05 - mean\_absolute\_error: 0.0053126/126 [==============================] - 0s 3ms/step - loss: 4.4832e-05 - mean\_absolute\_error: 0.0051 - val\_loss: 6.4036e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1792e-05 - mean\_absolute\_error: 0.0041 22/126 [====>.........................] - ETA: 0s - loss: 2.8669e-05 - mean\_absolute\_error: 0.0039 44/126 [=========>....................] - ETA: 0s - loss: 3.7232e-05 - mean\_absolute\_error: 0.0046 66/126 [==============>...............] - ETA: 0s - loss: 3.8343e-05 - mean\_absolute\_error: 0.0046 89/126 [====================>.........] - ETA: 0s - loss: 3.9143e-05 - mean\_absolute\_error: 0.0047111/126 [=========================>....] - ETA: 0s - loss: 3.8752e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8554e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.0853e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5980e-05 - mean\_absolute\_error: 0.0032 23/126 [====>.........................] - ETA: 0s - loss: 3.0843e-05 - mean\_absolute\_error: 0.0041 46/126 [=========>....................] - ETA: 0s - loss: 3.4107e-05 - mean\_absolute\_error: 0.0043 69/126 [===============>..............] - ETA: 0s - loss: 3.4417e-05 - mean\_absolute\_error: 0.0044 91/126 [====================>.........] - ETA: 0s - loss: 3.5653e-05 - mean\_absolute\_error: 0.0044113/126 [=========================>....] - ETA: 0s - loss: 3.9041e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9157e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 1.3812e-04 - val\_mean\_absolute\_error: 0.0096  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 6.7043e-05 - mean\_absolute\_error: 0.0067 24/126 [====>.........................] - ETA: 0s - loss: 5.1761e-05 - mean\_absolute\_error: 0.0057 47/126 [==========>...................] - ETA: 0s - loss: 4.6934e-05 - mean\_absolute\_error: 0.0053 68/126 [===============>..............] - ETA: 0s - loss: 5.1269e-05 - mean\_absolute\_error: 0.0056 90/126 [====================>.........] - ETA: 0s - loss: 4.7897e-05 - mean\_absolute\_error: 0.0053112/126 [=========================>....] - ETA: 0s - loss: 4.9021e-05 - mean\_absolute\_error: 0.0055126/126 [==============================] - 0s 3ms/step - loss: 4.7589e-05 - mean\_absolute\_error: 0.0054 - val\_loss: 5.9437e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8932e-05 - mean\_absolute\_error: 0.0060 24/126 [====>.........................] - ETA: 0s - loss: 3.5330e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 3.4299e-05 - mean\_absolute\_error: 0.0043 68/126 [===============>..............] - ETA: 0s - loss: 3.4456e-05 - mean\_absolute\_error: 0.0043 90/126 [====================>.........] - ETA: 0s - loss: 3.4142e-05 - mean\_absolute\_error: 0.0043112/126 [=========================>....] - ETA: 0s - loss: 3.3694e-05 - mean\_absolute\_error: 0.0042126/126 [==============================] - 0s 3ms/step - loss: 3.3945e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 5.9206e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0388e-05 - mean\_absolute\_error: 0.0052 24/126 [====>.........................] - ETA: 0s - loss: 4.1678e-05 - mean\_absolute\_error: 0.0050 45/126 [=========>....................] - ETA: 0s - loss: 3.8256e-05 - mean\_absolute\_error: 0.0047 67/126 [==============>...............] - ETA: 0s - loss: 3.8693e-05 - mean\_absolute\_error: 0.0047 89/126 [====================>.........] - ETA: 0s - loss: 3.7004e-05 - mean\_absolute\_error: 0.0046111/126 [=========================>....] - ETA: 0s - loss: 3.6857e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6892e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 7.6259e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6573e-05 - mean\_absolute\_error: 0.0032 24/126 [====>.........................] - ETA: 0s - loss: 4.1087e-05 - mean\_absolute\_error: 0.0049 46/126 [=========>....................] - ETA: 0s - loss: 3.8173e-05 - mean\_absolute\_error: 0.0047 68/126 [===============>..............] - ETA: 0s - loss: 4.0294e-05 - mean\_absolute\_error: 0.0048 90/126 [====================>.........] - ETA: 0s - loss: 4.0222e-05 - mean\_absolute\_error: 0.0048112/126 [=========================>....] - ETA: 0s - loss: 3.8003e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8556e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 9.4865e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 4.6080e-05 - mean\_absolute\_error: 0.0050 24/126 [====>.........................] - ETA: 0s - loss: 4.2700e-05 - mean\_absolute\_error: 0.0050 47/126 [==========>...................] - ETA: 0s - loss: 3.9040e-05 - mean\_absolute\_error: 0.0047 70/126 [===============>..............] - ETA: 0s - loss: 3.9949e-05 - mean\_absolute\_error: 0.0048 92/126 [====================>.........] - ETA: 0s - loss: 3.6538e-05 - mean\_absolute\_error: 0.0045115/126 [==========================>...] - ETA: 0s - loss: 3.6805e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.8004e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 5.9155e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 3.9104e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.3612e-05 - mean\_absolute\_error: 0.0044 47/126 [==========>...................] - ETA: 0s - loss: 3.5988e-05 - mean\_absolute\_error: 0.0045 69/126 [===============>..............] - ETA: 0s - loss: 3.7983e-05 - mean\_absolute\_error: 0.0047 91/126 [====================>.........] - ETA: 0s - loss: 3.9264e-05 - mean\_absolute\_error: 0.0048114/126 [==========================>...] - ETA: 0s - loss: 3.8365e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.9544e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.0860e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 4.0111e-05 - mean\_absolute\_error: 0.0052 24/126 [====>.........................] - ETA: 0s - loss: 4.1521e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 4.1973e-05 - mean\_absolute\_error: 0.0049 68/126 [===============>..............] - ETA: 0s - loss: 3.9228e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 3.9553e-05 - mean\_absolute\_error: 0.0047112/126 [=========================>....] - ETA: 0s - loss: 3.8103e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.6888e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.0293e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 3.7267e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.3670e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 4.0165e-05 - mean\_absolute\_error: 0.0048 68/126 [===============>..............] - ETA: 0s - loss: 4.5254e-05 - mean\_absolute\_error: 0.0052 90/126 [====================>.........] - ETA: 0s - loss: 4.4943e-05 - mean\_absolute\_error: 0.0052112/126 [=========================>....] - ETA: 0s - loss: 4.3398e-05 - mean\_absolute\_error: 0.0051126/126 [==============================] - 0s 3ms/step - loss: 4.1972e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 1.5604e-04 - val\_mean\_absolute\_error: 0.0104  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 4.8805e-05 - mean\_absolute\_error: 0.0055 24/126 [====>.........................] - ETA: 0s - loss: 3.7294e-05 - mean\_absolute\_error: 0.0044 46/126 [=========>....................] - ETA: 0s - loss: 3.4596e-05 - mean\_absolute\_error: 0.0042 68/126 [===============>..............] - ETA: 0s - loss: 3.4454e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.4184e-05 - mean\_absolute\_error: 0.0042112/126 [=========================>....] - ETA: 0s - loss: 3.6149e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5737e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 6.3025e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3606e-05 - mean\_absolute\_error: 0.0037 24/126 [====>.........................] - ETA: 0s - loss: 2.9210e-05 - mean\_absolute\_error: 0.0040 47/126 [==========>...................] - ETA: 0s - loss: 3.3499e-05 - mean\_absolute\_error: 0.0044 69/126 [===============>..............] - ETA: 0s - loss: 3.6515e-05 - mean\_absolute\_error: 0.0045 91/126 [====================>.........] - ETA: 0s - loss: 3.4820e-05 - mean\_absolute\_error: 0.0044113/126 [=========================>....] - ETA: 0s - loss: 3.4927e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5632e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 5.8292e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 2.2240e-05 - mean\_absolute\_error: 0.0036 24/126 [====>.........................] - ETA: 0s - loss: 3.9030e-05 - mean\_absolute\_error: 0.0047 47/126 [==========>...................] - ETA: 0s - loss: 4.2118e-05 - mean\_absolute\_error: 0.0049 69/126 [===============>..............] - ETA: 0s - loss: 4.1336e-05 - mean\_absolute\_error: 0.0049 91/126 [====================>.........] - ETA: 0s - loss: 4.0876e-05 - mean\_absolute\_error: 0.0049113/126 [=========================>....] - ETA: 0s - loss: 3.8708e-05 - mean\_absolute\_error: 0.0047126/126 [==============================] - 0s 3ms/step - loss: 3.8557e-05 - mean\_absolute\_error: 0.0047 - val\_loss: 5.7735e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 3.0337e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 4.9671e-05 - mean\_absolute\_error: 0.0055 47/126 [==========>...................] - ETA: 0s - loss: 4.3889e-05 - mean\_absolute\_error: 0.0051 70/126 [===============>..............] - ETA: 0s - loss: 4.2370e-05 - mean\_absolute\_error: 0.0051 92/126 [====================>.........] - ETA: 0s - loss: 3.9397e-05 - mean\_absolute\_error: 0.0049115/126 [==========================>...] - ETA: 0s - loss: 3.9752e-05 - mean\_absolute\_error: 0.0049126/126 [==============================] - 0s 3ms/step - loss: 4.0017e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 1.2089e-04 - val\_mean\_absolute\_error: 0.0089  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1217e-05 - mean\_absolute\_error: 0.0062 24/126 [====>.........................] - ETA: 0s - loss: 3.5034e-05 - mean\_absolute\_error: 0.0045 46/126 [=========>....................] - ETA: 0s - loss: 3.8508e-05 - mean\_absolute\_error: 0.0046 68/126 [===============>..............] - ETA: 0s - loss: 3.9378e-05 - mean\_absolute\_error: 0.0047 90/126 [====================>.........] - ETA: 0s - loss: 4.0224e-05 - mean\_absolute\_error: 0.0048112/126 [=========================>....] - ETA: 0s - loss: 3.9877e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0530e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 6.3763e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6565e-05 - mean\_absolute\_error: 0.0051 24/126 [====>.........................] - ETA: 0s - loss: 4.0270e-05 - mean\_absolute\_error: 0.0050 46/126 [=========>....................] - ETA: 0s - loss: 4.5641e-05 - mean\_absolute\_error: 0.0053 66/126 [==============>...............] - ETA: 0s - loss: 4.3397e-05 - mean\_absolute\_error: 0.0052 85/126 [===================>..........] - ETA: 0s - loss: 4.1398e-05 - mean\_absolute\_error: 0.0049105/126 [========================>.....] - ETA: 0s - loss: 4.0202e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 4.0251e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.5133e-05 - val\_mean\_absolute\_error: 0.0068  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 8.4883e-05 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 4.2545e-05 - mean\_absolute\_error: 0.0052 44/126 [=========>....................] - ETA: 0s - loss: 4.2564e-05 - mean\_absolute\_error: 0.0051 66/126 [==============>...............] - ETA: 0s - loss: 4.3573e-05 - mean\_absolute\_error: 0.0052 88/126 [===================>..........] - ETA: 0s - loss: 4.3334e-05 - mean\_absolute\_error: 0.0052110/126 [=========================>....] - ETA: 0s - loss: 4.2882e-05 - mean\_absolute\_error: 0.0052126/126 [==============================] - 0s 3ms/step - loss: 4.1785e-05 - mean\_absolute\_error: 0.0050 - val\_loss: 5.7612e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 3.1535e-05 - mean\_absolute\_error: 0.0042 14/126 [==>...........................] - ETA: 0s - loss: 4.3207e-05 - mean\_absolute\_error: 0.0052 32/126 [======>.......................] - ETA: 0s - loss: 4.4651e-05 - mean\_absolute\_error: 0.0052 53/126 [===========>..................] - ETA: 0s - loss: 4.3187e-05 - mean\_absolute\_error: 0.0050 74/126 [================>.............] - ETA: 0s - loss: 3.9213e-05 - mean\_absolute\_error: 0.0047 93/126 [=====================>........] - ETA: 0s - loss: 3.7979e-05 - mean\_absolute\_error: 0.0046114/126 [==========================>...] - ETA: 0s - loss: 3.7090e-05 - mean\_absolute\_error: 0.0045126/126 [==============================] - 0s 3ms/step - loss: 3.6587e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.0572e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6124e-05 - mean\_absolute\_error: 0.0041 23/126 [====>.........................] - ETA: 0s - loss: 3.6902e-05 - mean\_absolute\_error: 0.0045 45/126 [=========>....................] - ETA: 0s - loss: 3.3344e-05 - mean\_absolute\_error: 0.0043 67/126 [==============>...............] - ETA: 0s - loss: 3.2420e-05 - mean\_absolute\_error: 0.0042 89/126 [====================>.........] - ETA: 0s - loss: 3.2860e-05 - mean\_absolute\_error: 0.0042111/126 [=========================>....] - ETA: 0s - loss: 3.4966e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5557e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 7.1451e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6541e-05 - mean\_absolute\_error: 0.0031 24/126 [====>.........................] - ETA: 0s - loss: 3.6372e-05 - mean\_absolute\_error: 0.0043 46/126 [=========>....................] - ETA: 0s - loss: 3.4106e-05 - mean\_absolute\_error: 0.0042 68/126 [===============>..............] - ETA: 0s - loss: 3.3310e-05 - mean\_absolute\_error: 0.0042 90/126 [====================>.........] - ETA: 0s - loss: 3.4467e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.5073e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.4387e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 5.6471e-05 - val\_mean\_absolute\_error: 0.0052  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5423e-05 - mean\_absolute\_error: 0.0048 24/126 [====>.........................] - ETA: 0s - loss: 3.5077e-05 - mean\_absolute\_error: 0.0047 46/126 [=========>....................] - ETA: 0s - loss: 3.4250e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.5085e-05 - mean\_absolute\_error: 0.0045 91/126 [====================>.........] - ETA: 0s - loss: 3.6442e-05 - mean\_absolute\_error: 0.0046113/126 [=========================>....] - ETA: 0s - loss: 3.9532e-05 - mean\_absolute\_error: 0.0048126/126 [==============================] - 0s 3ms/step - loss: 3.8939e-05 - mean\_absolute\_error: 0.0048 - val\_loss: 7.7677e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5592e-05 - mean\_absolute\_error: 0.0028 24/126 [====>.........................] - ETA: 0s - loss: 2.9018e-05 - mean\_absolute\_error: 0.0039 46/126 [=========>....................] - ETA: 0s - loss: 3.6181e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.6361e-05 - mean\_absolute\_error: 0.0045 90/126 [====================>.........] - ETA: 0s - loss: 3.5738e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.5728e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.6011e-05 - mean\_absolute\_error: 0.0045 - val\_loss: 6.2213e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0671e-05 - mean\_absolute\_error: 0.0059 23/126 [====>.........................] - ETA: 0s - loss: 3.3908e-05 - mean\_absolute\_error: 0.0043 45/126 [=========>....................] - ETA: 0s - loss: 3.4087e-05 - mean\_absolute\_error: 0.0043 67/126 [==============>...............] - ETA: 0s - loss: 3.5820e-05 - mean\_absolute\_error: 0.0045 89/126 [====================>.........] - ETA: 0s - loss: 3.5837e-05 - mean\_absolute\_error: 0.0045111/126 [=========================>....] - ETA: 0s - loss: 3.4166e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.4226e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 6.1189e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 5.4064e-05 - mean\_absolute\_error: 0.0059 23/126 [====>.........................] - ETA: 0s - loss: 5.7559e-05 - mean\_absolute\_error: 0.0061 44/126 [=========>....................] - ETA: 0s - loss: 5.5338e-05 - mean\_absolute\_error: 0.0059 67/126 [==============>...............] - ETA: 0s - loss: 4.8861e-05 - mean\_absolute\_error: 0.0054 89/126 [====================>.........] - ETA: 0s - loss: 4.4258e-05 - mean\_absolute\_error: 0.0051111/126 [=========================>....] - ETA: 0s - loss: 4.2415e-05 - mean\_absolute\_error: 0.0050126/126 [==============================] - 0s 3ms/step - loss: 4.1387e-05 - mean\_absolute\_error: 0.0049 - val\_loss: 9.1516e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 3.6237e-05 - mean\_absolute\_error: 0.0043 24/126 [====>.........................] - ETA: 0s - loss: 3.6540e-05 - mean\_absolute\_error: 0.0045 47/126 [==========>...................] - ETA: 0s - loss: 3.6594e-05 - mean\_absolute\_error: 0.0046 69/126 [===============>..............] - ETA: 0s - loss: 3.6161e-05 - mean\_absolute\_error: 0.0046 91/126 [====================>.........] - ETA: 0s - loss: 3.6159e-05 - mean\_absolute\_error: 0.0046113/126 [=========================>....] - ETA: 0s - loss: 3.6246e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.6593e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 6.8335e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0805e-05 - mean\_absolute\_error: 0.0033 24/126 [====>.........................] - ETA: 0s - loss: 3.0529e-05 - mean\_absolute\_error: 0.0039 46/126 [=========>....................] - ETA: 0s - loss: 3.0930e-05 - mean\_absolute\_error: 0.0040 68/126 [===============>..............] - ETA: 0s - loss: 3.1344e-05 - mean\_absolute\_error: 0.0040 90/126 [====================>.........] - ETA: 0s - loss: 3.2056e-05 - mean\_absolute\_error: 0.0041113/126 [=========================>....] - ETA: 0s - loss: 3.3143e-05 - mean\_absolute\_error: 0.0041126/126 [==============================] - 0s 3ms/step - loss: 3.2642e-05 - mean\_absolute\_error: 0.0041 - val\_loss: 6.4058e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9679e-05 - mean\_absolute\_error: 0.0038 24/126 [====>.........................] - ETA: 0s - loss: 3.2209e-05 - mean\_absolute\_error: 0.0041 46/126 [=========>....................] - ETA: 0s - loss: 3.4867e-05 - mean\_absolute\_error: 0.0044 68/126 [===============>..............] - ETA: 0s - loss: 3.3701e-05 - mean\_absolute\_error: 0.0043 90/126 [====================>.........] - ETA: 0s - loss: 3.4850e-05 - mean\_absolute\_error: 0.0044112/126 [=========================>....] - ETA: 0s - loss: 3.4747e-05 - mean\_absolute\_error: 0.0044126/126 [==============================] - 0s 3ms/step - loss: 3.5054e-05 - mean\_absolute\_error: 0.0044 - val\_loss: 5.4211e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1993e-05 - mean\_absolute\_error: 0.0032 24/126 [====>.........................] - ETA: 0s - loss: 3.9657e-05 - mean\_absolute\_error: 0.0047 46/126 [=========>....................] - ETA: 0s - loss: 3.6223e-05 - mean\_absolute\_error: 0.0045 68/126 [===============>..............] - ETA: 0s - loss: 3.5776e-05 - mean\_absolute\_error: 0.0044 90/126 [====================>.........] - ETA: 0s - loss: 3.7123e-05 - mean\_absolute\_error: 0.0045112/126 [=========================>....] - ETA: 0s - loss: 3.7170e-05 - mean\_absolute\_error: 0.0046126/126 [==============================] - 0s 3ms/step - loss: 3.7285e-05 - mean\_absolute\_error: 0.0046 - val\_loss: 9.5703e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 5.2517e-05 - mean\_absolute\_error: 0.0059 23/126 [====>.........................] - ETA: 0s - loss: 3.0356e-05 - mean\_absolute\_error: 0.0040 45/126 [=========>....................] - ETA: 0s - loss: 3.3195e-05 - mean\_absolute\_error: 0.0043 67/126 [==============>...............] - ETA: 0s - loss: 3.1973e-05 - mean\_absolute\_error: 0.0042 89/126 [====================>.........] - ETA: 0s - loss: 3.3193e-05 - mean\_absolute\_error: 0.0042112/126 [=========================>....] - ETA: 0s - loss: 3.3902e-05 - mean\_absolute\_error: 0.0043126/126 [==============================] - 0s 3ms/step - loss: 3.3510e-05 - mean\_absolute\_error: 0.0043 - val\_loss: 5.5446e-05 - val\_mean\_absolute\_error: 0.0052

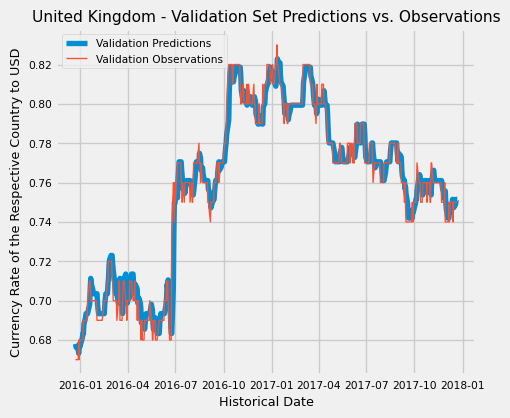
<keras.src.callbacks.History at 0x1b9cce64710>

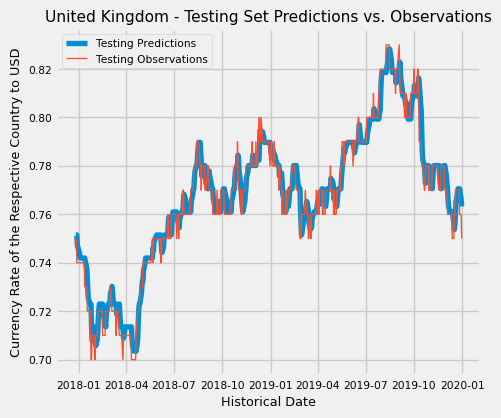
After the training and fitting of the Machine Learning model for the United Kingdom, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and 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: 1:08 46/126 [=========>....................] - ETA: 0s 91/126 [====================>.........] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

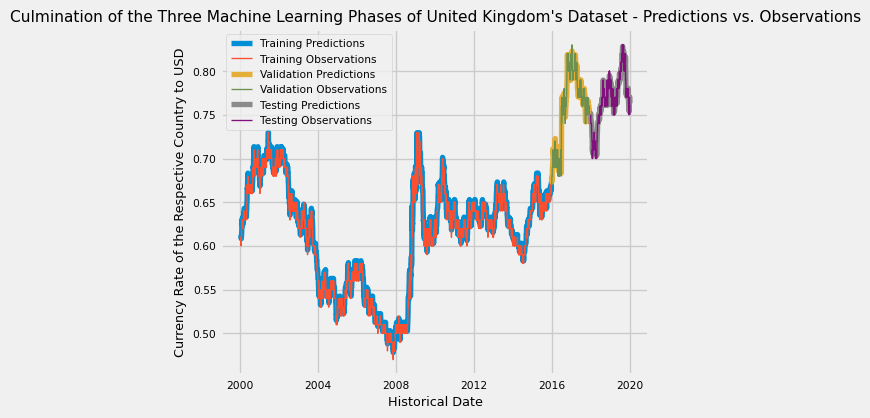






Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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

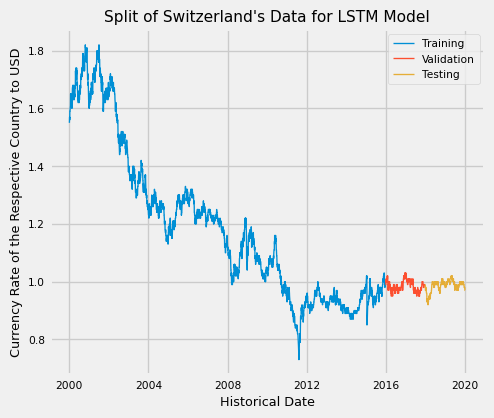
```{python}  
# Plotting United Kingdom's observational (reference) data with the predictions   
# of its Machine Learning Model (as a way to visually inspect the effectiveness   
# of the model)   
plt.plot(dates\_united\_kingdom\_train, united\_kingdom\_train\_pred, linewidth=4)  
plt.plot(dates\_united\_kingdom\_train,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



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

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

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



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

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

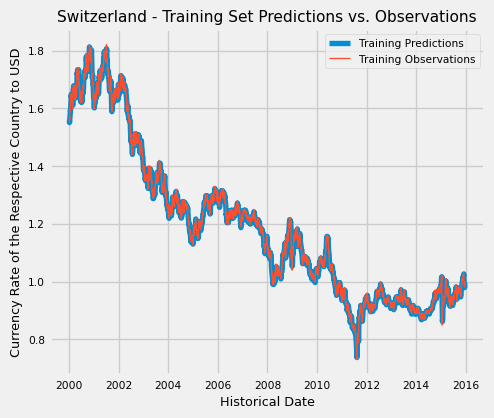
Epoch 1/100  
 1/126 [..............................] - ETA: 3:45 - loss: 1.3590 - mean\_absolute\_error: 1.1459 23/126 [====>.........................] - ETA: 0s - loss: 0.8303 - mean\_absolute\_error: 0.8635 47/126 [==========>...................] - ETA: 0s - loss: 0.4317 - mean\_absolute\_error: 0.5188 71/126 [===============>..............] - ETA: 0s - loss: 0.2883 - mean\_absolute\_error: 0.3652 94/126 [=====================>........] - ETA: 0s - loss: 0.2186 - mean\_absolute\_error: 0.2882117/126 [==========================>...] - ETA: 0s - loss: 0.1762 - mean\_absolute\_error: 0.2402126/126 [==============================] - 3s 6ms/step - loss: 0.1646 - mean\_absolute\_error: 0.2270 - val\_loss: 0.0018 - val\_mean\_absolute\_error: 0.0419  
Epoch 2/100  
 1/126 [..............................] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0395 27/126 [=====>........................] - ETA: 0s - loss: 0.0021 - mean\_absolute\_error: 0.0380 51/126 [===========>..................] - ETA: 0s - loss: 0.0019 - mean\_absolute\_error: 0.0361 74/126 [================>.............] - ETA: 0s - loss: 0.0017 - mean\_absolute\_error: 0.0337 97/126 [======================>.......] - ETA: 0s - loss: 0.0015 - mean\_absolute\_error: 0.0319120/126 [===========================>..] - ETA: 0s - loss: 0.0014 - mean\_absolute\_error: 0.0300126/126 [==============================] - 0s 2ms/step - loss: 0.0013 - mean\_absolute\_error: 0.0296 - val\_loss: 4.4025e-04 - val\_mean\_absolute\_error: 0.0198  
Epoch 3/100  
 1/126 [..............................] - ETA: 0s - loss: 5.0985e-04 - mean\_absolute\_error: 0.0182 24/126 [====>.........................] - ETA: 0s - loss: 5.5478e-04 - mean\_absolute\_error: 0.0187 46/126 [=========>....................] - ETA: 0s - loss: 4.5819e-04 - mean\_absolute\_error: 0.0170 68/126 [===============>..............] - ETA: 0s - loss: 3.9970e-04 - mean\_absolute\_error: 0.0159 90/126 [====================>.........] - ETA: 0s - loss: 3.5529e-04 - mean\_absolute\_error: 0.0149112/126 [=========================>....] - ETA: 0s - loss: 3.2511e-04 - mean\_absolute\_error: 0.0142126/126 [==============================] - 0s 3ms/step - loss: 3.0806e-04 - mean\_absolute\_error: 0.0138 - val\_loss: 8.3917e-05 - val\_mean\_absolute\_error: 0.0075  
