PREDICCIÓN DEL FACTOR DE COMPRESIBILIDAD DE UN GAS NATURAL PARA ISOTÉRMAS USANDO MÉTODOS INTELIGENTES

Desarrollo de un proyecto para predecir el factor de compresibilidad del gas natural con las siguientes composiciones (metano,etano,propano,i-butano,n-butano, i-pentano,n-pentano,n-hexano,nitrogeno y dióxido de carbono) para diversas datas bibliográficas de isotérmas utilizando Redes Neuronales Artificiales Difusas (ANFIS) y Redes Neuronales Artificiales (ANN) en Python, comparando los resultados con las ecuaciones de estado de Peng-Robinson y Soave-Redlich-Kwong.

Referencias:

- Prediction of gas compressibility factor using intelligent models, Mohamadi(2015)
- A New Correlation Based on Artificial Neural Networks for Predicting the Natural Gas Compressibility Factor, Baniasadi(2012)
- Predicting the Compressibility Factor of Natural Gas by Using Statistical Modeling and Neural Network, Ghanem(2022)

Data de Referencia:

- Compressibility Isotherms of Simulated Natural Gases, Biswas(1990)
- Isochoric (P,ρ,T) measurements for five natural gas mixtures from T (225 to 350)K at pressures to 35 MPa, Magee(1997)
- Isothermal pVT measurements on gas hydrocarbon mixtures using a vibrating-tube apparatus, Capla(2002)

In [81]:
```
#Importando módulos
import sys
import io

#Gradicas y propiedades
import thermo as th
import chemicals as ch
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats import linregress

#Predicción
import tensorflow as tf
from sklearn.preprocessing import StandardScaler
```

In [82]:
```
#PROPIEDADES
#Tomar datos de constantes y propiedades criticas
N_C=["methane","ethane","propane","i-butane","n-butane","i-pentane","n-pentane",
#Se buscan componentes en base de datos
```

```
v_n=list(range(0,len(N_C)))
v_c=[ch.search_chemical(N_C[k]).InChI_key for k in v_n]
constants,propierties=th.ChemicalConstantsPackage.from_IDs(v_c)
#Se añaden datos de componentes no disponibles con InChI_key y se utiliza CAS.
N2_CO2_CAS=[ch.CAS_from_any('Nitrogen'),ch.CAS_from_any('Carbon dioxide')]
N2_CO2_Tcs=[ch.Tc(N2_CO2_CAS[0]),ch.Tc(N2_CO2_CAS[1])]
N2_CO2_Pcs=[ch.Pc(N2_CO2_CAS[0]),ch.Pc(N2_CO2_CAS[1])]
N2_CO2_ws=[ch.omega(N2_CO2_CAS[0]),ch.omega(N2_CO2_CAS[1])]
#Se buscan los parametros de interaccion binarias
#Se añaden datos de N2 y CO2, uniendo listas
#Union de lista de CAS
m_kij=th.interaction_parameters.IPDB.get_ip_asymmetric_matrix('ChemSep PR',
                                                              constants.CASs+N2_
#Union interna de propiedades criticas
DATA={'Pcs':constants.Pcs+N2_CO2_Pcs,
      'Tcs':constants.Tcs+N2_CO2_Tcs,
      'omegas':constants.omegas+N2_CO2_ws}

print(DATA)
```

```
{'Pcs': [4599200.0, 4872200.0, 4251200.0, 3629000.0, 3796000.0, 3378000.0, 336750
0.0, 3044100.0, 3395800.0, 7377300.0], 'Tcs': [190.564, 305.322, 369.89, 407.81,
425.125, 460.35, 469.7, 507.82, 126.192, 304.1282], 'omegas': [0.01142, 0.0995,
0.1521, 0.184, 0.201, 0.2274, 0.251, 0.3, 0.0372, 0.22394]}
```

In [83]:
```
#IMPORTACIÓN DE BASE DE DATOS (se puede cambiar de acuerdo a la data)
# Leer base de datos
basedatos = pd.read_excel(r'C:\Users\cesar\Desktop\Proyecto-Gas Natural\data_iso
# Lista para almacenar resultados
results = []
# Número de filas
lon = len(basedatos.index)
# Visualizar la base de datos
basedatos.head()
```

Out[83]:

	T (K)	P(Pa)	CH4	C2H6	C3H8	i-C4H10	n-C4H10	i-C5H12	n-C5H12	n C6H1
0	225.0	3193190.0	0.81299	0.03294	0.00637	0.00101	0.001	0.0	0.0	0.
1	225.0	4512100.0	0.81299	0.03294	0.00637	0.00101	0.001	0.0	0.0	0.
2	225.0	14818200.0	0.81299	0.03294	0.00637	0.00101	0.001	0.0	0.0	0.
3	225.0	19712390.0	0.81299	0.03294	0.00637	0.00101	0.001	0.0	0.0	0.
4	250.0	1996080.0	0.81299	0.03294	0.00637	0.00101	0.001	0.0	0.0	0.

In [84]:
```
basedatos.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 426 entries, 0 to 425
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   T (K)            426 non-null    float64
 1   P(Pa)            426 non-null    float64
 2   CH4              426 non-null    float64
 3   C2H6             426 non-null    float64
 4   C3H8             426 non-null    float64
 5   i-C4H10          426 non-null    float64
 6   n-C4H10          426 non-null    float64
 7   i-C5H12          426 non-null    float64
 8   n-C5H12          426 non-null    float64
 9   n-C6H14          426 non-null    float64
 10  N2               426 non-null    float64
 11  CO2              426 non-null    float64
 12  ρ exp (mol/dm3)  426 non-null    float64
 13  Z exp            426 non-null    float64
dtypes: float64(14)
memory usage: 46.7 KB
```

In [85]:
```
basedatos.describe()
```

Out[85]:

	T (K)	P(Pa)	CH4	C2H6	C3H8	i-C4H10	n-C
count	426.000000	4.260000e+02	426.000000	426.000000	426.000000	426.000000	426.0
mean	289.187775	1.107037e+07	0.867847	0.051115	0.014873	0.001657	0.0
std	32.663720	8.462415e+06	0.056640	0.028207	0.016227	0.001747	0.0
min	225.000000	1.208300e+05	0.800780	0.018150	0.004050	0.000000	0.0
25%	263.152000	4.222648e+06	0.812990	0.032940	0.006370	0.000990	0.0
50%	280.000000	8.986855e+06	0.858980	0.043060	0.008940	0.001010	0.0
75%	323.148000	1.596908e+07	0.906440	0.061150	0.015130	0.001480	0.0
max	349.981000	3.464920e+07	0.965800	0.116420	0.065300	0.007550	0.0

Ecuaciones de Peng-Robinson(PR) y Soaver-Redlich-Kwong(SRK)

Se utiliza los módulos thermo y chemicals para el calculo de las propiedades termodinámicas para gases reales con respectos a las Ecuaciones de Estado de Peng-Robinson(PR) y Soaver-Redlich-Kwong(SRK), asi como el cálculo de las propiedades pseudoreducidas(P_{pr}, T_{pr}) y un coeficiente X que relaciona a estas dos, estos valores del gas natural estudiado permitirá tener valores en rangos pequeños para poder utilizar nuestro modelo de Predicción.

In [86]:
```
#CALCULOS
for i in range(0, lon):
    # Datos del data frame
```

```
    R=8.3145
    T = basedatos.iloc[i, 0]
    P = basedatos.iloc[i, 1]
    X = basedatos.iloc[i, 2:12].tolist()  # Obtener las composiciones desde la c
    rho_exp = basedatos.iloc[i, 12]
    Z_exp= basedatos.iloc[i, 13]
    #CALCULOS DE VALORES PSEUDOREDUCIDOS
    # Calculando las presiones y temperaturas pseudocríticas
    Ppc = sum([X[j] * DATA['Pcs'][j] for j in range(len(X))])
    Tpc = sum([X[j] * DATA['Tcs'][j] for j in range(len(X))])

    # Calculando las presiones y temperaturas pseudoreducidas
    Ppr = P / Ppc
    Tpr = T / Tpc
    equis= Ppr/Tpr

    #CALCULOS DE DENSIDADES POR EC.DE ESTADOS
    # Definición de ecuaciones de estado
    EOS_PRmix = th.PRMIX(Tcs=DATA['Tcs'], Pcs=DATA['Pcs'], omegas=DATA['omegas']
                         zs=X, kijs=m_kij, T=T, P=P)
    EOS_SRKmix = th.SRKMIX(Tcs=DATA['Tcs'], Pcs=DATA['Pcs'], omegas=DATA['omegas
                         zs=X, kijs=m_kij, T=T, P=P)

    try:
        # Verifica si existen métodos para obtener el volumen molar
        if hasattr(EOS_PRmix, 'Z_g'):
            Z_PR = EOS_PRmix.to(T=T, P=P).Z_g
        else:
            Z_PR = EOS_PRmix.to(T=T, P=P).Z_l  # Usa Z_l como alternativa si no

        if hasattr(EOS_SRKmix, 'Z_g'):
            Z_SRK = EOS_SRKmix.to(T=T, P=P).Z_g
        else:
            Z_SRK = EOS_SRKmix.to(T=T, P=P).Z_l  # Usa Z_l como alternativa si n

    except AttributeError as e:
        print(f"Error al acceder a atributos: {e}")
    # Almacenar los resultados
    results.append([Ppr, Tpr, equis, Z_exp,Z_PR, Z_SRK])

# Crear un DataFrame con los resultados
columns = ['Ppr','Tpr','X','Z(exp)','Z(PR)','Z(SRK)']
data = pd.DataFrame(results, columns=columns)
data.head()
```

Out[86]:

	Ppr	Tpr	X	Z(exp)	Z(PR)	Z(SRK)
0	0.714609	1.194707	0.598146	0.85127	0.831137	0.851514
1	1.009769	1.194707	0.845203	0.78334	0.758910	0.785745
2	3.316187	1.194707	2.775733	0.56427	0.553238	0.600779
3	4.411465	1.194707	3.692509	0.65462	0.626810	0.685755
4	0.446706	1.327452	0.336514	0.93835	0.925536	0.937494

In [87]:

```
## Normalizando los valores de Ppr,Tpr y X para usar en los modelos de predicció
scaler = StandardScaler()
```

```
data[['Ppr', 'Tpr', 'X']] = scaler.fit_transform(data[['Ppr', 'Tpr', 'X']])
data.head()
```

Out[87]:

	Ppr	Tpr	X	Z(exp)	Z(PR)	Z(SRK)
0	-0.918927	-1.514769	-0.845877	0.85127	0.831137	0.851514
1	-0.758450	-1.514769	-0.651715	0.78334	0.758910	0.785745
2	0.495533	-1.514769	0.865487	0.56427	0.553238	0.600779
3	1.091028	-1.514769	1.585981	0.65462	0.626810	0.685755
4	-1.064584	-0.714518	-1.051493	0.93835	0.925536	0.937494

Redes Neuronales Artificales (ANN)

En este caso luego de tener los datos normalizados empleamos la libreria tensorflow usando el método de predicción realizado por el modelo de Adam para entrenar la red neuronal debido a su eficiencia y velocidad de convergencia. Adam combina las ventajas de los optimizadores AdaGrad y RMSProp, permitiendo una adaptación dinámica de las tasas de aprendizaje para cada parámetro, lo que resulta en un ajuste más efectivo, especialmente en problemas con datos ruidosos y complejos. Su capacidad para manejar momentos acumulados y su robustez lo convierten en una opción confiable para la regresión, facilitando un entrenamiento eficaz en el predicción del factor de compresibilidad Z. Además, su configuración predeterminada permite iniciar el proceso de entrenamiento sin la necesidad de un ajuste exhaustivo de hiperparámetros, lo que optimiza el flujo de trabajo en el análisis de datos experimentales.