Epoch 4/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5955e-04 - mean\_absolute\_error: 0.0104 23/126 [====>.........................] - ETA: 0s - loss: 1.6437e-04 - mean\_absolute\_error: 0.0103 45/126 [=========>....................] - ETA: 0s - loss: 1.6491e-04 - mean\_absolute\_error: 0.0101 67/126 [==============>...............] - ETA: 0s - loss: 1.6593e-04 - mean\_absolute\_error: 0.0099 89/126 [====================>.........] - ETA: 0s - loss: 1.5859e-04 - mean\_absolute\_error: 0.0097110/126 [=========================>....] - ETA: 0s - loss: 1.5920e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6450e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 6.1081e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 5/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6511e-04 - mean\_absolute\_error: 0.0102 24/126 [====>.........................] - ETA: 0s - loss: 1.4656e-04 - mean\_absolute\_error: 0.0094 47/126 [==========>...................] - ETA: 0s - loss: 1.5571e-04 - mean\_absolute\_error: 0.0094 69/126 [===============>..............] - ETA: 0s - loss: 1.5725e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.5367e-04 - mean\_absolute\_error: 0.0093112/126 [=========================>....] - ETA: 0s - loss: 1.5297e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5535e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.0733e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 6/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2962e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.3988e-04 - mean\_absolute\_error: 0.0092 47/126 [==========>...................] - ETA: 0s - loss: 1.5887e-04 - mean\_absolute\_error: 0.0093 69/126 [===============>..............] - ETA: 0s - loss: 1.6337e-04 - mean\_absolute\_error: 0.0095 91/126 [====================>.........] - ETA: 0s - loss: 1.6252e-04 - mean\_absolute\_error: 0.0095113/126 [=========================>....] - ETA: 0s - loss: 1.5674e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5573e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.3883e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 7/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1630e-04 - mean\_absolute\_error: 0.0119 24/126 [====>.........................] - ETA: 0s - loss: 1.4727e-04 - mean\_absolute\_error: 0.0092 47/126 [==========>...................] - ETA: 0s - loss: 1.4681e-04 - mean\_absolute\_error: 0.0092 69/126 [===============>..............] - ETA: 0s - loss: 1.5352e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.6421e-04 - mean\_absolute\_error: 0.0095113/126 [=========================>....] - ETA: 0s - loss: 1.5909e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5660e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.6471e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 8/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5605e-04 - mean\_absolute\_error: 0.0092 24/126 [====>.........................] - ETA: 0s - loss: 1.7691e-04 - mean\_absolute\_error: 0.0095 46/126 [=========>....................] - ETA: 0s - loss: 1.7218e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.6951e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.6326e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.5834e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5653e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.9514e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 9/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3093e-04 - mean\_absolute\_error: 0.0083 24/126 [====>.........................] - ETA: 0s - loss: 1.5392e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.5123e-04 - mean\_absolute\_error: 0.0090 68/126 [===============>..............] - ETA: 0s - loss: 1.5213e-04 - mean\_absolute\_error: 0.0092 91/126 [====================>.........] - ETA: 0s - loss: 1.5159e-04 - mean\_absolute\_error: 0.0092113/126 [=========================>....] - ETA: 0s - loss: 1.5404e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5277e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9293e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 10/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4518e-04 - mean\_absolute\_error: 0.0098 25/126 [====>.........................] - ETA: 0s - loss: 1.3402e-04 - mean\_absolute\_error: 0.0089 47/126 [==========>...................] - ETA: 0s - loss: 1.4359e-04 - mean\_absolute\_error: 0.0091 70/126 [===============>..............] - ETA: 0s - loss: 1.5091e-04 - mean\_absolute\_error: 0.0092 92/126 [====================>.........] - ETA: 0s - loss: 1.5731e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.5409e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5225e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.3463e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 11/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3666e-04 - mean\_absolute\_error: 0.0088 24/126 [====>.........................] - ETA: 0s - loss: 1.2743e-04 - mean\_absolute\_error: 0.0088 47/126 [==========>...................] - ETA: 0s - loss: 1.4986e-04 - mean\_absolute\_error: 0.0091 69/126 [===============>..............] - ETA: 0s - loss: 1.6037e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.5666e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.5398e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5071e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.8290e-05 - val\_mean\_absolute\_error: 0.0061  
Epoch 12/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9862e-04 - mean\_absolute\_error: 0.0106 24/126 [====>.........................] - ETA: 0s - loss: 1.4564e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.5147e-04 - mean\_absolute\_error: 0.0091 68/126 [===============>..............] - ETA: 0s - loss: 1.4600e-04 - mean\_absolute\_error: 0.0091 90/126 [====================>.........] - ETA: 0s - loss: 1.5257e-04 - mean\_absolute\_error: 0.0093112/126 [=========================>....] - ETA: 0s - loss: 1.4867e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5325e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.1463e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 13/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3039e-05 - mean\_absolute\_error: 0.0066 24/126 [====>.........................] - ETA: 0s - loss: 1.4794e-04 - mean\_absolute\_error: 0.0091 46/126 [=========>....................] - ETA: 0s - loss: 1.4290e-04 - mean\_absolute\_error: 0.0091 69/126 [===============>..............] - ETA: 0s - loss: 1.5891e-04 - mean\_absolute\_error: 0.0092 92/126 [====================>.........] - ETA: 0s - loss: 1.5331e-04 - mean\_absolute\_error: 0.0092114/126 [==========================>...] - ETA: 0s - loss: 1.5062e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4983e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.0919e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 14/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3850e-04 - mean\_absolute\_error: 0.0098 24/126 [====>.........................] - ETA: 0s - loss: 1.6790e-04 - mean\_absolute\_error: 0.0099 46/126 [=========>....................] - ETA: 0s - loss: 1.6257e-04 - mean\_absolute\_error: 0.0095 68/126 [===============>..............] - ETA: 0s - loss: 1.5928e-04 - mean\_absolute\_error: 0.0094 90/126 [====================>.........] - ETA: 0s - loss: 1.5910e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.5512e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5159e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 6.0350e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 15/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6605e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.3325e-04 - mean\_absolute\_error: 0.0089 47/126 [==========>...................] - ETA: 0s - loss: 1.5058e-04 - mean\_absolute\_error: 0.0093 69/126 [===============>..............] - ETA: 0s - loss: 1.4784e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.5359e-04 - mean\_absolute\_error: 0.0094114/126 [==========================>...] - ETA: 0s - loss: 1.5016e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5493e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.4301e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 16/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7995e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 2.0514e-04 - mean\_absolute\_error: 0.0099 46/126 [=========>....................] - ETA: 0s - loss: 1.7243e-04 - mean\_absolute\_error: 0.0094 69/126 [===============>..............] - ETA: 0s - loss: 1.6328e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.5782e-04 - mean\_absolute\_error: 0.0092113/126 [=========================>....] - ETA: 0s - loss: 1.5095e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5118e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9505e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 17/100  
 1/126 [..............................] - ETA: 0s - loss: 2.5343e-04 - mean\_absolute\_error: 0.0114 23/126 [====>.........................] - ETA: 0s - loss: 1.7347e-04 - mean\_absolute\_error: 0.0095 46/126 [=========>....................] - ETA: 0s - loss: 1.7930e-04 - mean\_absolute\_error: 0.0096 68/126 [===============>..............] - ETA: 0s - loss: 1.5943e-04 - mean\_absolute\_error: 0.0092 90/126 [====================>.........] - ETA: 0s - loss: 1.5669e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.5335e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5266e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.0938e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 18/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5076e-04 - mean\_absolute\_error: 0.0094 23/126 [====>.........................] - ETA: 0s - loss: 1.3839e-04 - mean\_absolute\_error: 0.0091 45/126 [=========>....................] - ETA: 0s - loss: 1.4196e-04 - mean\_absolute\_error: 0.0091 67/126 [==============>...............] - ETA: 0s - loss: 1.4774e-04 - mean\_absolute\_error: 0.0091 89/126 [====================>.........] - ETA: 0s - loss: 1.4646e-04 - mean\_absolute\_error: 0.0091111/126 [=========================>....] - ETA: 0s - loss: 1.4284e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4798e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9283e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 19/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3863e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 1.4464e-04 - mean\_absolute\_error: 0.0093 46/126 [=========>....................] - ETA: 0s - loss: 1.4497e-04 - mean\_absolute\_error: 0.0093 69/126 [===============>..............] - ETA: 0s - loss: 1.5124e-04 - mean\_absolute\_error: 0.0093 92/126 [====================>.........] - ETA: 0s - loss: 1.5475e-04 - mean\_absolute\_error: 0.0093114/126 [==========================>...] - ETA: 0s - loss: 1.5056e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4957e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9427e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 20/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5202e-04 - mean\_absolute\_error: 0.0091 24/126 [====>.........................] - ETA: 0s - loss: 1.4471e-04 - mean\_absolute\_error: 0.0093 47/126 [==========>...................] - ETA: 0s - loss: 1.5149e-04 - mean\_absolute\_error: 0.0092 70/126 [===============>..............] - ETA: 0s - loss: 1.5008e-04 - mean\_absolute\_error: 0.0091 92/126 [====================>.........] - ETA: 0s - loss: 1.4834e-04 - mean\_absolute\_error: 0.0091115/126 [==========================>...] - ETA: 0s - loss: 1.4625e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5169e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9777e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 21/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6326e-04 - mean\_absolute\_error: 0.0100 24/126 [====>.........................] - ETA: 0s - loss: 1.5005e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.5279e-04 - mean\_absolute\_error: 0.0093 68/126 [===============>..............] - ETA: 0s - loss: 1.5938e-04 - mean\_absolute\_error: 0.0094 91/126 [====================>.........] - ETA: 0s - loss: 1.6354e-04 - mean\_absolute\_error: 0.0096113/126 [=========================>....] - ETA: 0s - loss: 1.5862e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5723e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 9.4914e-05 - val\_mean\_absolute\_error: 0.0080  
Epoch 22/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6231e-04 - mean\_absolute\_error: 0.0095 23/126 [====>.........................] - ETA: 0s - loss: 1.5544e-04 - mean\_absolute\_error: 0.0097 45/126 [=========>....................] - ETA: 0s - loss: 1.5163e-04 - mean\_absolute\_error: 0.0094 67/126 [==============>...............] - ETA: 0s - loss: 1.6500e-04 - mean\_absolute\_error: 0.0096 89/126 [====================>.........] - ETA: 0s - loss: 1.7206e-04 - mean\_absolute\_error: 0.0100110/126 [=========================>....] - ETA: 0s - loss: 1.7561e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.6955e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 5.0331e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 23/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9036e-05 - mean\_absolute\_error: 0.0074 24/126 [====>.........................] - ETA: 0s - loss: 1.8057e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 1.7517e-04 - mean\_absolute\_error: 0.0096 68/126 [===============>..............] - ETA: 0s - loss: 1.6607e-04 - mean\_absolute\_error: 0.0095 90/126 [====================>.........] - ETA: 0s - loss: 1.6188e-04 - mean\_absolute\_error: 0.0095112/126 [=========================>....] - ETA: 0s - loss: 1.6083e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5936e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0737e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 24/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8304e-04 - mean\_absolute\_error: 0.0106 24/126 [====>.........................] - ETA: 0s - loss: 1.5659e-04 - mean\_absolute\_error: 0.0091 47/126 [==========>...................] - ETA: 0s - loss: 1.4351e-04 - mean\_absolute\_error: 0.0089 69/126 [===============>..............] - ETA: 0s - loss: 1.3947e-04 - mean\_absolute\_error: 0.0090 91/126 [====================>.........] - ETA: 0s - loss: 1.4859e-04 - mean\_absolute\_error: 0.0092113/126 [=========================>....] - ETA: 0s - loss: 1.5791e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5464e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.0918e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 25/100  