In [88]:

```
# RED NEURONAL ARTIFICAL(ANN) con el modelo de ADAM
np.random.seed(42)
tf.random.set_seed(42)

# Asumir que el dataset tiene columnas ['Ppr', 'Tpr', 'X', 'Z(exp)']
x = data[['Ppr', 'Tpr', 'X']].values
y = data['Z(exp)'].values  # Verifica que el nombre de la columna sea correcto

# Definir la red neuronal
model = tf.keras.Sequential([
    tf.keras.layers.Input(shape=(3,)),
    tf.keras.layers.Dense(10, activation='relu'),
    tf.keras.layers.Dense(10, activation='relu'),
    tf.keras.layers.Dense(1)  # Una salida para predecir Z
])

# Compilar el modelo con el optimizador ADAM
model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=0.01),  # Usamos el modelo
    loss='mean_squared_error',  # Usamos MSE porque es una regresión
    metrics=['mean_absolute_error']
)

# Crear un dataset de TensorFlow
train_dataset = tf.data.Dataset.from_tensor_slices((x, y))
train_dataset = train_dataset.batch(256)  # Ajustar el tamaño del batch según se
```

```
# Entrenar el modelo
model.fit(train_dataset, epochs=1000)
# Hacer predicciones
predictions = model.predict(x)
print('Predicciones finalizadas')
# Agregar predicciones al DataFrame
data['Z(ANN)'] = predictions
```

```
Epoch 1/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 3s 68ms/step - loss: 0.4472 - mean_absolute_error: 0.656
1
Epoch 2/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 23ms/step - loss: 0.2069 - mean_absolute_error: 0.423
1
Epoch 3/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.1159 - mean_absolute_error: 0.296
3
Epoch 4/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.0987 - mean_absolute_error: 0.234
6
Epoch 5/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0966 - mean_absolute_error: 0.235
0
Epoch 6/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.0844 - mean_absolute_error: 0.231
0
Epoch 7/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0613 - mean_absolute_error: 0.199
6
Epoch 8/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0456 - mean_absolute_error: 0.170
0
Epoch 9/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 38ms/step - loss: 0.0432 - mean_absolute_error: 0.171
3
Epoch 10/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0450 - mean_absolute_error: 0.178
9
Epoch 11/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0420 - mean_absolute_error: 0.175
2
Epoch 12/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0335 - mean_absolute_error: 0.1552
Epoch 13/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0246 - mean_absolute_error: 0.129
2
Epoch 14/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0200 - mean_absolute_error: 0.116
3
Epoch 15/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0202 - mean_absolute_error: 0.114
0
Epoch 16/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0211 - mean_absolute_error: 0.112
8
Epoch 17/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 0.0187 - mean_absolute_error: 0.105
3
Epoch 18/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.0140 - mean_absolute_error: 0.089
9
Epoch 19/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0102 - mean_absolute_error: 0.0752
Epoch 20/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 0.0090 - mean_absolute_error: 0.074
5
Epoch 21/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0090 - mean_absolute_error: 0.077
```

```
7
Epoch 22/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0085 - mean_absolute_error: 0.075
0
Epoch 23/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0069 - mean_absolute_error: 0.065
3
Epoch 24/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 0.0061 - mean_absolute_error: 0.061
7
Epoch 25/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0065 - mean_absolute_error: 0.063
8
Epoch 26/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 0.0061 - mean_absolute_error: 0.061
8
Epoch 27/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 23ms/step - loss: 0.0053 - mean_absolute_error: 0.057
1
Epoch 28/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0050 - mean_absolute_error: 0.055
8
Epoch 29/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0049 - mean_absolute_error: 0.0549
Epoch 30/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0045 - mean_absolute_error: 0.052
6
Epoch 31/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0040 - mean_absolute_error: 0.050
3
Epoch 32/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0039 - mean_absolute_error: 0.049
3
Epoch 33/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 0.0037 - mean_absolute_error: 0.048
2
Epoch 34/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 34ms/step - loss: 0.0034 - mean_absolute_error: 0.046
1
Epoch 35/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 0.0032 - mean_absolute_error: 0.0440
Epoch 36/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 0.0030 - mean_absolute_error: 0.0424
Epoch 37/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0029 - mean_absolute_error: 0.041
3
Epoch 38/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0028 - mean_absolute_error: 0.040
2
Epoch 39/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0027 - mean_absolute_error: 0.039
0
Epoch 40/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0026 - mean_absolute_error: 0.0381
Epoch 41/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0025 - mean_absolute_error: 0.0373
Epoch 42/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 0.0024 - mean_absolute_error: 0.036
4
Epoch 43/1000
```

```
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0023 - mean_absolute_error: 0.035
6
Epoch 44/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 0.0022 - mean_absolute_error: 0.035
0
Epoch 45/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0021 - mean_absolute_error: 0.034
5
Epoch 46/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0021 - mean_absolute_error: 0.034
0
Epoch 47/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0020 - mean_absolute_error: 0.033
3
Epoch 48/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0019 - mean_absolute_error: 0.032
8
Epoch 49/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0019 - mean_absolute_error: 0.032
3
Epoch 50/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0018 - mean_absolute_error: 0.031
9
Epoch 51/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0018 - mean_absolute_error: 0.031
4
Epoch 52/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.0017 - mean_absolute_error: 0.031
0
Epoch 53/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0017 - mean_absolute_error: 0.030
7
Epoch 54/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0017 - mean_absolute_error: 0.030
4
Epoch 55/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.0016 - mean_absolute_error: 0.030
1
Epoch 56/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.0016 - mean_absolute_error: 0.029
7
Epoch 57/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 0.0015 - mean_absolute_error: 0.029
4
Epoch 58/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0015 - mean_absolute_error: 0.029
0
Epoch 59/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 0.0015 - mean_absolute_error: 0.028
7
Epoch 60/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 0.0014 - mean_absolute_error: 0.028
4
Epoch 61/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0014 - mean_absolute_error: 0.028
2
Epoch 62/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0014 - mean_absolute_error: 0.027
8
Epoch 63/1000
```

```
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0014 - mean_absolute_error: 0.027
5
Epoch 64/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0013 - mean_absolute_error: 0.0271
Epoch 65/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0013 - mean_absolute_error: 0.0268
Epoch 66/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0013 - mean_absolute_error: 0.026
6
Epoch 67/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0013 - mean_absolute_error: 0.026
3
Epoch 68/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 31ms/step - loss: 0.0012 - mean_absolute_error: 0.026
1
Epoch 69/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 0.0012 - mean_absolute_error: 0.0258
Epoch 70/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 0.0012 - mean_absolute_error: 0.025
5
Epoch 71/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0012 - mean_absolute_error: 0.025
3
Epoch 72/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 0.0011 - mean_absolute_error: 0.0251
Epoch 73/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0011 - mean_absolute_error: 0.024
8
Epoch 74/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0011 - mean_absolute_error: 0.0246
Epoch 75/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0011 - mean_absolute_error: 0.0244
Epoch 76/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0011 - mean_absolute_error: 0.024
2
Epoch 77/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0011 - mean_absolute_error: 0.024
0
Epoch 78/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 0.0010 - mean_absolute_error: 0.0237
Epoch 79/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 0.0010 - mean_absolute_error: 0.0235
Epoch 80/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 0.0010 - mean_absolute_error: 0.023
4
Epoch 81/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0010 - mean_absolute_error: 0.023
2
Epoch 82/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 24ms/step - loss: 9.8931e-04 - mean_absolute_error:
0.0231
Epoch 83/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 9.7695e-04 - mean_absolute_error:
0.0230
Epoch 84/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 9.6385e-04 - mean_absolute_error:
0.0229
Epoch 85/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 9.5054e-04 - mean_absolute_error:
0.0227
```

```
Epoch 86/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 9.3784e-04 - mean_absolute_error:
0.0225
Epoch 87/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 9.2630e-04 - mean_absolute_error:
0.0224
Epoch 88/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 9.1570e-04 - mean_absolute_error: 0.
0222
Epoch 89/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 9.0560e-04 - mean_absolute_error:
0.0221
Epoch 90/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 8.9553e-04 - mean_absolute_error:
0.0220
Epoch 91/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 8.8534e-04 - mean_absolute_error:
0.0219
Epoch 92/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 8.7546e-04 - mean_absolute_error:
0.0217
Epoch 93/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 8.6670e-04 - mean_absolute_error:
0.0216
Epoch 94/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 8.5853e-04 - mean_absolute_error:
0.0216
Epoch 95/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 8.5000e-04 - mean_absolute_error:
0.0215
Epoch 96/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 8.4150e-04 - mean_absolute_error:
0.0214
Epoch 97/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 8.3301e-04 - mean_absolute_error:
0.0213
Epoch 98/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 8.2442e-04 - mean_absolute_error: 0.
0212
Epoch 99/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 8.1575e-04 - mean_absolute_error:
0.0211
Epoch 100/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 8.0773e-04 - mean_absolute_error: 0.
0210
Epoch 101/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 8.0030e-04 - mean_absolute_error:
0.0209
Epoch 102/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 7.9302e-04 - mean_absolute_error:
0.0208
Epoch 103/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 7.8559e-04 - mean_absolute_error:
0.0207
Epoch 104/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 7.7793e-04 - mean_absolute_error:
0.0206
Epoch 105/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 7.7024e-04 - mean_absolute_error: 0.
0205
```

```
Epoch 106/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 7.6285e-04 - mean_absolute_error: 0.
0204
Epoch 107/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 7.5580e-04 - mean_absolute_error:
0.0204
Epoch 108/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 7.4894e-04 - mean_absolute_error:
0.0203
Epoch 109/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 7.4206e-04 - mean_absolute_error: 0.
0202
Epoch 110/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 7.3517e-04 - mean_absolute_error: 0.
0201
Epoch 111/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 7.2816e-04 - mean_absolute_error:
0.0200
Epoch 112/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 7.2120e-04 - mean_absolute_error:
0.0199
Epoch 113/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 7.1440e-04 - mean_absolute_error:
0.0198
Epoch 114/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 7.0774e-04 - mean_absolute_error:
0.0197
Epoch 115/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 7.0114e-04 - mean_absolute_error: 0.
0197
Epoch 116/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 6.9446e-04 - mean_absolute_error:
0.0196
Epoch 117/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 6.8782e-04 - mean_absolute_error:
0.0195
Epoch 118/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 6.8138e-04 - mean_absolute_error:
0.0194
Epoch 119/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 6.7521e-04 - mean_absolute_error: 0.
0193
Epoch 120/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 22ms/step - loss: 6.6931e-04 - mean_absolute_error:
0.0192
Epoch 121/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 6.6358e-04 - mean_absolute_error:
0.0192
Epoch 122/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 6.5786e-04 - mean_absolute_error: 0.
0191
Epoch 123/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 6.5212e-04 - mean_absolute_error:
0.0190
Epoch 124/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 6.4646e-04 - mean_absolute_error:
0.0189
Epoch 125/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 6.4100e-04 - mean_absolute_error:
0.0189
```

```
Epoch 126/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 6.3579e-04 - mean_absolute_error:
0.0188
Epoch 127/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 6.3078e-04 - mean_absolute_error: 0.
0187
Epoch 128/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 6.2583e-04 - mean_absolute_error: 0.
0186
Epoch 129/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 6.2094e-04 - mean_absolute_error:
0.0186
Epoch 130/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 6.1609e-04 - mean_absolute_error:
0.0185
Epoch 131/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 6.1138e-04 - mean_absolute_error: 0.
0184
Epoch 132/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 6.0665e-04 - mean_absolute_error:
0.0184
Epoch 133/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 6.0191e-04 - mean_absolute_error:
0.0183
Epoch 134/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 5.9726e-04 - mean_absolute_error:
0.0182
Epoch 135/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.9269e-04 - mean_absolute_error:
0.0181
Epoch 136/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 5.8821e-04 - mean_absolute_error:
0.0181
Epoch 137/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 5.8382e-04 - mean_absolute_error: 0.
0180
Epoch 138/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 5.7950e-04 - mean_absolute_error:
0.0179
Epoch 139/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.7527e-04 - mean_absolute_error:
0.0179
Epoch 140/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 5.7108e-04 - mean_absolute_error: 0.
0178
Epoch 141/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 5.6693e-04 - mean_absolute_error: 0.
0178
Epoch 142/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 5.6278e-04 - mean_absolute_error:
0.0177
Epoch 143/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 5.5861e-04 - mean_absolute_error:
0.0176
Epoch 144/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 5.5442e-04 - mean_absolute_error: 0.
0176
Epoch 145/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 23ms/step - loss: 5.5027e-04 - mean_absolute_error:
0.0175
```

```
Epoch 146/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.4616e-04 - mean_absolute_error:
0.0174
Epoch 147/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.4205e-04 - mean_absolute_error:
0.0174
Epoch 148/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 5.3793e-04 - mean_absolute_error: 0.0
173
Epoch 149/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.3391e-04 - mean_absolute_error:
0.0172
Epoch 150/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.3034e-04 - mean_absolute_error:
0.0172
Epoch 151/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.2690e-04 - mean_absolute_error:
0.0172
Epoch 152/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 5.2328e-04 - mean_absolute_error:
0.0171
Epoch 153/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 5.1959e-04 - mean_absolute_error: 0.
0170
Epoch 154/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 5.1511e-04 - mean_absolute_error: 0.
0169
Epoch 155/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.1108e-04 - mean_absolute_error:
0.0169
Epoch 156/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.0757e-04 - mean_absolute_error:
0.0168
Epoch 157/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 5.0454e-04 - mean_absolute_error:
0.0168
Epoch 158/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 5.0074e-04 - mean_absolute_error:
0.0167
Epoch 159/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.9659e-04 - mean_absolute_error:
0.0166
Epoch 160/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.9313e-04 - mean_absolute_error:
0.0165
Epoch 161/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.9023e-04 - mean_absolute_error:
0.0165
Epoch 162/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.8737e-04 - mean_absolute_error:
0.0164
Epoch 163/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.8431e-04 - mean_absolute_error:
0.0164
Epoch 164/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.8025e-04 - mean_absolute_error:
0.0163
Epoch 165/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 4.7677e-04 - mean_absolute_error: 0.
0162
```

```
Epoch 166/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.7395e-04 - mean_absolute_error:
0.0162
Epoch 167/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.7138e-04 - mean_absolute_error:
0.0161
Epoch 168/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 4.6847e-04 - mean_absolute_error:
0.0161
Epoch 169/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.6527e-04 - mean_absolute_error:
0.0160
Epoch 170/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.6138e-04 - mean_absolute_error:
0.0159
Epoch 171/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.5812e-04 - mean_absolute_error:
0.0159
Epoch 172/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.5549e-04 - mean_absolute_error:
0.0158
Epoch 173/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.5284e-04 - mean_absolute_error:
0.0158
Epoch 174/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.4970e-04 - mean_absolute_error:
0.0157
Epoch 175/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 4.4629e-04 - mean_absolute_error: 0.
0156
Epoch 176/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.4308e-04 - mean_absolute_error:
0.0156
Epoch 177/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.4018e-04 - mean_absolute_error:
0.0155
Epoch 178/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 4.3737e-04 - mean_absolute_error: 0.
0155
Epoch 179/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.3437e-04 - mean_absolute_error:
0.0154
Epoch 180/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.3123e-04 - mean_absolute_error:
0.0153
Epoch 181/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.2813e-04 - mean_absolute_error:
0.0153
Epoch 182/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.2528e-04 - mean_absolute_error:
0.0152
Epoch 183/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 4.2263e-04 - mean_absolute_error: 0.
0151
Epoch 184/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.2002e-04 - mean_absolute_error:
0.0151
Epoch 185/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 4.1689e-04 - mean_absolute_error: 0.0
150
```

```
Epoch 186/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.1382e-04 - mean_absolute_error:
0.0149
Epoch 187/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.1102e-04 - mean_absolute_error:
0.0149
Epoch 188/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.0848e-04 - mean_absolute_error:
0.0148
Epoch 189/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.0565e-04 - mean_absolute_error:
0.0148
Epoch 190/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 4.0263e-04 - mean_absolute_error:
0.0147
Epoch 191/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.9972e-04 - mean_absolute_error:
0.0146
Epoch 192/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.9736e-04 - mean_absolute_error:
0.0146
Epoch 193/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.9501e-04 - mean_absolute_error:
0.0145
Epoch 194/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.9243e-04 - mean_absolute_error:
0.0145
Epoch 195/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.8965e-04 - mean_absolute_error:
0.0144
Epoch 196/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 3.8735e-04 - mean_absolute_error:
0.0144
Epoch 197/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.8505e-04 - mean_absolute_error:
0.0143
Epoch 198/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 3.8255e-04 - mean_absolute_error: 0.
0142
Epoch 199/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.7992e-04 - mean_absolute_error:
0.0142
Epoch 200/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.7750e-04 - mean_absolute_error:
0.0141
Epoch 201/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.7528e-04 - mean_absolute_error:
0.0141
Epoch 202/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.7309e-04 - mean_absolute_error:
0.0140
Epoch 203/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.7057e-04 - mean_absolute_error:
0.0139
Epoch 204/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.6797e-04 - mean_absolute_error:
0.0139
Epoch 205/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 3.6541e-04 - mean_absolute_error: 0.
0138
```

```
Epoch 206/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.6304e-04 - mean_absolute_error:
0.0138
Epoch 207/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.6080e-04 - mean_absolute_error:
0.0138
Epoch 208/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.5851e-04 - mean_absolute_error:
0.0137
Epoch 209/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.5620e-04 - mean_absolute_error:
0.0137
Epoch 210/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.5406e-04 - mean_absolute_error:
0.0136
Epoch 211/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 3.5217e-04 - mean_absolute_error:
0.0136
Epoch 212/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.5035e-04 - mean_absolute_error:
0.0135
Epoch 213/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.4819e-04 - mean_absolute_error:
0.0135
Epoch 214/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 3.4570e-04 - mean_absolute_error:
0.0134
Epoch 215/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.4341e-04 - mean_absolute_error:
0.0134
Epoch 216/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.4138e-04 - mean_absolute_error:
0.0133
Epoch 217/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 3.3945e-04 - mean_absolute_error: 0.
0133
Epoch 218/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 3.3751e-04 - mean_absolute_error: 0.
0133
Epoch 219/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.3548e-04 - mean_absolute_error:
0.0132
Epoch 220/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 3.3342e-04 - mean_absolute_error:
0.0132
Epoch 221/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 3.3140e-04 - mean_absolute_error: 0.
0131
Epoch 222/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.2949e-04 - mean_absolute_error:
0.0131
Epoch 223/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.2764e-04 - mean_absolute_error:
0.0130
Epoch 224/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 3.2573e-04 - mean_absolute_error:
0.0130
Epoch 225/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.2390e-04 - mean_absolute_error:
0.0130
```

```
Epoch 226/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 3.2223e-04 - mean_absolute_error: 0.
0129
Epoch 227/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.2069e-04 - mean_absolute_error:
0.0129
Epoch 228/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.1889e-04 - mean_absolute_error:
0.0128
Epoch 229/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 3.1714e-04 - mean_absolute_error: 0.0
128
Epoch 230/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 3.1541e-04 - mean_absolute_error: 0.0
128
Epoch 231/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.1383e-04 - mean_absolute_error:
0.0127
Epoch 232/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 3.1218e-04 - mean_absolute_error: 0.
0127
Epoch 233/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.1053e-04 - mean_absolute_error:
0.0127
Epoch 234/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.0911e-04 - mean_absolute_error:
0.0126
Epoch 235/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.0785e-04 - mean_absolute_error:
0.0126
Epoch 236/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.0631e-04 - mean_absolute_error:
0.0126
Epoch 237/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 3.0430e-04 - mean_absolute_error:
0.0125
Epoch 238/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 3.0204e-04 - mean_absolute_error: 0.
0124
Epoch 239/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.9989e-04 - mean_absolute_error:
0.0124
Epoch 240/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.9810e-04 - mean_absolute_error:
0.0124
Epoch 241/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 2.9646e-04 - mean_absolute_error:
0.0124
Epoch 242/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.9433e-04 - mean_absolute_error:
0.0123
Epoch 243/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 2.9174e-04 - mean_absolute_error:
0.0122
Epoch 244/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.8964e-04 - mean_absolute_error:
0.0122
Epoch 245/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.8817e-04 - mean_absolute_error:
0.0122
```

```
Epoch 246/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.8662e-04 - mean_absolute_error:
0.0122
Epoch 247/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.8474e-04 - mean_absolute_error: 0.
0121
Epoch 248/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.8282e-04 - mean_absolute_error:
0.0120
Epoch 249/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.8117e-04 - mean_absolute_error: 0.0
120
Epoch 250/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.7979e-04 - mean_absolute_error:
0.0120
Epoch 251/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.7834e-04 - mean_absolute_error: 0.0
120
Epoch 252/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 2.7679e-04 - mean_absolute_error:
0.0119
Epoch 253/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.7502e-04 - mean_absolute_error: 0.0
119
Epoch 254/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.7320e-04 - mean_absolute_error:
0.0118
Epoch 255/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 2.7173e-04 - mean_absolute_error:
0.0118
Epoch 256/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.7049e-04 - mean_absolute_error:
0.0118
Epoch 257/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.6905e-04 - mean_absolute_error:
0.0117
Epoch 258/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 2.6729e-04 - mean_absolute_error:
0.0117
Epoch 259/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.6554e-04 - mean_absolute_error:
0.0116
Epoch 260/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.6428e-04 - mean_absolute_error:
0.0116
Epoch 261/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.6330e-04 - mean_absolute_error: 0.
0116
Epoch 262/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.6202e-04 - mean_absolute_error: 0.0
116
Epoch 263/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.6042e-04 - mean_absolute_error: 0.
0115
Epoch 264/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 2.5893e-04 - mean_absolute_error:
0.0115
Epoch 265/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.5785e-04 - mean_absolute_error:
0.0115
```

```
Epoch 266/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.5681e-04 - mean_absolute_error:
0.0114
Epoch 267/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.5529e-04 - mean_absolute_error:
0.0114
Epoch 268/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.5417e-04 - mean_absolute_error: 0.0
113
Epoch 269/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.5304e-04 - mean_absolute_error: 0.0
113
Epoch 270/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.5198e-04 - mean_absolute_error: 0.
0113
Epoch 271/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - loss: 2.5077e-04 - mean_absolute_error:
0.0113
Epoch 272/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.5002e-04 - mean_absolute_error: 0.
0112
Epoch 273/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.4894e-04 - mean_absolute_error:
0.0112
Epoch 274/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.4762e-04 - mean_absolute_error:
0.0112
Epoch 275/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 2.4690e-04 - mean_absolute_error: 0.
0112
Epoch 276/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 2.4583e-04 - mean_absolute_error: 0.
0111
Epoch 277/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.4459e-04 - mean_absolute_error:
0.0111
Epoch 278/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 2.4396e-04 - mean_absolute_error:
0.0111
Epoch 279/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.4313e-04 - mean_absolute_error:
0.0111
Epoch 280/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.4199e-04 - mean_absolute_error:
0.0110
Epoch 281/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 2.4122e-04 - mean_absolute_error: 0.0
110
Epoch 282/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 2.4079e-04 - mean_absolute_error: 0.
0110
Epoch 283/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 2.3968e-04 - mean_absolute_error:
0.0110
Epoch 284/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.3840e-04 - mean_absolute_error:
0.0109
Epoch 285/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.3781e-04 - mean_absolute_error:
0.0109
```

```
Epoch 286/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 1ms/step - loss: 2.3759e-04 - mean_absolute_error: 0.
0109
Epoch 287/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.3654e-04 - mean_absolute_error: 0.
0109
Epoch 288/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.3520e-04 - mean_absolute_error:
0.0108
Epoch 289/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.3464e-04 - mean_absolute_error:
0.0108
Epoch 290/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.3455e-04 - mean_absolute_error:
0.0108
Epoch 291/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.3351e-04 - mean_absolute_error:
0.0108
Epoch 292/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.3218e-04 - mean_absolute_error: 0.
0108
Epoch 293/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.3169e-04 - mean_absolute_error:
0.0108
Epoch 294/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.3170e-04 - mean_absolute_error:
0.0108
Epoch 295/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.3071e-04 - mean_absolute_error:
0.0107
Epoch 296/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.2970e-04 - mean_absolute_error: 0.
0107
Epoch 297/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 2.2936e-04 - mean_absolute_error:
0.0107
Epoch 298/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.2873e-04 - mean_absolute_error:
0.0107
Epoch 299/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.2777e-04 - mean_absolute_error:
0.0107
Epoch 300/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.2720e-04 - mean_absolute_error:
0.0106
Epoch 301/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.2690e-04 - mean_absolute_error: 0.
0106
Epoch 302/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 2.2666e-04 - mean_absolute_error:
0.0106
Epoch 303/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.2567e-04 - mean_absolute_error: 0.
0106
Epoch 304/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 2.2470e-04 - mean_absolute_error: 0.
0106
Epoch 305/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.2443e-04 - mean_absolute_error:
0.0106
```

```
Epoch 306/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.2426e-04 - mean_absolute_error: 0.
0106
Epoch 307/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 2.2368e-04 - mean_absolute_error: 0.
0106