 1/126 [..............................] - ETA: 0s - loss: 8.2167e-05 - mean\_absolute\_error: 0.0070 24/126 [====>.........................] - ETA: 0s - loss: 1.3809e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.5976e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.5529e-04 - mean\_absolute\_error: 0.0093 90/126 [====================>.........] - ETA: 0s - loss: 1.5321e-04 - mean\_absolute\_error: 0.0093112/126 [=========================>....] - ETA: 0s - loss: 1.5502e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5045e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 6.7662e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 26/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0768e-04 - mean\_absolute\_error: 0.0083 24/126 [====>.........................] - ETA: 0s - loss: 1.5041e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.4870e-04 - mean\_absolute\_error: 0.0090 69/126 [===============>..............] - ETA: 0s - loss: 1.3897e-04 - mean\_absolute\_error: 0.0088 91/126 [====================>.........] - ETA: 0s - loss: 1.4198e-04 - mean\_absolute\_error: 0.0089114/126 [==========================>...] - ETA: 0s - loss: 1.4182e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4533e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.0245e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 27/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9010e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 1.4986e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.5137e-04 - mean\_absolute\_error: 0.0095 68/126 [===============>..............] - ETA: 0s - loss: 1.7384e-04 - mean\_absolute\_error: 0.0100 91/126 [====================>.........] - ETA: 0s - loss: 1.7208e-04 - mean\_absolute\_error: 0.0099113/126 [=========================>....] - ETA: 0s - loss: 1.6728e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6392e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 5.0358e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 28/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3438e-04 - mean\_absolute\_error: 0.0094 24/126 [====>.........................] - ETA: 0s - loss: 1.4160e-04 - mean\_absolute\_error: 0.0085 47/126 [==========>...................] - ETA: 0s - loss: 1.4071e-04 - mean\_absolute\_error: 0.0087 69/126 [===============>..............] - ETA: 0s - loss: 1.4252e-04 - mean\_absolute\_error: 0.0089 91/126 [====================>.........] - ETA: 0s - loss: 1.5647e-04 - mean\_absolute\_error: 0.0094112/126 [=========================>....] - ETA: 0s - loss: 1.5884e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5894e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.0021e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 29/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0736e-04 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 1.6198e-04 - mean\_absolute\_error: 0.0098 47/126 [==========>...................] - ETA: 0s - loss: 1.5938e-04 - mean\_absolute\_error: 0.0096 69/126 [===============>..............] - ETA: 0s - loss: 1.5833e-04 - mean\_absolute\_error: 0.0096 91/126 [====================>.........] - ETA: 0s - loss: 1.6176e-04 - mean\_absolute\_error: 0.0096113/126 [=========================>....] - ETA: 0s - loss: 1.5845e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5911e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.5645e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 30/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5393e-04 - mean\_absolute\_error: 0.0100 23/126 [====>.........................] - ETA: 0s - loss: 1.6856e-04 - mean\_absolute\_error: 0.0095 45/126 [=========>....................] - ETA: 0s - loss: 1.6676e-04 - mean\_absolute\_error: 0.0094 67/126 [==============>...............] - ETA: 0s - loss: 1.6118e-04 - mean\_absolute\_error: 0.0093 89/126 [====================>.........] - ETA: 0s - loss: 1.5764e-04 - mean\_absolute\_error: 0.0093111/126 [=========================>....] - ETA: 0s - loss: 1.5474e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5185e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 9.1201e-05 - val\_mean\_absolute\_error: 0.0078  
Epoch 31/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6381e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.2619e-04 - mean\_absolute\_error: 0.0086 47/126 [==========>...................] - ETA: 0s - loss: 1.3222e-04 - mean\_absolute\_error: 0.0087 69/126 [===============>..............] - ETA: 0s - loss: 1.4207e-04 - mean\_absolute\_error: 0.0090 91/126 [====================>.........] - ETA: 0s - loss: 1.5036e-04 - mean\_absolute\_error: 0.0091113/126 [=========================>....] - ETA: 0s - loss: 1.4664e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4546e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.9189e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 32/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8971e-05 - mean\_absolute\_error: 0.0072 24/126 [====>.........................] - ETA: 0s - loss: 1.2961e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.7985e-04 - mean\_absolute\_error: 0.0099 68/126 [===============>..............] - ETA: 0s - loss: 1.6582e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.5491e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.5398e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5277e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.9129e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 33/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3925e-04 - mean\_absolute\_error: 0.0090 24/126 [====>.........................] - ETA: 0s - loss: 1.5240e-04 - mean\_absolute\_error: 0.0089 46/126 [=========>....................] - ETA: 0s - loss: 1.5027e-04 - mean\_absolute\_error: 0.0092 68/126 [===============>..............] - ETA: 0s - loss: 1.6051e-04 - mean\_absolute\_error: 0.0093 90/126 [====================>.........] - ETA: 0s - loss: 1.5693e-04 - mean\_absolute\_error: 0.0093112/126 [=========================>....] - ETA: 0s - loss: 1.5340e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5205e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 6.5410e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 34/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0264e-04 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 1.8438e-04 - mean\_absolute\_error: 0.0105 46/126 [=========>....................] - ETA: 0s - loss: 1.6337e-04 - mean\_absolute\_error: 0.0099 68/126 [===============>..............] - ETA: 0s - loss: 1.6023e-04 - mean\_absolute\_error: 0.0096 90/126 [====================>.........] - ETA: 0s - loss: 1.6151e-04 - mean\_absolute\_error: 0.0095111/126 [=========================>....] - ETA: 0s - loss: 1.6495e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6212e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.1522e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 35/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2502e-04 - mean\_absolute\_error: 0.0092 24/126 [====>.........................] - ETA: 0s - loss: 1.5538e-04 - mean\_absolute\_error: 0.0097 46/126 [=========>....................] - ETA: 0s - loss: 1.4637e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.4882e-04 - mean\_absolute\_error: 0.0092 90/126 [====================>.........] - ETA: 0s - loss: 1.4868e-04 - mean\_absolute\_error: 0.0092112/126 [=========================>....] - ETA: 0s - loss: 1.5260e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5026e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.9610e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 36/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1815e-04 - mean\_absolute\_error: 0.0082 24/126 [====>.........................] - ETA: 0s - loss: 1.3978e-04 - mean\_absolute\_error: 0.0091 47/126 [==========>...................] - ETA: 0s - loss: 1.7329e-04 - mean\_absolute\_error: 0.0099 69/126 [===============>..............] - ETA: 0s - loss: 1.8153e-04 - mean\_absolute\_error: 0.0102 91/126 [====================>.........] - ETA: 0s - loss: 1.7681e-04 - mean\_absolute\_error: 0.0102113/126 [=========================>....] - ETA: 0s - loss: 1.6962e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.7426e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 1.1622e-04 - val\_mean\_absolute\_error: 0.0090  
Epoch 37/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6728e-04 - mean\_absolute\_error: 0.0108 24/126 [====>.........................] - ETA: 0s - loss: 1.7614e-04 - mean\_absolute\_error: 0.0097 46/126 [=========>....................] - ETA: 0s - loss: 1.7493e-04 - mean\_absolute\_error: 0.0096 67/126 [==============>...............] - ETA: 0s - loss: 1.6661e-04 - mean\_absolute\_error: 0.0095 89/126 [====================>.........] - ETA: 0s - loss: 1.6508e-04 - mean\_absolute\_error: 0.0096112/126 [=========================>....] - ETA: 0s - loss: 1.5986e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5664e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.9639e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 38/100  
 1/126 [..............................] - ETA: 0s - loss: 8.6848e-05 - mean\_absolute\_error: 0.0077 24/126 [====>.........................] - ETA: 0s - loss: 1.4873e-04 - mean\_absolute\_error: 0.0093 47/126 [==========>...................] - ETA: 0s - loss: 1.5729e-04 - mean\_absolute\_error: 0.0095 70/126 [===============>..............] - ETA: 0s - loss: 1.5500e-04 - mean\_absolute\_error: 0.0095 92/126 [====================>.........] - ETA: 0s - loss: 1.5237e-04 - mean\_absolute\_error: 0.0094115/126 [==========================>...] - ETA: 0s - loss: 1.5593e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.6085e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.4410e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 39/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9529e-05 - mean\_absolute\_error: 0.0078 24/126 [====>.........................] - ETA: 0s - loss: 1.5758e-04 - mean\_absolute\_error: 0.0098 46/126 [=========>....................] - ETA: 0s - loss: 1.5686e-04 - mean\_absolute\_error: 0.0097 68/126 [===============>..............] - ETA: 0s - loss: 1.5918e-04 - mean\_absolute\_error: 0.0097 90/126 [====================>.........] - ETA: 0s - loss: 1.5392e-04 - mean\_absolute\_error: 0.0096112/126 [=========================>....] - ETA: 0s - loss: 1.5541e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5852e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.6095e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 40/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8178e-04 - mean\_absolute\_error: 0.0107 24/126 [====>.........................] - ETA: 0s - loss: 1.3712e-04 - mean\_absolute\_error: 0.0088 46/126 [=========>....................] - ETA: 0s - loss: 1.7241e-04 - mean\_absolute\_error: 0.0098 62/126 [=============>................] - ETA: 0s - loss: 1.6836e-04 - mean\_absolute\_error: 0.0097 72/126 [================>.............] - ETA: 0s - loss: 1.6395e-04 - mean\_absolute\_error: 0.0096 82/126 [==================>...........] - ETA: 0s - loss: 1.5965e-04 - mean\_absolute\_error: 0.0095 91/126 [====================>.........] - ETA: 0s - loss: 1.5730e-04 - mean\_absolute\_error: 0.0095101/126 [=======================>......] - ETA: 0s - loss: 1.6524e-04 - mean\_absolute\_error: 0.0096114/126 [==========================>...] - ETA: 0s - loss: 1.7504e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 1s 4ms/step - loss: 1.7497e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 6.7484e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 41/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0164e-04 - mean\_absolute\_error: 0.0082 16/126 [==>...........................] - ETA: 0s - loss: 1.3765e-04 - mean\_absolute\_error: 0.0090 29/126 [=====>........................] - ETA: 0s - loss: 1.4010e-04 - mean\_absolute\_error: 0.0090 39/126 [========>.....................] - ETA: 0s - loss: 1.5159e-04 - mean\_absolute\_error: 0.0094 52/126 [===========>..................] - ETA: 0s - loss: 1.4633e-04 - mean\_absolute\_error: 0.0092 66/126 [==============>...............] - ETA: 0s - loss: 1.4503e-04 - mean\_absolute\_error: 0.0092 80/126 [==================>...........] - ETA: 0s - loss: 1.5142e-04 - mean\_absolute\_error: 0.0093 92/126 [====================>.........] - ETA: 0s - loss: 1.4738e-04 - mean\_absolute\_error: 0.0091103/126 [=======================>......] - ETA: 0s - loss: 1.4661e-04 - mean\_absolute\_error: 0.0091114/126 [==========================>...] - ETA: 0s - loss: 1.5115e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - ETA: 0s - loss: 1.4942e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 1s 5ms/step - loss: 1.4942e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.2070e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 42/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1088e-04 - mean\_absolute\_error: 0.0084 12/126 [=>............................] - ETA: 0s - loss: 1.6053e-04 - mean\_absolute\_error: 0.0095 23/126 [====>.........................] - ETA: 0s - loss: 1.4095e-04 - mean\_absolute\_error: 0.0091 35/126 [=======>......................] - ETA: 0s - loss: 1.6693e-04 - mean\_absolute\_error: 0.0091 46/126 [=========>....................] - ETA: 0s - loss: 1.6626e-04 - mean\_absolute\_error: 0.0094 58/126 [============>.................] - ETA: 0s - loss: 1.6344e-04 - mean\_absolute\_error: 0.0094 71/126 [===============>..............] - ETA: 0s - loss: 1.5510e-04 - mean\_absolute\_error: 0.0092 83/126 [==================>...........] - ETA: 0s - loss: 1.5280e-04 - mean\_absolute\_error: 0.0092 94/126 [=====================>........] - ETA: 0s - loss: 1.4946e-04 - mean\_absolute\_error: 0.0091104/126 [=======================>......] - ETA: 0s - loss: 1.4900e-04 - mean\_absolute\_error: 0.0091115/126 [==========================>...] - ETA: 0s - loss: 1.4964e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 1s 5ms/step - loss: 1.5220e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.2544e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 43/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7548e-04 - mean\_absolute\_error: 0.0091 14/126 [==>...........................] - ETA: 0s - loss: 1.7393e-04 - mean\_absolute\_error: 0.0093 26/126 [=====>........................] - ETA: 0s - loss: 1.4197e-04 - mean\_absolute\_error: 0.0087 44/126 [=========>....................] - ETA: 0s - loss: 1.4906e-04 - mean\_absolute\_error: 0.0091 62/126 [=============>................] - ETA: 0s - loss: 1.6299e-04 - mean\_absolute\_error: 0.0096 80/126 [==================>...........] - ETA: 0s - loss: 1.5856e-04 - mean\_absolute\_error: 0.0095 99/126 [======================>.......] - ETA: 0s - loss: 1.6442e-04 - mean\_absolute\_error: 0.0095117/126 [==========================>...] - ETA: 0s - loss: 1.6262e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5923e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 4.9717e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 44/100  
 1/126 [..............................] - ETA: 0s - loss: 7.9888e-05 - mean\_absolute\_error: 0.0069 19/126 [===>..........................] - ETA: 0s - loss: 1.8025e-04 - mean\_absolute\_error: 0.0093 38/126 [========>.....................] - ETA: 0s - loss: 1.5765e-04 - mean\_absolute\_error: 0.0091 57/126 [============>.................] - ETA: 0s - loss: 1.5186e-04 - mean\_absolute\_error: 0.0091 76/126 [=================>............] - ETA: 0s - loss: 1.4988e-04 - mean\_absolute\_error: 0.0091 94/126 [=====================>........] - ETA: 0s - loss: 1.6276e-04 - mean\_absolute\_error: 0.0095113/126 [=========================>....] - ETA: 0s - loss: 1.5971e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5543e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.2624e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 45/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2464e-04 - mean\_absolute\_error: 0.0085 20/126 [===>..........................] - ETA: 0s - loss: 1.4854e-04 - mean\_absolute\_error: 0.0095 39/126 [========>.....................] - ETA: 0s - loss: 1.6229e-04 - mean\_absolute\_error: 0.0096 59/126 [=============>................] - ETA: 0s - loss: 1.5591e-04 - mean\_absolute\_error: 0.0092 78/126 [=================>............] - ETA: 0s - loss: 1.5672e-04 - mean\_absolute\_error: 0.0093 97/126 [======================>.......] - ETA: 0s - loss: 1.5190e-04 - mean\_absolute\_error: 0.0092116/126 [==========================>...] - ETA: 0s - loss: 1.5358e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5157e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.8313e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 46/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9726e-05 - mean\_absolute\_error: 0.0073 21/126 [====>.........................] - ETA: 0s - loss: 1.5341e-04 - mean\_absolute\_error: 0.0094 40/126 [========>.....................] - ETA: 0s - loss: 1.7935e-04 - mean\_absolute\_error: 0.0104 59/126 [=============>................] - ETA: 0s - loss: 1.9070e-04 - mean\_absolute\_error: 0.0106 78/126 [=================>............] - ETA: 0s - loss: 1.7468e-04 - mean\_absolute\_error: 0.0102 97/126 [======================>.......] - ETA: 0s - loss: 1.7034e-04 - mean\_absolute\_error: 0.0099116/126 [==========================>...] - ETA: 0s - loss: 1.6667e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6362e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.1424e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 47/100  
 1/126 [..............................] - ETA: 0s - loss: 9.9551e-05 - mean\_absolute\_error: 0.0078 21/126 [====>.........................] - ETA: 0s - loss: 1.6914e-04 - mean\_absolute\_error: 0.0101 41/126 [========>.....................] - ETA: 0s - loss: 2.0795e-04 - mean\_absolute\_error: 0.0110 61/126 [=============>................] - ETA: 0s - loss: 1.8424e-04 - mean\_absolute\_error: 0.0103 81/126 [==================>...........] - ETA: 0s - loss: 1.7601e-04 - mean\_absolute\_error: 0.0101101/126 [=======================>......] - ETA: 0s - loss: 1.8818e-04 - mean\_absolute\_error: 0.0104120/126 [===========================>..] - ETA: 0s - loss: 1.9115e-04 - mean\_absolute\_error: 0.0106126/126 [==============================] - 0s 3ms/step - loss: 1.8970e-04 - mean\_absolute\_error: 0.0106 - val\_loss: 8.6135e-05 - val\_mean\_absolute\_error: 0.0077  
Epoch 48/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3272e-04 - mean\_absolute\_error: 0.0094 20/126 [===>..........................] - ETA: 0s - loss: 1.5474e-04 - mean\_absolute\_error: 0.0094 39/126 [========>.....................] - ETA: 0s - loss: 1.4778e-04 - mean\_absolute\_error: 0.0089 58/126 [============>.................] - ETA: 0s - loss: 1.5929e-04 - mean\_absolute\_error: 0.0092 77/126 [=================>............] - ETA: 0s - loss: 1.5319e-04 - mean\_absolute\_error: 0.0091 96/126 [=====================>........] - ETA: 0s - loss: 1.4809e-04 - mean\_absolute\_error: 0.0090115/126 [==========================>...] - ETA: 0s - loss: 1.4650e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4886e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.0757e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 49/100  
 1/126 [..............................] - ETA: 0s - loss: 1.8273e-04 - mean\_absolute\_error: 0.0106 21/126 [====>.........................] - ETA: 0s - loss: 2.2621e-04 - mean\_absolute\_error: 0.0115 39/126 [========>.....................] - ETA: 0s - loss: 2.0155e-04 - mean\_absolute\_error: 0.0110 58/126 [============>.................] - ETA: 0s - loss: 1.8909e-04 - mean\_absolute\_error: 0.0106 77/126 [=================>............] - ETA: 0s - loss: 1.7360e-04 - mean\_absolute\_error: 0.0101 96/126 [=====================>........] - ETA: 0s - loss: 1.6103e-04 - mean\_absolute\_error: 0.0097116/126 [==========================>...] - ETA: 0s - loss: 1.6337e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6828e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 1.6841e-04 - val\_mean\_absolute\_error: 0.0112  
Epoch 50/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3168e-04 - mean\_absolute\_error: 0.0122 21/126 [====>.........................] - ETA: 0s - loss: 1.3135e-04 - mean\_absolute\_error: 0.0087 41/126 [========>.....................] - ETA: 0s - loss: 1.4281e-04 - mean\_absolute\_error: 0.0091 61/126 [=============>................] - ETA: 0s - loss: 1.3418e-04 - mean\_absolute\_error: 0.0089 80/126 [==================>...........] - ETA: 0s - loss: 1.3378e-04 - mean\_absolute\_error: 0.0089100/126 [======================>.......] - ETA: 0s - loss: 1.3748e-04 - mean\_absolute\_error: 0.0090120/126 [===========================>..] - ETA: 0s - loss: 1.4604e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4520e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 6.1556e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 51/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0131e-04 - mean\_absolute\_error: 0.0080 20/126 [===>..........................] - ETA: 0s - loss: 1.2769e-04 - mean\_absolute\_error: 0.0087 40/126 [========>.....................] - ETA: 0s - loss: 1.2771e-04 - mean\_absolute\_error: 0.0086 60/126 [=============>................] - ETA: 0s - loss: 1.3785e-04 - mean\_absolute\_error: 0.0087 80/126 [==================>...........] - ETA: 0s - loss: 1.4895e-04 - mean\_absolute\_error: 0.0090100/126 [======================>.......] - ETA: 0s - loss: 1.5183e-04 - mean\_absolute\_error: 0.0092119/126 [===========================>..] - ETA: 0s - loss: 1.5022e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5568e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.5808e-05 - val\_mean\_absolute\_error: 0.0060  
Epoch 52/100  
 1/126 [..............................] - ETA: 0s - loss: 2.1181e-04 - mean\_absolute\_error: 0.0109 21/126 [====>.........................] - ETA: 0s - loss: 1.6750e-04 - mean\_absolute\_error: 0.0093 41/126 [========>.....................] - ETA: 0s - loss: 1.7317e-04 - mean\_absolute\_error: 0.0100 60/126 [=============>................] - ETA: 0s - loss: 1.6200e-04 - mean\_absolute\_error: 0.0097 80/126 [==================>...........] - ETA: 0s - loss: 1.5207e-04 - mean\_absolute\_error: 0.0094100/126 [======================>.......] - ETA: 0s - loss: 1.4912e-04 - mean\_absolute\_error: 0.0093120/126 [===========================>..] - ETA: 0s - loss: 1.5446e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.5425e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.5931e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 53/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4316e-04 - mean\_absolute\_error: 0.0096 21/126 [====>.........................] - ETA: 0s - loss: 1.4900e-04 - mean\_absolute\_error: 0.0092 40/126 [========>.....................] - ETA: 0s - loss: 2.1348e-04 - mean\_absolute\_error: 0.0108 59/126 [=============>................] - ETA: 0s - loss: 1.9082e-04 - mean\_absolute\_error: 0.0103 79/126 [=================>............] - ETA: 0s - loss: 1.7849e-04 - mean\_absolute\_error: 0.0100 97/126 [======================>.......] - ETA: 0s - loss: 1.7792e-04 - mean\_absolute\_error: 0.0100117/126 [==========================>...] - ETA: 0s - loss: 1.7245e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.6852e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 1.7173e-04 - val\_mean\_absolute\_error: 0.0115  
Epoch 54/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3381e-04 - mean\_absolute\_error: 0.0133 20/126 [===>..........................] - ETA: 0s - loss: 1.7680e-04 - mean\_absolute\_error: 0.0097 39/126 [========>.....................] - ETA: 0s - loss: 1.6111e-04 - mean\_absolute\_error: 0.0094 58/126 [============>.................] - ETA: 0s - loss: 1.6063e-04 - mean\_absolute\_error: 0.0095 77/126 [=================>............] - ETA: 0s - loss: 1.6261e-04 - mean\_absolute\_error: 0.0097 96/126 [=====================>........] - ETA: 0s - loss: 1.6237e-04 - mean\_absolute\_error: 0.0097116/126 [==========================>...] - ETA: 0s - loss: 1.5803e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6458e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 7.8091e-05 - val\_mean\_absolute\_error: 0.0073  
Epoch 55/100  