Epoch 308/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.2314e-04 - mean_absolute_error:
0.0105
Epoch 309/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.2228e-04 - mean_absolute_error:
0.0105
Epoch 310/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.2160e-04 - mean_absolute_error: 0.
0105
Epoch 311/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.2126e-04 - mean_absolute_error: 0.
0105
Epoch 312/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.2091e-04 - mean_absolute_error: 0.
0105
Epoch 313/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.2044e-04 - mean_absolute_error:
0.0105
Epoch 314/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.1993e-04 - mean_absolute_error: 0.
0105
Epoch 315/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.1900e-04 - mean_absolute_error:
0.0104
Epoch 316/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.1819e-04 - mean_absolute_error: 0.
0104
Epoch 317/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.1767e-04 - mean_absolute_error:
0.0104
Epoch 318/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.1725e-04 - mean_absolute_error: 0.
0104
Epoch 319/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.1702e-04 - mean_absolute_error:
0.0104
Epoch 320/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.1626e-04 - mean_absolute_error: 0.
0104
Epoch 321/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.1591e-04 - mean_absolute_error:
0.0104
Epoch 322/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.1520e-04 - mean_absolute_error: 0.
0103
Epoch 323/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.1470e-04 - mean_absolute_error:
0.0103
Epoch 324/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.1452e-04 - mean_absolute_error: 0.
0103
Epoch 325/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 2.1389e-04 - mean_absolute_error:
0.0103
```

```
Epoch 326/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.1350e-04 - mean_absolute_error:
0.0103
Epoch 327/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 2.1315e-04 - mean_absolute_error:
0.0103
Epoch 328/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.1268e-04 - mean_absolute_error:
0.0103
Epoch 329/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 2.1169e-04 - mean_absolute_error: 0.
0103
Epoch 330/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.1130e-04 - mean_absolute_error:
0.0102
Epoch 331/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.1134e-04 - mean_absolute_error:
0.0103
Epoch 332/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.1055e-04 - mean_absolute_error: 0.
0102
Epoch 333/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 2.0991e-04 - mean_absolute_error:
0.0102
Epoch 334/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.0962e-04 - mean_absolute_error: 0.
0102
Epoch 335/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.0940e-04 - mean_absolute_error: 0.
0102
Epoch 336/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.0852e-04 - mean_absolute_error:
0.0102
Epoch 337/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.0799e-04 - mean_absolute_error:
0.0102
Epoch 338/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 2.0785e-04 - mean_absolute_error: 0.
0102
Epoch 339/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.0751e-04 - mean_absolute_error:
0.0102
Epoch 340/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 2.0700e-04 - mean_absolute_error:
0.0102
Epoch 341/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.0610e-04 - mean_absolute_error:
0.0101
Epoch 342/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.0585e-04 - mean_absolute_error:
0.0101
Epoch 343/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.0573e-04 - mean_absolute_error: 0.
0101
Epoch 344/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 2.0539e-04 - mean_absolute_error: 0.
0101
Epoch 345/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 2.0452e-04 - mean_absolute_error: 0.
0101
```

```
Epoch 346/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.0430e-04 - mean_absolute_error:
0.0101
Epoch 347/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.0427e-04 - mean_absolute_error:
0.0101
Epoch 348/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 36ms/step - loss: 2.0392e-04 - mean_absolute_error:
0.0101
Epoch 349/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.0301e-04 - mean_absolute_error:
0.0101
Epoch 350/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 2.0277e-04 - mean_absolute_error: 0.
0101
Epoch 351/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 2.0287e-04 - mean_absolute_error:
0.0101
Epoch 352/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.0255e-04 - mean_absolute_error:
0.0101
Epoch 353/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 2.0156e-04 - mean_absolute_error: 0.
0100
Epoch 354/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 2.0128e-04 - mean_absolute_error:
0.0100
Epoch 355/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 2.0140e-04 - mean_absolute_error:
0.0100
Epoch 356/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 2.0112e-04 - mean_absolute_error:
0.0100
Epoch 357/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.0013e-04 - mean_absolute_error:
0.0100
Epoch 358/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.9985e-04 - mean_absolute_error:
0.0100
Epoch 359/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9999e-04 - mean_absolute_error:
0.0100
Epoch 360/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.9973e-04 - mean_absolute_error:
0.0100
Epoch 361/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.9877e-04 - mean_absolute_error: 0.
0100
Epoch 362/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.9857e-04 - mean_absolute_error: 0.
0100
Epoch 363/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.9879e-04 - mean_absolute_error:
0.0100
Epoch 364/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9853e-04 - mean_absolute_error:
0.0100
Epoch 365/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9758e-04 - mean_absolute_error:
0.0099
```

```
Epoch 366/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.9739e-04 - mean_absolute_error: 0.0
099
Epoch 367/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9759e-04 - mean_absolute_error:
0.0099
Epoch 368/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9720e-04 - mean_absolute_error:
0.0099
Epoch 369/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9654e-04 - mean_absolute_error:
0.0099
Epoch 370/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.9629e-04 - mean_absolute_error:
0.0099
Epoch 371/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9631e-04 - mean_absolute_error:
0.0099
Epoch 372/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.9554e-04 - mean_absolute_error: 0.
0099
Epoch 373/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.9505e-04 - mean_absolute_error:
0.0099
Epoch 374/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9504e-04 - mean_absolute_error:
0.0099
Epoch 375/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9498e-04 - mean_absolute_error:
0.0099
Epoch 376/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.9450e-04 - mean_absolute_error:
0.0099
Epoch 377/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 35ms/step - loss: 1.9362e-04 - mean_absolute_error:
0.0098
Epoch 378/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9358e-04 - mean_absolute_error:
0.0098
Epoch 379/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.9365e-04 - mean_absolute_error:
0.0098
Epoch 380/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.9338e-04 - mean_absolute_error:
0.0098
Epoch 381/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.9260e-04 - mean_absolute_error:
0.0098
Epoch 382/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9255e-04 - mean_absolute_error:
0.0098
Epoch 383/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9246e-04 - mean_absolute_error:
0.0098
Epoch 384/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.9179e-04 - mean_absolute_error: 0.
0098
Epoch 385/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.9141e-04 - mean_absolute_error: 0.
0098
```

```
Epoch 386/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.9155e-04 - mean_absolute_error:
0.0098
Epoch 387/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9103e-04 - mean_absolute_error:
0.0098
Epoch 388/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.9055e-04 - mean_absolute_error: 0.
0098
Epoch 389/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.9023e-04 - mean_absolute_error:
0.0097
Epoch 390/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8995e-04 - mean_absolute_error:
0.0097
Epoch 391/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.8987e-04 - mean_absolute_error:
0.0097
Epoch 392/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8922e-04 - mean_absolute_error:
0.0097
Epoch 393/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8893e-04 - mean_absolute_error:
0.0097
Epoch 394/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.8879e-04 - mean_absolute_error: 0.
0097
Epoch 395/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.8802e-04 - mean_absolute_error:
0.0097
Epoch 396/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.8772e-04 - mean_absolute_error:
0.0097
Epoch 397/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.8770e-04 - mean_absolute_error: 0.
0097
Epoch 398/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.8736e-04 - mean_absolute_error: 0.
0097
Epoch 399/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.8638e-04 - mean_absolute_error:
0.0096
Epoch 400/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.8620e-04 - mean_absolute_error:
0.0096
Epoch 401/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.8633e-04 - mean_absolute_error: 0.
0097
Epoch 402/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.8545e-04 - mean_absolute_error: 0.
0096
Epoch 403/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.8503e-04 - mean_absolute_error:
0.0096
Epoch 404/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.8539e-04 - mean_absolute_error:
0.0096
Epoch 405/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.8485e-04 - mean_absolute_error: 0.
0096
```

```
Epoch 406/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 33ms/step - loss: 1.8423e-04 - mean_absolute_error:
0.0096
Epoch 407/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.8428e-04 - mean_absolute_error: 0.
0096
Epoch 408/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.8452e-04 - mean_absolute_error:
0.0096
Epoch 409/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.8373e-04 - mean_absolute_error:
0.0096
Epoch 410/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.8328e-04 - mean_absolute_error: 0.
0096
Epoch 411/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8347e-04 - mean_absolute_error:
0.0096
Epoch 412/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.8330e-04 - mean_absolute_error:
0.0096
Epoch 413/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.8273e-04 - mean_absolute_error:
0.0095
Epoch 414/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.8273e-04 - mean_absolute_error: 0.
0096
Epoch 415/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.8250e-04 - mean_absolute_error:
0.0095
Epoch 416/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.8227e-04 - mean_absolute_error:
0.0095
Epoch 417/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.8192e-04 - mean_absolute_error:
0.0095
Epoch 418/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8166e-04 - mean_absolute_error:
0.0095
Epoch 419/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - loss: 1.8160e-04 - mean_absolute_error:
0.0095
Epoch 420/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8161e-04 - mean_absolute_error:
0.0095
Epoch 421/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8102e-04 - mean_absolute_error:
0.0095
Epoch 422/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.8084e-04 - mean_absolute_error:
0.0095
Epoch 423/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.8095e-04 - mean_absolute_error: 0.
0095
Epoch 424/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.8062e-04 - mean_absolute_error: 0.
0095
Epoch 425/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.8007e-04 - mean_absolute_error:
0.0095
```

```
Epoch 426/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.7999e-04 - mean_absolute_error: 0.0
095
Epoch 427/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.8009e-04 - mean_absolute_error:
0.0095
Epoch 428/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7988e-04 - mean_absolute_error: 0.
0095
Epoch 429/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.7921e-04 - mean_absolute_error:
0.0094
Epoch 430/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7924e-04 - mean_absolute_error:
0.0095
Epoch 431/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7917e-04 - mean_absolute_error:
0.0095
Epoch 432/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7861e-04 - mean_absolute_error:
0.0094
Epoch 433/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.7839e-04 - mean_absolute_error:
0.0094
Epoch 434/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - loss: 1.7864e-04 - mean_absolute_error:
0.0094
Epoch 435/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7848e-04 - mean_absolute_error: 0.
0094
Epoch 436/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7796e-04 - mean_absolute_error: 0.
0094
Epoch 437/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7779e-04 - mean_absolute_error:
0.0094
Epoch 438/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.7764e-04 - mean_absolute_error:
0.0094
Epoch 439/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7720e-04 - mean_absolute_error: 0.
0094
Epoch 440/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.7693e-04 - mean_absolute_error: 0.
0094
Epoch 441/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7715e-04 - mean_absolute_error: 0.
0094
Epoch 442/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7674e-04 - mean_absolute_error: 0.
0094
Epoch 443/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.7642e-04 - mean_absolute_error:
0.0094
Epoch 444/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7643e-04 - mean_absolute_error:
0.0094
Epoch 445/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.7621e-04 - mean_absolute_error:
0.0094
```

```
Epoch 446/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7573e-04 - mean_absolute_error: 0.
0093
Epoch 447/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7564e-04 - mean_absolute_error:
0.0094
Epoch 448/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.7574e-04 - mean_absolute_error: 0.
0094
Epoch 449/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.7559e-04 - mean_absolute_error:
0.0094
Epoch 450/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.7497e-04 - mean_absolute_error:
0.0093
Epoch 451/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7482e-04 - mean_absolute_error: 0.
0093
Epoch 452/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 26ms/step - loss: 1.7474e-04 - mean_absolute_error:
0.0093
Epoch 453/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7450e-04 - mean_absolute_error: 0.
0093
Epoch 454/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.7426e-04 - mean_absolute_error:
0.0093
Epoch 455/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.7437e-04 - mean_absolute_error: 0.0
093
Epoch 456/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7423e-04 - mean_absolute_error:
0.0093
Epoch 457/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7372e-04 - mean_absolute_error:
0.0093
Epoch 458/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7342e-04 - mean_absolute_error: 0.
0093
Epoch 459/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.7357e-04 - mean_absolute_error: 0.
0093
Epoch 460/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7345e-04 - mean_absolute_error: 0.
0093
Epoch 461/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7274e-04 - mean_absolute_error:
0.0093
Epoch 462/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.7286e-04 - mean_absolute_error:
0.0093
Epoch 463/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7292e-04 - mean_absolute_error:
0.0093
Epoch 464/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7243e-04 - mean_absolute_error:
0.0093
Epoch 465/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.7234e-04 - mean_absolute_error:
0.0093
```

```
Epoch 466/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.7243e-04 - mean_absolute_error: 0.