 1/126 [..............................] - ETA: 0s - loss: 1.9845e-04 - mean\_absolute\_error: 0.0114 21/126 [====>.........................] - ETA: 0s - loss: 1.3854e-04 - mean\_absolute\_error: 0.0090 40/126 [========>.....................] - ETA: 0s - loss: 1.2708e-04 - mean\_absolute\_error: 0.0087 60/126 [=============>................] - ETA: 0s - loss: 1.4643e-04 - mean\_absolute\_error: 0.0091 79/126 [=================>............] - ETA: 0s - loss: 1.5319e-04 - mean\_absolute\_error: 0.0092 98/126 [======================>.......] - ETA: 0s - loss: 1.5233e-04 - mean\_absolute\_error: 0.0092117/126 [==========================>...] - ETA: 0s - loss: 1.5227e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.4845e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.9648e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 56/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2386e-04 - mean\_absolute\_error: 0.0082 21/126 [====>.........................] - ETA: 0s - loss: 1.2300e-04 - mean\_absolute\_error: 0.0084 40/126 [========>.....................] - ETA: 0s - loss: 1.3212e-04 - mean\_absolute\_error: 0.0089 59/126 [=============>................] - ETA: 0s - loss: 1.3480e-04 - mean\_absolute\_error: 0.0089 76/126 [=================>............] - ETA: 0s - loss: 1.4153e-04 - mean\_absolute\_error: 0.0090 94/126 [=====================>........] - ETA: 0s - loss: 1.4926e-04 - mean\_absolute\_error: 0.0092108/126 [========================>.....] - ETA: 0s - loss: 1.5142e-04 - mean\_absolute\_error: 0.0092124/126 [============================>.] - ETA: 0s - loss: 1.5097e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5184e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 6.1748e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 57/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3187e-05 - mean\_absolute\_error: 0.0069 18/126 [===>..........................] - ETA: 0s - loss: 1.8515e-04 - mean\_absolute\_error: 0.0107 35/126 [=======>......................] - ETA: 0s - loss: 1.7088e-04 - mean\_absolute\_error: 0.0100 52/126 [===========>..................] - ETA: 0s - loss: 1.7516e-04 - mean\_absolute\_error: 0.0101 68/126 [===============>..............] - ETA: 0s - loss: 1.6587e-04 - mean\_absolute\_error: 0.0098 85/126 [===================>..........] - ETA: 0s - loss: 1.5959e-04 - mean\_absolute\_error: 0.0097102/126 [=======================>......] - ETA: 0s - loss: 1.6492e-04 - mean\_absolute\_error: 0.0098119/126 [===========================>..] - ETA: 0s - loss: 1.6752e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6714e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 1.5792e-04 - val\_mean\_absolute\_error: 0.0109  
Epoch 58/100  
 1/126 [..............................] - ETA: 0s - loss: 5.1993e-04 - mean\_absolute\_error: 0.0177 20/126 [===>..........................] - ETA: 0s - loss: 1.9375e-04 - mean\_absolute\_error: 0.0108 38/126 [========>.....................] - ETA: 0s - loss: 1.5777e-04 - mean\_absolute\_error: 0.0096 57/126 [============>.................] - ETA: 0s - loss: 1.5683e-04 - mean\_absolute\_error: 0.0094 76/126 [=================>............] - ETA: 0s - loss: 1.6068e-04 - mean\_absolute\_error: 0.0096 95/126 [=====================>........] - ETA: 0s - loss: 1.6090e-04 - mean\_absolute\_error: 0.0095115/126 [==========================>...] - ETA: 0s - loss: 1.5958e-04 - mean\_absolute\_error: 0.0095126/126 [==============================] - 0s 3ms/step - loss: 1.5800e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 5.4404e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 59/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0237e-04 - mean\_absolute\_error: 0.0112 17/126 [===>..........................] - ETA: 0s - loss: 1.8083e-04 - mean\_absolute\_error: 0.0107 35/126 [=======>......................] - ETA: 0s - loss: 2.1673e-04 - mean\_absolute\_error: 0.0113 54/126 [===========>..................] - ETA: 0s - loss: 1.8759e-04 - mean\_absolute\_error: 0.0103 74/126 [================>.............] - ETA: 0s - loss: 1.8120e-04 - mean\_absolute\_error: 0.0102 93/126 [=====================>........] - ETA: 0s - loss: 1.7132e-04 - mean\_absolute\_error: 0.0100108/126 [========================>.....] - ETA: 0s - loss: 1.6575e-04 - mean\_absolute\_error: 0.0098123/126 [============================>.] - ETA: 0s - loss: 1.6084e-04 - mean\_absolute\_error: 0.0096126/126 [==============================] - 0s 3ms/step - loss: 1.6016e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.1537e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 60/100  
 1/126 [..............................] - ETA: 0s - loss: 9.4163e-05 - mean\_absolute\_error: 0.0073 19/126 [===>..........................] - ETA: 0s - loss: 1.4606e-04 - mean\_absolute\_error: 0.0086 38/126 [========>.....................] - ETA: 0s - loss: 1.3908e-04 - mean\_absolute\_error: 0.0088 57/126 [============>.................] - ETA: 0s - loss: 1.6476e-04 - mean\_absolute\_error: 0.0094 75/126 [================>.............] - ETA: 0s - loss: 1.6093e-04 - mean\_absolute\_error: 0.0094 94/126 [=====================>........] - ETA: 0s - loss: 1.5851e-04 - mean\_absolute\_error: 0.0094114/126 [==========================>...] - ETA: 0s - loss: 1.5466e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5227e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 5.0771e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 61/100  
 1/126 [..............................] - ETA: 0s - loss: 6.2362e-05 - mean\_absolute\_error: 0.0065 21/126 [====>.........................] - ETA: 0s - loss: 1.4212e-04 - mean\_absolute\_error: 0.0091 41/126 [========>.....................] - ETA: 0s - loss: 1.7771e-04 - mean\_absolute\_error: 0.0101 60/126 [=============>................] - ETA: 0s - loss: 1.8814e-04 - mean\_absolute\_error: 0.0104 78/126 [=================>............] - ETA: 0s - loss: 1.7863e-04 - mean\_absolute\_error: 0.0102 92/126 [====================>.........] - ETA: 0s - loss: 1.8114e-04 - mean\_absolute\_error: 0.0101106/126 [========================>.....] - ETA: 0s - loss: 1.7388e-04 - mean\_absolute\_error: 0.0100119/126 [===========================>..] - ETA: 0s - loss: 1.6845e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 4ms/step - loss: 1.6839e-04 - mean\_absolute\_error: 0.0098 - val\_loss: 6.3560e-05 - val\_mean\_absolute\_error: 0.0065  
Epoch 62/100  
 1/126 [..............................] - ETA: 0s - loss: 2.0943e-04 - mean\_absolute\_error: 0.0110 20/126 [===>..........................] - ETA: 0s - loss: 1.3816e-04 - mean\_absolute\_error: 0.0090 40/126 [========>.....................] - ETA: 0s - loss: 1.4566e-04 - mean\_absolute\_error: 0.0092 61/126 [=============>................] - ETA: 0s - loss: 1.4701e-04 - mean\_absolute\_error: 0.0094 82/126 [==================>...........] - ETA: 0s - loss: 1.5939e-04 - mean\_absolute\_error: 0.0098104/126 [=======================>......] - ETA: 0s - loss: 1.7449e-04 - mean\_absolute\_error: 0.0101125/126 [============================>.] - ETA: 0s - loss: 1.6958e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.7000e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 4.8478e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 63/100  
 1/126 [..............................] - ETA: 0s - loss: 9.2668e-05 - mean\_absolute\_error: 0.0078 23/126 [====>.........................] - ETA: 0s - loss: 1.3830e-04 - mean\_absolute\_error: 0.0090 45/126 [=========>....................] - ETA: 0s - loss: 1.3377e-04 - mean\_absolute\_error: 0.0088 67/126 [==============>...............] - ETA: 0s - loss: 1.3110e-04 - mean\_absolute\_error: 0.0087 89/126 [====================>.........] - ETA: 0s - loss: 1.3405e-04 - mean\_absolute\_error: 0.0087111/126 [=========================>....] - ETA: 0s - loss: 1.3391e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.4233e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 7.3490e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 64/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3998e-04 - mean\_absolute\_error: 0.0095 24/126 [====>.........................] - ETA: 0s - loss: 1.6873e-04 - mean\_absolute\_error: 0.0096 47/126 [==========>...................] - ETA: 0s - loss: 1.7448e-04 - mean\_absolute\_error: 0.0098 69/126 [===============>..............] - ETA: 0s - loss: 1.7318e-04 - mean\_absolute\_error: 0.0100 91/126 [====================>.........] - ETA: 0s - loss: 1.7438e-04 - mean\_absolute\_error: 0.0100112/126 [=========================>....] - ETA: 0s - loss: 1.7354e-04 - mean\_absolute\_error: 0.0100126/126 [==============================] - 0s 3ms/step - loss: 1.7019e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 5.1227e-05 - val\_mean\_absolute\_error: 0.0057  
Epoch 65/100  
 1/126 [..............................] - ETA: 0s - loss: 1.2036e-04 - mean\_absolute\_error: 0.0079 24/126 [====>.........................] - ETA: 0s - loss: 1.3496e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.5366e-04 - mean\_absolute\_error: 0.0088 68/126 [===============>..............] - ETA: 0s - loss: 1.5581e-04 - mean\_absolute\_error: 0.0092 90/126 [====================>.........] - ETA: 0s - loss: 1.5890e-04 - mean\_absolute\_error: 0.0094112/126 [=========================>....] - ETA: 0s - loss: 1.6436e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6813e-04 - mean\_absolute\_error: 0.0099 - val\_loss: 8.4997e-05 - val\_mean\_absolute\_error: 0.0076  
Epoch 66/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4346e-04 - mean\_absolute\_error: 0.0097 24/126 [====>.........................] - ETA: 0s - loss: 1.2468e-04 - mean\_absolute\_error: 0.0088 46/126 [=========>....................] - ETA: 0s - loss: 1.4984e-04 - mean\_absolute\_error: 0.0093 68/126 [===============>..............] - ETA: 0s - loss: 1.4153e-04 - mean\_absolute\_error: 0.0091 91/126 [====================>.........] - ETA: 0s - loss: 1.4141e-04 - mean\_absolute\_error: 0.0091113/126 [=========================>....] - ETA: 0s - loss: 1.4631e-04 - mean\_absolute\_error: 0.0092126/126 [==============================] - 0s 3ms/step - loss: 1.5699e-04 - mean\_absolute\_error: 0.0095 - val\_loss: 5.2908e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 67/100  
 1/126 [..............................] - ETA: 0s - loss: 5.9556e-05 - mean\_absolute\_error: 0.0061 24/126 [====>.........................] - ETA: 0s - loss: 1.6965e-04 - mean\_absolute\_error: 0.0099 46/126 [=========>....................] - ETA: 0s - loss: 1.5020e-04 - mean\_absolute\_error: 0.0094 69/126 [===============>..............] - ETA: 0s - loss: 1.3984e-04 - mean\_absolute\_error: 0.0090 91/126 [====================>.........] - ETA: 0s - loss: 1.4586e-04 - mean\_absolute\_error: 0.0090114/126 [==========================>...] - ETA: 0s - loss: 1.4820e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4700e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 1.3045e-04 - val\_mean\_absolute\_error: 0.0098  
Epoch 68/100  
 1/126 [..............................] - ETA: 0s - loss: 2.7395e-04 - mean\_absolute\_error: 0.0139 24/126 [====>.........................] - ETA: 0s - loss: 1.6239e-04 - mean\_absolute\_error: 0.0092 47/126 [==========>...................] - ETA: 0s - loss: 1.3903e-04 - mean\_absolute\_error: 0.0088 70/126 [===============>..............] - ETA: 0s - loss: 1.3420e-04 - mean\_absolute\_error: 0.0087 92/126 [====================>.........] - ETA: 0s - loss: 1.3348e-04 - mean\_absolute\_error: 0.0087115/126 [==========================>...] - ETA: 0s - loss: 1.4403e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4965e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.2120e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 69/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1388e-04 - mean\_absolute\_error: 0.0093 24/126 [====>.........................] - ETA: 0s - loss: 1.3974e-04 - mean\_absolute\_error: 0.0091 47/126 [==========>...................] - ETA: 0s - loss: 1.4279e-04 - mean\_absolute\_error: 0.0090 69/126 [===============>..............] - ETA: 0s - loss: 1.5789e-04 - mean\_absolute\_error: 0.0093 91/126 [====================>.........] - ETA: 0s - loss: 1.4842e-04 - mean\_absolute\_error: 0.0091113/126 [=========================>....] - ETA: 0s - loss: 1.4207e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4273e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 7.2248e-05 - val\_mean\_absolute\_error: 0.0070  
Epoch 70/100  
 1/126 [..............................] - ETA: 0s - loss: 1.4191e-04 - mean\_absolute\_error: 0.0092 24/126 [====>.........................] - ETA: 0s - loss: 1.8696e-04 - mean\_absolute\_error: 0.0100 46/126 [=========>....................] - ETA: 0s - loss: 1.6008e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.6102e-04 - mean\_absolute\_error: 0.0094 90/126 [====================>.........] - ETA: 0s - loss: 1.5047e-04 - mean\_absolute\_error: 0.0091111/126 [=========================>....] - ETA: 0s - loss: 1.4617e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4740e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 5.2452e-05 - val\_mean\_absolute\_error: 0.0058  
Epoch 71/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7669e-04 - mean\_absolute\_error: 0.0103 24/126 [====>.........................] - ETA: 0s - loss: 1.2555e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.4575e-04 - mean\_absolute\_error: 0.0089 68/126 [===============>..............] - ETA: 0s - loss: 1.5099e-04 - mean\_absolute\_error: 0.0091 90/126 [====================>.........] - ETA: 0s - loss: 1.4597e-04 - mean\_absolute\_error: 0.0091112/126 [=========================>....] - ETA: 0s - loss: 1.4603e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4709e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.7692e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 72/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6170e-04 - mean\_absolute\_error: 0.0103 24/126 [====>.........................] - ETA: 0s - loss: 1.3874e-04 - mean\_absolute\_error: 0.0090 47/126 [==========>...................] - ETA: 0s - loss: 1.4895e-04 - mean\_absolute\_error: 0.0093 69/126 [===============>..............] - ETA: 0s - loss: 1.4801e-04 - mean\_absolute\_error: 0.0091 91/126 [====================>.........] - ETA: 0s - loss: 1.4598e-04 - mean\_absolute\_error: 0.0091114/126 [==========================>...] - ETA: 0s - loss: 1.5387e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5429e-04 - mean\_absolute\_error: 0.0093 - val\_loss: 6.7024e-05 - val\_mean\_absolute\_error: 0.0067  
Epoch 73/100  
 1/126 [..............................] - ETA: 0s - loss: 9.5689e-05 - mean\_absolute\_error: 0.0085 24/126 [====>.........................] - ETA: 0s - loss: 2.3070e-04 - mean\_absolute\_error: 0.0121 46/126 [=========>....................] - ETA: 0s - loss: 2.0804e-04 - mean\_absolute\_error: 0.0111 68/126 [===============>..............] - ETA: 0s - loss: 1.9446e-04 - mean\_absolute\_error: 0.0105 90/126 [====================>.........] - ETA: 0s - loss: 1.7683e-04 - mean\_absolute\_error: 0.0101112/126 [=========================>....] - ETA: 0s - loss: 1.6432e-04 - mean\_absolute\_error: 0.0097126/126 [==============================] - 0s 3ms/step - loss: 1.6199e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 1.3407e-04 - val\_mean\_absolute\_error: 0.0099  
Epoch 74/100  
 1/126 [..............................] - ETA: 0s - loss: 2.4086e-04 - mean\_absolute\_error: 0.0135 21/126 [====>.........................] - ETA: 0s - loss: 1.4741e-04 - mean\_absolute\_error: 0.0096 41/126 [========>.....................] - ETA: 0s - loss: 1.5533e-04 - mean\_absolute\_error: 0.0094 61/126 [=============>................] - ETA: 0s - loss: 1.5014e-04 - mean\_absolute\_error: 0.0093 83/126 [==================>...........] - ETA: 0s - loss: 1.5196e-04 - mean\_absolute\_error: 0.0092105/126 [========================>.....] - ETA: 0s - loss: 1.4775e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4833e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.0180e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 75/100  
 1/126 [..............................] - ETA: 0s - loss: 9.7562e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 1.6949e-04 - mean\_absolute\_error: 0.0103 46/126 [=========>....................] - ETA: 0s - loss: 2.0999e-04 - mean\_absolute\_error: 0.0115 68/126 [===============>..............] - ETA: 0s - loss: 2.1150e-04 - mean\_absolute\_error: 0.0115 91/126 [====================>.........] - ETA: 0s - loss: 2.0126e-04 - mean\_absolute\_error: 0.0112113/126 [=========================>....] - ETA: 0s - loss: 1.9700e-04 - mean\_absolute\_error: 0.0110126/126 [==============================] - 0s 3ms/step - loss: 1.9439e-04 - mean\_absolute\_error: 0.0108 - val\_loss: 5.9666e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 76/100  
 1/126 [..............................] - ETA: 0s - loss: 1.6346e-04 - mean\_absolute\_error: 0.0105 23/126 [====>.........................] - ETA: 0s - loss: 1.4263e-04 - mean\_absolute\_error: 0.0093 45/126 [=========>....................] - ETA: 0s - loss: 1.3337e-04 - mean\_absolute\_error: 0.0088 67/126 [==============>...............] - ETA: 0s - loss: 1.2844e-04 - mean\_absolute\_error: 0.0086 89/126 [====================>.........] - ETA: 0s - loss: 1.3717e-04 - mean\_absolute\_error: 0.0087110/126 [=========================>....] - ETA: 0s - loss: 1.3762e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.3492e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 4.6586e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 77/100  
 1/126 [..............................] - ETA: 0s - loss: 7.1844e-05 - mean\_absolute\_error: 0.0065 23/126 [====>.........................] - ETA: 0s - loss: 1.5884e-04 - mean\_absolute\_error: 0.0093 42/126 [=========>....................] - ETA: 0s - loss: 1.3681e-04 - mean\_absolute\_error: 0.0088 64/126 [==============>...............] - ETA: 0s - loss: 1.3116e-04 - mean\_absolute\_error: 0.0086 86/126 [===================>..........] - ETA: 0s - loss: 1.2809e-04 - mean\_absolute\_error: 0.0085108/126 [========================>.....] - ETA: 0s - loss: 1.3455e-04 - mean\_absolute\_error: 0.0087126/126 [==============================] - 0s 3ms/step - loss: 1.3599e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 1.5090e-04 - val\_mean\_absolute\_error: 0.0107  
Epoch 78/100  
 1/126 [..............................] - ETA: 0s - loss: 3.5405e-04 - mean\_absolute\_error: 0.0165 23/126 [====>.........................] - ETA: 0s - loss: 1.4268e-04 - mean\_absolute\_error: 0.0091 45/126 [=========>....................] - ETA: 0s - loss: 1.3667e-04 - mean\_absolute\_error: 0.0089 67/126 [==============>...............] - ETA: 0s - loss: 1.4986e-04 - mean\_absolute\_error: 0.0090 89/126 [====================>.........] - ETA: 0s - loss: 1.4171e-04 - mean\_absolute\_error: 0.0088111/126 [=========================>....] - ETA: 0s - loss: 1.3944e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.4353e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 2.1370e-04 - val\_mean\_absolute\_error: 0.0131  
Epoch 79/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3100e-04 - mean\_absolute\_error: 0.0159 24/126 [====>.........................] - ETA: 0s - loss: 1.4526e-04 - mean\_absolute\_error: 0.0092 46/126 [=========>....................] - ETA: 0s - loss: 1.3687e-04 - mean\_absolute\_error: 0.0089 68/126 [===============>..............] - ETA: 0s - loss: 1.3469e-04 - mean\_absolute\_error: 0.0088 90/126 [====================>.........] - ETA: 0s - loss: 1.4079e-04 - mean\_absolute\_error: 0.0089112/126 [=========================>....] - ETA: 0s - loss: 1.3859e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4234e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 5.0646e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 80/100  
 1/126 [..............................] - ETA: 0s - loss: 8.7819e-05 - mean\_absolute\_error: 0.0072 24/126 [====>.........................] - ETA: 0s - loss: 1.2827e-04 - mean\_absolute\_error: 0.0087 46/126 [=========>....................] - ETA: 0s - loss: 1.2550e-04 - mean\_absolute\_error: 0.0086 68/126 [===============>..............] - ETA: 0s - loss: 1.3551e-04 - mean\_absolute\_error: 0.0089 91/126 [====================>.........] - ETA: 0s - loss: 1.4953e-04 - mean\_absolute\_error: 0.0092114/126 [==========================>...] - ETA: 0s - loss: 1.6720e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.7303e-04 - mean\_absolute\_error: 0.0100 - val\_loss: 9.4941e-05 - val\_mean\_absolute\_error: 0.0082  
Epoch 81/100  
 1/126 [..............................] - ETA: 0s - loss: 1.5419e-04 - mean\_absolute\_error: 0.0101 24/126 [====>.........................] - ETA: 0s - loss: 1.8128e-04 - mean\_absolute\_error: 0.0106 46/126 [=========>....................] - ETA: 0s - loss: 1.6318e-04 - mean\_absolute\_error: 0.0097 69/126 [===============>..............] - ETA: 0s - loss: 1.5364e-04 - mean\_absolute\_error: 0.0092 91/126 [====================>.........] - ETA: 0s - loss: 1.4782e-04 - mean\_absolute\_error: 0.0090114/126 [==========================>...] - ETA: 0s - loss: 1.4551e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4220e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 4.7836e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 82/100  
 1/126 [..............................] - ETA: 0s - loss: 9.6448e-05 - mean\_absolute\_error: 0.0077 23/126 [====>.........................] - ETA: 0s - loss: 1.0503e-04 - mean\_absolute\_error: 0.0078 45/126 [=========>....................] - ETA: 0s - loss: 1.3655e-04 - mean\_absolute\_error: 0.0086 67/126 [==============>...............] - ETA: 0s - loss: 1.3910e-04 - mean\_absolute\_error: 0.0086 88/126 [===================>..........] - ETA: 0s - loss: 1.4139e-04 - mean\_absolute\_error: 0.0088111/126 [=========================>....] - ETA: 0s - loss: 1.4391e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4372e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 4.9325e-05 - val\_mean\_absolute\_error: 0.0056  
Epoch 83/100  
 1/126 [..............................] - ETA: 0s - loss: 9.1564e-05 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 1.5491e-04 - mean\_absolute\_error: 0.0090 46/126 [=========>....................] - ETA: 0s - loss: 1.3769e-04 - mean\_absolute\_error: 0.0087 69/126 [===============>..............] - ETA: 0s - loss: 1.5644e-04 - mean\_absolute\_error: 0.0095 91/126 [====================>.........] - ETA: 0s - loss: 1.5027e-04 - mean\_absolute\_error: 0.0093113/126 [=========================>....] - ETA: 0s - loss: 1.4442e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.4663e-04 - mean\_absolute\_error: 0.0091 - val\_loss: 4.7552e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 84/100  
 1/126 [..............................] - ETA: 0s - loss: 1.1184e-04 - mean\_absolute\_error: 0.0075 24/126 [====>.........................] - ETA: 0s - loss: 2.3967e-04 - mean\_absolute\_error: 0.0125 46/126 [=========>....................] - ETA: 0s - loss: 2.0254e-04 - mean\_absolute\_error: 0.0113 68/126 [===============>..............] - ETA: 0s - loss: 1.9231e-04 - mean\_absolute\_error: 0.0107 90/126 [====================>.........] - ETA: 0s - loss: 1.8129e-04 - mean\_absolute\_error: 0.0102112/126 [=========================>....] - ETA: 0s - loss: 1.6964e-04 - mean\_absolute\_error: 0.0099126/126 [==============================] - 0s 3ms/step - loss: 1.6467e-04 - mean\_absolute\_error: 0.0097 - val\_loss: 6.1664e-05 - val\_mean\_absolute\_error: 0.0064  
Epoch 85/100  
 1/126 [..............................] - ETA: 0s - loss: 8.9770e-05 - mean\_absolute\_error: 0.0078 24/126 [====>.........................] - ETA: 0s - loss: 1.5850e-04 - mean\_absolute\_error: 0.0097 46/126 [=========>....................] - ETA: 0s - loss: 1.6607e-04 - mean\_absolute\_error: 0.0100 69/126 [===============>..............] - ETA: 0s - loss: 1.5175e-04 - mean\_absolute\_error: 0.0096 91/126 [====================>.........] - ETA: 0s - loss: 1.4675e-04 - mean\_absolute\_error: 0.0092114/126 [==========================>...] - ETA: 0s - loss: 1.4293e-04 - mean\_absolute\_error: 0.0091126/126 [==============================] - 0s 3ms/step - loss: 1.5325e-04 - mean\_absolute\_error: 0.0094 - val\_loss: 1.6288e-04 - val\_mean\_absolute\_error: 0.0111  
Epoch 86/100  
 1/126 [..............................] - ETA: 0s - loss: 2.9978e-04 - mean\_absolute\_error: 0.0138 24/126 [====>.........................] - ETA: 0s - loss: 1.8863e-04 - mean\_absolute\_error: 0.0107 47/126 [==========>...................] - ETA: 0s - loss: 1.7400e-04 - mean\_absolute\_error: 0.0099 69/126 [===============>..............] - ETA: 0s - loss: 1.8147e-04 - mean\_absolute\_error: 0.0102 92/126 [====================>.........] - ETA: 0s - loss: 1.7756e-04 - mean\_absolute\_error: 0.0101114/126 [==========================>...] - ETA: 0s - loss: 1.6636e-04 - mean\_absolute\_error: 0.0098126/126 [==============================] - 0s 3ms/step - loss: 1.6048e-04 - mean\_absolute\_error: 0.0096 - val\_loss: 5.4946e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 87/100  
 1/126 [..............................] - ETA: 0s - loss: 6.1217e-05 - mean\_absolute\_error: 0.0058 24/126 [====>.........................] - ETA: 0s - loss: 1.2437e-04 - mean\_absolute\_error: 0.0085 46/126 [=========>....................] - ETA: 0s - loss: 1.3797e-04 - mean\_absolute\_error: 0.0087 69/126 [===============>..............] - ETA: 0s - loss: 1.3460e-04 - mean\_absolute\_error: 0.0086 91/126 [====================>.........] - ETA: 0s - loss: 1.3018e-04 - mean\_absolute\_error: 0.0084113/126 [=========================>....] - ETA: 0s - loss: 1.3510e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.3164e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.9016e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 88/100  