0093
Epoch 467/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7212e-04 - mean_absolute_error: 0.
0092
Epoch 468/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.7185e-04 - mean_absolute_error:
0.0092
Epoch 469/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7189e-04 - mean_absolute_error: 0.
0092
Epoch 470/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7168e-04 - mean_absolute_error: 0.
0092
Epoch 471/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7125e-04 - mean_absolute_error: 0.
0092
Epoch 472/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7114e-04 - mean_absolute_error: 0.
0092
Epoch 473/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7125e-04 - mean_absolute_error:
0.0092
Epoch 474/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7114e-04 - mean_absolute_error:
0.0092
Epoch 475/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7067e-04 - mean_absolute_error:
0.0092
Epoch 476/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.7058e-04 - mean_absolute_error: 0.
0092
Epoch 477/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.7039e-04 - mean_absolute_error:
0.0092
Epoch 478/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.7016e-04 - mean_absolute_error: 0.
0092
Epoch 479/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.7022e-04 - mean_absolute_error:
0.0092
Epoch 480/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.7026e-04 - mean_absolute_error:
0.0092
Epoch 481/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6985e-04 - mean_absolute_error: 0.
0092
Epoch 482/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6945e-04 - mean_absolute_error: 0.
0092
Epoch 483/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.6940e-04 - mean_absolute_error: 0.0
092
Epoch 484/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - loss: 1.6928e-04 - mean_absolute_error:
0.0092
Epoch 485/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6919e-04 - mean_absolute_error: 0.
0092
```

```
Epoch 486/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6912e-04 - mean_absolute_error:
0.0092
Epoch 487/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6876e-04 - mean_absolute_error: 0.
0091
Epoch 488/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.6835e-04 - mean_absolute_error:
0.0091
Epoch 489/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6829e-04 - mean_absolute_error: 0.
0091
Epoch 490/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6851e-04 - mean_absolute_error:
0.0091
Epoch 491/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.6816e-04 - mean_absolute_error:
0.0091
Epoch 492/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.6770e-04 - mean_absolute_error: 0.
0091
Epoch 493/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 1.6773e-04 - mean_absolute_error:
0.0091
Epoch 494/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.6767e-04 - mean_absolute_error:
0.0091
Epoch 495/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6735e-04 - mean_absolute_error:
0.0091
Epoch 496/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6749e-04 - mean_absolute_error: 0.
0091
Epoch 497/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.6745e-04 - mean_absolute_error:
0.0091
Epoch 498/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6699e-04 - mean_absolute_error: 0.
0091
Epoch 499/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6685e-04 - mean_absolute_error:
0.0091
Epoch 500/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.6679e-04 - mean_absolute_error:
0.0091
Epoch 501/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6657e-04 - mean_absolute_error:
0.0091
Epoch 502/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.6648e-04 - mean_absolute_error: 0.
0091
Epoch 503/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.6624e-04 - mean_absolute_error:
0.0091
Epoch 504/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6595e-04 - mean_absolute_error:
0.0091
Epoch 505/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6597e-04 - mean_absolute_error: 0.
0091
```

```
Epoch 506/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6585e-04 - mean_absolute_error:
0.0091
Epoch 507/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6561e-04 - mean_absolute_error:
0.0090
Epoch 508/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.6564e-04 - mean_absolute_error:
0.0091
Epoch 509/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6545e-04 - mean_absolute_error: 0.
0090
Epoch 510/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6510e-04 - mean_absolute_error:
0.0090
Epoch 511/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.6515e-04 - mean_absolute_error:
0.0090
Epoch 512/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.6520e-04 - mean_absolute_error: 0.
0090
Epoch 513/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6484e-04 - mean_absolute_error:
0.0090
Epoch 514/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.6453e-04 - mean_absolute_error:
0.0090
Epoch 515/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6462e-04 - mean_absolute_error:
0.0090
Epoch 516/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6466e-04 - mean_absolute_error: 0.
0090
Epoch 517/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6445e-04 - mean_absolute_error: 0.
0090
Epoch 518/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6440e-04 - mean_absolute_error:
0.0090
Epoch 519/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6418e-04 - mean_absolute_error: 0.
0090
Epoch 520/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6376e-04 - mean_absolute_error: 0.
0090
Epoch 521/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6367e-04 - mean_absolute_error:
0.0090
Epoch 522/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6391e-04 - mean_absolute_error:
0.0090
Epoch 523/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.6380e-04 - mean_absolute_error:
0.0090
Epoch 524/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6350e-04 - mean_absolute_error: 0.
0090
Epoch 525/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6325e-04 - mean_absolute_error: 0.
0090
```

```
Epoch 526/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6301e-04 - mean_absolute_error: 0.
0090
Epoch 527/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.6294e-04 - mean_absolute_error: 0.
0090
Epoch 528/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.6315e-04 - mean_absolute_error:
0.0090
Epoch 529/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.6305e-04 - mean_absolute_error:
0.0090
Epoch 530/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6275e-04 - mean_absolute_error:
0.0090
Epoch 531/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6242e-04 - mean_absolute_error: 0.
0089
Epoch 532/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6227e-04 - mean_absolute_error:
0.0089
Epoch 533/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6227e-04 - mean_absolute_error: 0.
0089
Epoch 534/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.6220e-04 - mean_absolute_error:
0.0089
Epoch 535/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.6221e-04 - mean_absolute_error:
0.0089
Epoch 536/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6202e-04 - mean_absolute_error:
0.0089
Epoch 537/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.6167e-04 - mean_absolute_error:
0.0089
Epoch 538/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.6156e-04 - mean_absolute_error:
0.0089
Epoch 539/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6177e-04 - mean_absolute_error: 0.
0089
Epoch 540/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.6152e-04 - mean_absolute_error: 0.
0089
Epoch 541/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.6120e-04 - mean_absolute_error:
0.0089
Epoch 542/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.6135e-04 - mean_absolute_error: 0.
0089
Epoch 543/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.6112e-04 - mean_absolute_error:
0.0089
Epoch 544/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6079e-04 - mean_absolute_error:
0.0089
Epoch 545/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - loss: 1.6103e-04 - mean_absolute_error:
0.0089
```

```
Epoch 546/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.6090e-04 - mean_absolute_error: 0.
0089
Epoch 547/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6048e-04 - mean_absolute_error: 0.
0089
Epoch 548/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.6060e-04 - mean_absolute_error: 0.
0089
Epoch 549/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.6052e-04 - mean_absolute_error:
0.0089
Epoch 550/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.6017e-04 - mean_absolute_error: 0.
0089
Epoch 551/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.6025e-04 - mean_absolute_error:
0.0089
Epoch 552/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.6015e-04 - mean_absolute_error:
0.0089
Epoch 553/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.5984e-04 - mean_absolute_error: 0.
0089
Epoch 554/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5993e-04 - mean_absolute_error: 0.
0089
Epoch 555/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5980e-04 - mean_absolute_error:
0.0089
Epoch 556/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5953e-04 - mean_absolute_error: 0.
0088
Epoch 557/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.5953e-04 - mean_absolute_error:
0.0089
Epoch 558/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.5947e-04 - mean_absolute_error:
0.0089
Epoch 559/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 53ms/step - loss: 1.5940e-04 - mean_absolute_error:
0.0088
Epoch 560/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 46ms/step - loss: 1.5932e-04 - mean_absolute_error:
0.0088
Epoch 561/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.5909e-04 - mean_absolute_error: 0.
0088
Epoch 562/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5881e-04 - mean_absolute_error:
0.0088
Epoch 563/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5882e-04 - mean_absolute_error: 0.
0088
Epoch 564/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5894e-04 - mean_absolute_error: 0.
0088
Epoch 565/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5885e-04 - mean_absolute_error: 0.
0088
```

```
Epoch 566/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5856e-04 - mean_absolute_error: 0.
0088
Epoch 567/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5833e-04 - mean_absolute_error: 0.
0088
Epoch 568/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5833e-04 - mean_absolute_error: 0.
0088
Epoch 569/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.5839e-04 - mean_absolute_error:
0.0088
Epoch 570/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5836e-04 - mean_absolute_error: 0.
0088
Epoch 571/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.5806e-04 - mean_absolute_error:
0.0088
Epoch 572/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5773e-04 - mean_absolute_error: 0.
0088
Epoch 573/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.5771e-04 - mean_absolute_error:
0.0088
Epoch 574/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5785e-04 - mean_absolute_error: 0.
0088
Epoch 575/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5787e-04 - mean_absolute_error:
0.0088
Epoch 576/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5752e-04 - mean_absolute_error: 0.
0088
Epoch 577/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5721e-04 - mean_absolute_error:
0.0088
Epoch 578/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.5719e-04 - mean_absolute_error:
0.0088
Epoch 579/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.5732e-04 - mean_absolute_error:
0.0088
Epoch 580/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5735e-04 - mean_absolute_error:
0.0088
Epoch 581/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.5700e-04 - mean_absolute_error: 0.
0088
Epoch 582/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5671e-04 - mean_absolute_error:
0.0087
Epoch 583/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.5671e-04 - mean_absolute_error:
0.0087
Epoch 584/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5690e-04 - mean_absolute_error:
0.0088
Epoch 585/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.5687e-04 - mean_absolute_error:
0.0087
```

```
Epoch 586/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.5651e-04 - mean_absolute_error: 0.
0087
Epoch 587/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.5624e-04 - mean_absolute_error:
0.0087
Epoch 588/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.5620e-04 - mean_absolute_error:
0.0087
Epoch 589/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 22ms/step - loss: 1.5635e-04 - mean_absolute_error:
0.0087
Epoch 590/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5640e-04 - mean_absolute_error: 0.
0087
Epoch 591/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5602e-04 - mean_absolute_error: 0.
0087
Epoch 592/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5572e-04 - mean_absolute_error: 0.0
087
Epoch 593/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5575e-04 - mean_absolute_error:
0.0087
Epoch 594/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.5591e-04 - mean_absolute_error:
0.0087
Epoch 595/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5591e-04 - mean_absolute_error:
0.0087
Epoch 596/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5556e-04 - mean_absolute_error:
0.0087
Epoch 597/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5525e-04 - mean_absolute_error: 0.
0087
Epoch 598/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.5524e-04 - mean_absolute_error:
0.0087
Epoch 599/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.5545e-04 - mean_absolute_error:
0.0087
Epoch 600/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5545e-04 - mean_absolute_error: 0.0
087
Epoch 601/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5504e-04 - mean_absolute_error:
0.0087
Epoch 602/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5475e-04 - mean_absolute_error: 0.
0087
Epoch 603/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5470e-04 - mean_absolute_error: 0.
0087
Epoch 604/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5487e-04 - mean_absolute_error:
0.0087
Epoch 605/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5489e-04 - mean_absolute_error:
0.0087
```

```
Epoch 606/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5451e-04 - mean_absolute_error:
0.0087
Epoch 607/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5421e-04 - mean_absolute_error: 0.0
086
Epoch 608/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5425e-04 - mean_absolute_error: 0.
0086
Epoch 609/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5443e-04 - mean_absolute_error:
0.0087
Epoch 610/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.5446e-04 - mean_absolute_error:
0.0087
Epoch 611/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5411e-04 - mean_absolute_error:
0.0086
Epoch 612/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5378e-04 - mean_absolute_error: 0.
0086
Epoch 613/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5380e-04 - mean_absolute_error:
0.0086
Epoch 614/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5401e-04 - mean_absolute_error: 0.
0086
Epoch 615/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 1.5382e-04 - mean_absolute_error:
0.0086
Epoch 616/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5354e-04 - mean_absolute_error:
0.0086
Epoch 617/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5365e-04 - mean_absolute_error: 0.
0086
Epoch 618/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 44ms/step - loss: 1.5336e-04 - mean_absolute_error:
0.0086
Epoch 619/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5318e-04 - mean_absolute_error:
0.0086
Epoch 620/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5348e-04 - mean_absolute_error: 0.0
086
Epoch 621/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5336e-04 - mean_absolute_error:
0.0086
Epoch 622/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.5303e-04 - mean_absolute_error: 0.
0086
Epoch 623/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5303e-04 - mean_absolute_error:
0.0086
Epoch 624/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5292e-04 - mean_absolute_error:
0.0086
Epoch 625/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5281e-04 - mean_absolute_error:
0.0086
```

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Epoch 626/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5295e-04 - mean_absolute_error:
0.0086
Epoch 627/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5273e-04 - mean_absolute_error: 0.0
086
Epoch 628/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5250e-04 - mean_absolute_error:
0.0086
Epoch 629/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 50ms/step - loss: 1.5266e-04 - mean_absolute_error:
0.0086
Epoch 630/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5277e-04 - mean_absolute_error:
0.0086
Epoch 631/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 1.5260e-04 - mean_absolute_error:
0.0086
Epoch 632/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5236e-04 - mean_absolute_error:
0.0086
Epoch 633/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.5208e-04 - mean_absolute_error: 0.0
086
Epoch 634/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5205e-04 - mean_absolute_error: 0.
0086
Epoch 635/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5230e-04 - mean_absolute_error: 0.
0086
Epoch 636/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5210e-04 - mean_absolute_error: 0.
0086
Epoch 637/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.5179e-04 - mean_absolute_error:
0.0085
Epoch 638/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5192e-04 - mean_absolute_error:
0.0086
Epoch 639/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.5201e-04 - mean_absolute_error: 0.
0086
Epoch 640/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 24ms/step - loss: 1.5175e-04 - mean_absolute_error:
0.0085
Epoch 641/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5160e-04 - mean_absolute_error: 0.
0085
Epoch 642/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.5172e-04 - mean_absolute_error: 0.
0086
Epoch 643/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.5154e-04 - mean_absolute_error: 0.
0085
Epoch 644/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5134e-04 - mean_absolute_error: 0.
0085
Epoch 645/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5136e-04 - mean_absolute_error:
0.0085
```

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Epoch 646/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5139e-04 - mean_absolute_error:
0.0085
Epoch 647/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.5131e-04 - mean_absolute_error: 0.
0085
Epoch 648/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5117e-04 - mean_absolute_error:
0.0085
Epoch 649/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5106e-04 - mean_absolute_error: 0.
0085
Epoch 650/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5107e-04 - mean_absolute_error:
0.0085
Epoch 651/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5103e-04 - mean_absolute_error: 0.
0085
Epoch 652/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.5085e-04 - mean_absolute_error: 0.
0085
Epoch 653/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.5071e-04 - mean_absolute_error: 0.
0085
Epoch 654/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 62ms/step - loss: 1.5079e-04 - mean_absolute_error:
0.0085
Epoch 655/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5083e-04 - mean_absolute_error:
0.0085
Epoch 656/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5063e-04 - mean_absolute_error: 0.
0085
Epoch 657/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.5045e-04 - mean_absolute_error: 0.
0085
Epoch 658/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.5055e-04 - mean_absolute_error:
0.0085
Epoch 659/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.5050e-04 - mean_absolute_error:
0.0085
Epoch 660/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5029e-04 - mean_absolute_error: 0.
0085
Epoch 661/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.5016e-04 - mean_absolute_error:
0.0085
Epoch 662/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5024e-04 - mean_absolute_error: 0.
0085
Epoch 663/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.5026e-04 - mean_absolute_error:
0.0085
Epoch 664/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.5003e-04 - mean_absolute_error: 0.
0085
Epoch 665/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4987e-04 - mean_absolute_error:
0.0085
```

```
Epoch 666/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4996e-04 - mean_absolute_error:
0.0085
Epoch 667/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4981e-04 - mean_absolute_error: 0.
0085
Epoch 668/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.4971e-04 - mean_absolute_error: 0.
0085
Epoch 669/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 20ms/step - loss: 1.4999e-04 - mean_absolute_error:
0.0085
Epoch 670/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4959e-04 - mean_absolute_error: 0.
0084
Epoch 671/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4920e-04 - mean_absolute_error: 0.
0084
Epoch 672/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.4952e-04 - mean_absolute_error:
0.0085
Epoch 673/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.4959e-04 - mean_absolute_error:
0.0085
Epoch 674/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4941e-04 - mean_absolute_error: 0.
0084
Epoch 675/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4926e-04 - mean_absolute_error: 0.
0084
Epoch 676/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4910e-04 - mean_absolute_error: 0.
0084
Epoch 677/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4908e-04 - mean_absolute_error: 0.
0084
Epoch 678/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4927e-04 - mean_absolute_error: 0.
0084
Epoch 679/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4893e-04 - mean_absolute_error:
0.0084
Epoch 680/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4860e-04 - mean_absolute_error: 0.
0084
Epoch 681/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4877e-04 - mean_absolute_error: 0.
0084
Epoch 682/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4882e-04 - mean_absolute_error: 0.
0084
Epoch 683/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 28ms/step - loss: 1.4888e-04 - mean_absolute_error:
0.0084
Epoch 684/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4889e-04 - mean_absolute_error:
0.0084
Epoch 685/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4851e-04 - mean_absolute_error:
0.0084
```

```
Epoch 686/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4819e-04 - mean_absolute_error:
0.0084
Epoch 687/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4827e-04 - mean_absolute_error: 0.
0084
Epoch 688/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.4845e-04 - mean_absolute_error:
0.0084
Epoch 689/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4849e-04 - mean_absolute_error:
0.0084
Epoch 690/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4844e-04 - mean_absolute_error:
0.0084
Epoch 691/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.4823e-04 - mean_absolute_error:
0.0084
Epoch 692/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4803e-04 - mean_absolute_error:
0.0084
Epoch 693/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4787e-04 - mean_absolute_error:
0.0084
Epoch 694/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4772e-04 - mean_absolute_error:
0.0084
Epoch 695/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4774e-04 - mean_absolute_error:
0.0084
Epoch 696/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4790e-04 - mean_absolute_error:
0.0084
Epoch 697/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4760e-04 - mean_absolute_error:
0.0084
Epoch 698/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.4737e-04 - mean_absolute_error:
0.0084
Epoch 699/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 79ms/step - loss: 1.4759e-04 - mean_absolute_error:
0.0084
Epoch 700/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 50ms/step - loss: 1.4772e-04 - mean_absolute_error:
0.0084
Epoch 701/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4771e-04 - mean_absolute_error: 0.
0084
Epoch 702/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.4733e-04 - mean_absolute_error: 0.
0084
Epoch 703/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.4701e-04 - mean_absolute_error: 0.0
083
Epoch 704/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4714e-04 - mean_absolute_error: 0.
0084
Epoch 705/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4713e-04 - mean_absolute_error:
0.0084
```

```
Epoch 706/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4691e-04 - mean_absolute_error:
0.0083
Epoch 707/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4711e-04 - mean_absolute_error:
0.0084
Epoch 708/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4714e-04 - mean_absolute_error:
0.0083
Epoch 709/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.4674e-04 - mean_absolute_error:
0.0083
Epoch 710/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4664e-04 - mean_absolute_error: 0.
0083
Epoch 711/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4675e-04 - mean_absolute_error: 0.
0083
Epoch 712/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4658e-04 - mean_absolute_error: 0.
0083
Epoch 713/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4671e-04 - mean_absolute_error:
0.0083
Epoch 714/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4654e-04 - mean_absolute_error:
0.0083
Epoch 715/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4611e-04 - mean_absolute_error: 0.
0083
Epoch 716/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4630e-04 - mean_absolute_error:
0.0083
Epoch 717/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - loss: 1.4651e-04 - mean_absolute_error:
0.0083
Epoch 718/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4645e-04 - mean_absolute_error:
0.0083
Epoch 719/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4606e-04 - mean_absolute_error: 0.
0083
Epoch 720/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4583e-04 - mean_absolute_error: 0.
0083
Epoch 721/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4592e-04 - mean_absolute_error: 0.
0083
Epoch 722/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4607e-04 - mean_absolute_error:
0.0083
Epoch 723/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.4618e-04 - mean_absolute_error: 0.0
083
Epoch 724/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4573e-04 - mean_absolute_error:
0.0083
Epoch 725/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4546e-04 - mean_absolute_error: 0.
0083
```