 1/126 [..............................] - ETA: 0s - loss: 6.3300e-05 - mean\_absolute\_error: 0.0054 24/126 [====>.........................] - ETA: 0s - loss: 1.5679e-04 - mean\_absolute\_error: 0.0086 46/126 [=========>....................] - ETA: 0s - loss: 1.3681e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.2878e-04 - mean\_absolute\_error: 0.0082 89/126 [====================>.........] - ETA: 0s - loss: 1.3166e-04 - mean\_absolute\_error: 0.0084112/126 [=========================>....] - ETA: 0s - loss: 1.2961e-04 - mean\_absolute\_error: 0.0084126/126 [==============================] - 0s 3ms/step - loss: 1.3063e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.6435e-05 - val\_mean\_absolute\_error: 0.0054  
Epoch 89/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3287e-04 - mean\_absolute\_error: 0.0090 23/126 [====>.........................] - ETA: 0s - loss: 1.7622e-04 - mean\_absolute\_error: 0.0102 45/126 [=========>....................] - ETA: 0s - loss: 1.6109e-04 - mean\_absolute\_error: 0.0095 67/126 [==============>...............] - ETA: 0s - loss: 1.4972e-04 - mean\_absolute\_error: 0.0091 87/126 [===================>..........] - ETA: 0s - loss: 1.4450e-04 - mean\_absolute\_error: 0.0090107/126 [========================>.....] - ETA: 0s - loss: 1.4087e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.4059e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 1.0379e-04 - val\_mean\_absolute\_error: 0.0086  
Epoch 90/100  
 1/126 [..............................] - ETA: 0s - loss: 3.3532e-04 - mean\_absolute\_error: 0.0140 23/126 [====>.........................] - ETA: 0s - loss: 2.0927e-04 - mean\_absolute\_error: 0.0114 45/126 [=========>....................] - ETA: 0s - loss: 1.7613e-04 - mean\_absolute\_error: 0.0103 68/126 [===============>..............] - ETA: 0s - loss: 1.5901e-04 - mean\_absolute\_error: 0.0097 90/126 [====================>.........] - ETA: 0s - loss: 1.6426e-04 - mean\_absolute\_error: 0.0097112/126 [=========================>....] - ETA: 0s - loss: 1.5303e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.5048e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 4.8187e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 91/100  
 1/126 [..............................] - ETA: 0s - loss: 9.8367e-05 - mean\_absolute\_error: 0.0077 24/126 [====>.........................] - ETA: 0s - loss: 1.2192e-04 - mean\_absolute\_error: 0.0084 46/126 [=========>....................] - ETA: 0s - loss: 1.3275e-04 - mean\_absolute\_error: 0.0085 68/126 [===============>..............] - ETA: 0s - loss: 1.2288e-04 - mean\_absolute\_error: 0.0082 90/126 [====================>.........] - ETA: 0s - loss: 1.4243e-04 - mean\_absolute\_error: 0.0089113/126 [=========================>....] - ETA: 0s - loss: 1.3984e-04 - mean\_absolute\_error: 0.0089126/126 [==============================] - 0s 3ms/step - loss: 1.3776e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 6.0664e-05 - val\_mean\_absolute\_error: 0.0063  
Epoch 92/100  
 1/126 [..............................] - ETA: 0s - loss: 1.7194e-04 - mean\_absolute\_error: 0.0105 24/126 [====>.........................] - ETA: 0s - loss: 1.2514e-04 - mean\_absolute\_error: 0.0085 45/126 [=========>....................] - ETA: 0s - loss: 1.2789e-04 - mean\_absolute\_error: 0.0083 67/126 [==============>...............] - ETA: 0s - loss: 1.3158e-04 - mean\_absolute\_error: 0.0086 90/126 [====================>.........] - ETA: 0s - loss: 1.3250e-04 - mean\_absolute\_error: 0.0087110/126 [=========================>....] - ETA: 0s - loss: 1.4213e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.4109e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 4.7912e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 93/100  
 1/126 [..............................] - ETA: 0s - loss: 8.8831e-05 - mean\_absolute\_error: 0.0080 23/126 [====>.........................] - ETA: 0s - loss: 1.1946e-04 - mean\_absolute\_error: 0.0085 45/126 [=========>....................] - ETA: 0s - loss: 1.2230e-04 - mean\_absolute\_error: 0.0085 67/126 [==============>...............] - ETA: 0s - loss: 1.3349e-04 - mean\_absolute\_error: 0.0087 89/126 [====================>.........] - ETA: 0s - loss: 1.2831e-04 - mean\_absolute\_error: 0.0086112/126 [=========================>....] - ETA: 0s - loss: 1.3420e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3335e-04 - mean\_absolute\_error: 0.0087 - val\_loss: 4.5954e-05 - val\_mean\_absolute\_error: 0.0053  
Epoch 94/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0149e-04 - mean\_absolute\_error: 0.0081 24/126 [====>.........................] - ETA: 0s - loss: 1.4584e-04 - mean\_absolute\_error: 0.0093 46/126 [=========>....................] - ETA: 0s - loss: 1.4260e-04 - mean\_absolute\_error: 0.0090 68/126 [===============>..............] - ETA: 0s - loss: 1.3031e-04 - mean\_absolute\_error: 0.0086 89/126 [====================>.........] - ETA: 0s - loss: 1.3293e-04 - mean\_absolute\_error: 0.0088111/126 [=========================>....] - ETA: 0s - loss: 1.2832e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.3223e-04 - mean\_absolute\_error: 0.0086 - val\_loss: 4.8991e-05 - val\_mean\_absolute\_error: 0.0055  
Epoch 95/100  
 1/126 [..............................] - ETA: 0s - loss: 7.3158e-05 - mean\_absolute\_error: 0.0069 23/126 [====>.........................] - ETA: 0s - loss: 1.2577e-04 - mean\_absolute\_error: 0.0085 45/126 [=========>....................] - ETA: 0s - loss: 1.6517e-04 - mean\_absolute\_error: 0.0096 67/126 [==============>...............] - ETA: 0s - loss: 1.6310e-04 - mean\_absolute\_error: 0.0095 88/126 [===================>..........] - ETA: 0s - loss: 1.6482e-04 - mean\_absolute\_error: 0.0097107/126 [========================>.....] - ETA: 0s - loss: 1.5481e-04 - mean\_absolute\_error: 0.0093126/126 [==============================] - 0s 3ms/step - loss: 1.4965e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 7.6969e-05 - val\_mean\_absolute\_error: 0.0072  
Epoch 96/100  
 1/126 [..............................] - ETA: 0s - loss: 2.6878e-04 - mean\_absolute\_error: 0.0106 23/126 [====>.........................] - ETA: 0s - loss: 2.0298e-04 - mean\_absolute\_error: 0.0109 45/126 [=========>....................] - ETA: 0s - loss: 1.6014e-04 - mean\_absolute\_error: 0.0096 66/126 [==============>...............] - ETA: 0s - loss: 1.5913e-04 - mean\_absolute\_error: 0.0096 87/126 [===================>..........] - ETA: 0s - loss: 1.5355e-04 - mean\_absolute\_error: 0.0094110/126 [=========================>....] - ETA: 0s - loss: 1.5054e-04 - mean\_absolute\_error: 0.0094126/126 [==============================] - 0s 3ms/step - loss: 1.4786e-04 - mean\_absolute\_error: 0.0092 - val\_loss: 5.4526e-05 - val\_mean\_absolute\_error: 0.0059  
Epoch 97/100  
 1/126 [..............................] - ETA: 0s - loss: 1.0882e-04 - mean\_absolute\_error: 0.0088 23/126 [====>.........................] - ETA: 0s - loss: 1.0798e-04 - mean\_absolute\_error: 0.0080 45/126 [=========>....................] - ETA: 0s - loss: 1.1252e-04 - mean\_absolute\_error: 0.0081 67/126 [==============>...............] - ETA: 0s - loss: 1.1483e-04 - mean\_absolute\_error: 0.0082 90/126 [====================>.........] - ETA: 0s - loss: 1.3187e-04 - mean\_absolute\_error: 0.0087112/126 [=========================>....] - ETA: 0s - loss: 1.3224e-04 - mean\_absolute\_error: 0.0086126/126 [==============================] - 0s 3ms/step - loss: 1.2696e-04 - mean\_absolute\_error: 0.0085 - val\_loss: 4.2961e-05 - val\_mean\_absolute\_error: 0.0050  
Epoch 98/100  
 1/126 [..............................] - ETA: 0s - loss: 1.3731e-04 - mean\_absolute\_error: 0.0086 24/126 [====>.........................] - ETA: 0s - loss: 1.0526e-04 - mean\_absolute\_error: 0.0078 46/126 [=========>....................] - ETA: 0s - loss: 1.3336e-04 - mean\_absolute\_error: 0.0088 68/126 [===============>..............] - ETA: 0s - loss: 1.3675e-04 - mean\_absolute\_error: 0.0089 90/126 [====================>.........] - ETA: 0s - loss: 1.3021e-04 - mean\_absolute\_error: 0.0087113/126 [=========================>....] - ETA: 0s - loss: 1.3451e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3797e-04 - mean\_absolute\_error: 0.0089 - val\_loss: 4.3402e-05 - val\_mean\_absolute\_error: 0.0051  
Epoch 99/100  
 1/126 [..............................] - ETA: 0s - loss: 2.3801e-04 - mean\_absolute\_error: 0.0093 24/126 [====>.........................] - ETA: 0s - loss: 1.4946e-04 - mean\_absolute\_error: 0.0095 46/126 [=========>....................] - ETA: 0s - loss: 1.4220e-04 - mean\_absolute\_error: 0.0094 68/126 [===============>..............] - ETA: 0s - loss: 1.3664e-04 - mean\_absolute\_error: 0.0092 90/126 [====================>.........] - ETA: 0s - loss: 1.4109e-04 - mean\_absolute\_error: 0.0090112/126 [=========================>....] - ETA: 0s - loss: 1.3993e-04 - mean\_absolute\_error: 0.0090126/126 [==============================] - 0s 3ms/step - loss: 1.3891e-04 - mean\_absolute\_error: 0.0090 - val\_loss: 5.8336e-05 - val\_mean\_absolute\_error: 0.0062  
Epoch 100/100  
 1/126 [..............................] - ETA: 0s - loss: 6.5652e-05 - mean\_absolute\_error: 0.0063 24/126 [====>.........................] - ETA: 0s - loss: 1.2140e-04 - mean\_absolute\_error: 0.0086 47/126 [==========>...................] - ETA: 0s - loss: 1.1760e-04 - mean\_absolute\_error: 0.0083 68/126 [===============>..............] - ETA: 0s - loss: 1.3008e-04 - mean\_absolute\_error: 0.0087 90/126 [====================>.........] - ETA: 0s - loss: 1.2919e-04 - mean\_absolute\_error: 0.0087112/126 [=========================>....] - ETA: 0s - loss: 1.3313e-04 - mean\_absolute\_error: 0.0088126/126 [==============================] - 0s 3ms/step - loss: 1.3556e-04 - mean\_absolute\_error: 0.0088 - val\_loss: 5.0061e-05 - val\_mean\_absolute\_error: 0.0056

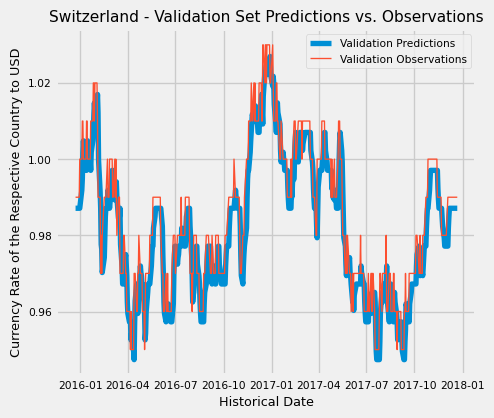
<keras.src.callbacks.History at 0x1b9a2b10490>

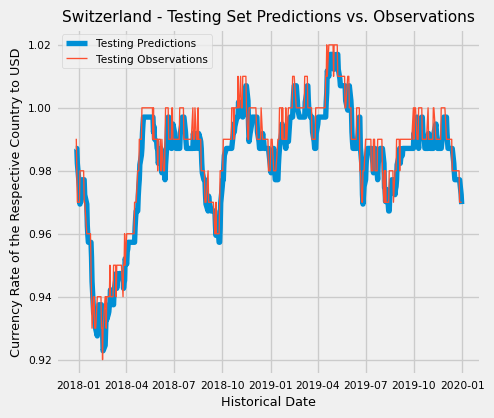
After the training and fitting of the Machine Learning model for Switzerland, I tried to create visualizations comparing the model against the country’s training dataset, validation dataset, but most importantly the testing dataset (as shown below in the line graphs). Note that the darker and thicker 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: 45s 44/126 [=========>....................] - ETA: 0s 87/126 [===================>..........] - ETA: 0s126/126 [==============================] - 1s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step  
 1/16 [>.............................] - ETA: 0s16/16 [==============================] - 0s 1ms/step

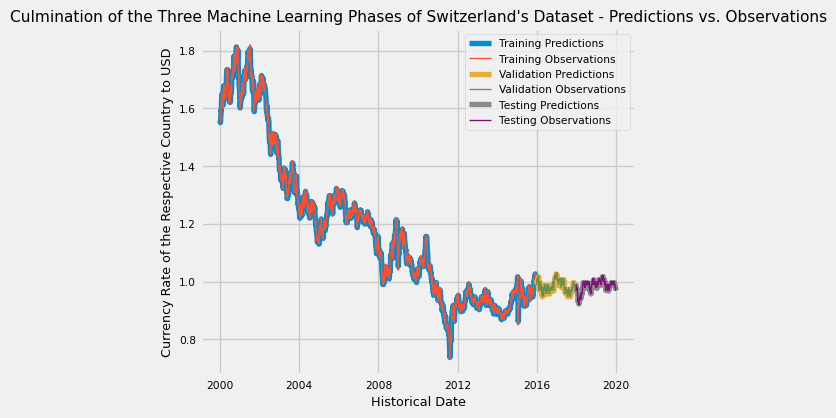






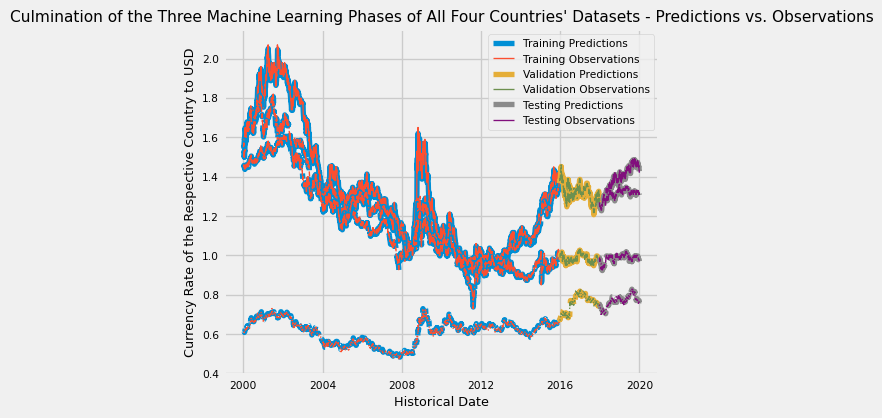
Through careful consideration of all of the prediction-based vs. observation-based contrast visualizations together, I consolidated all of graphics into one singular visualization for you to see below to get a more general perspective of the effectiveness of the Machine Learning model at training and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



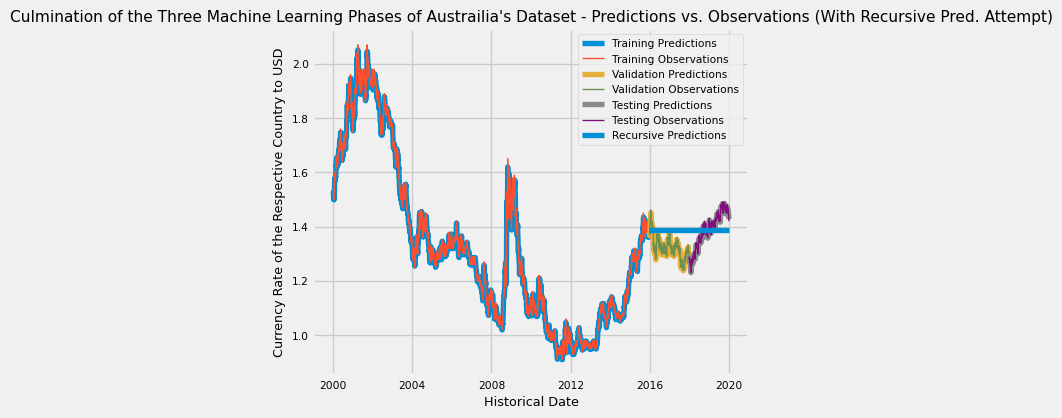
Ultimately, here is the moment of truth: I tried to recursively predict Austrailia’s future expected projection on its international currency rate between the United States through using my LSTM prediction model as shown below. By using the data from the training dataset for Austrailia, I tried to contrast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

1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 17ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 17ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 17ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 15ms/step  
1/1 [==============================] - ETA: 0s1/1 [==============================] - 0s 16ms/step  
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To visualize the results of my recursive prediction that I completed, I added these results to the previous large visualization that encompassed all 4 countries’ Machine Learning model prediction-based vs. observation-based visualizations - Austrailia, Canada, the United Kingdom, and Switzerland as shown below.

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



## Conclusions

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

## Reference Sources and Citations (IEEE Format)

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

[1] US International Exchange Rates Dataset:

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

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

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