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Epoch 726/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4565e-04 - mean_absolute_error:
0.0083
Epoch 727/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4583e-04 - mean_absolute_error:
0.0083
Epoch 728/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4581e-04 - mean_absolute_error: 0.
0083
Epoch 729/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4540e-04 - mean_absolute_error:
0.0083
Epoch 730/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4511e-04 - mean_absolute_error: 0.
0083
Epoch 731/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4531e-04 - mean_absolute_error:
0.0083
Epoch 732/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.4549e-04 - mean_absolute_error: 0.
0083
Epoch 733/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4547e-04 - mean_absolute_error: 0.
0083
Epoch 734/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4505e-04 - mean_absolute_error:
0.0082
Epoch 735/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4483e-04 - mean_absolute_error:
0.0082
Epoch 736/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 1.4497e-04 - mean_absolute_error:
0.0083
Epoch 737/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4518e-04 - mean_absolute_error:
0.0083
Epoch 738/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4506e-04 - mean_absolute_error:
0.0083
Epoch 739/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.4486e-04 - mean_absolute_error: 0.
0082
Epoch 740/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4477e-04 - mean_absolute_error: 0.
0082
Epoch 741/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4454e-04 - mean_absolute_error:
0.0082
Epoch 742/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4480e-04 - mean_absolute_error: 0.
0082
Epoch 743/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4471e-04 - mean_absolute_error: 0.
0082
Epoch 744/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4426e-04 - mean_absolute_error:
0.0082
Epoch 745/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4462e-04 - mean_absolute_error:
0.0082
```

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Epoch 746/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.4461e-04 - mean_absolute_error: 0.
0082
Epoch 747/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4415e-04 - mean_absolute_error:
0.0082
Epoch 748/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.4454e-04 - mean_absolute_error: 0.
0082
Epoch 749/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4440e-04 - mean_absolute_error:
0.0082
Epoch 750/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4390e-04 - mean_absolute_error: 0.
0082
Epoch 751/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.4441e-04 - mean_absolute_error: 0.
0082
Epoch 752/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4425e-04 - mean_absolute_error: 0.
0082
Epoch 753/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4366e-04 - mean_absolute_error:
0.0082
Epoch 754/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4427e-04 - mean_absolute_error:
0.0082
Epoch 755/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4410e-04 - mean_absolute_error: 0.
0082
Epoch 756/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4344e-04 - mean_absolute_error: 0.
0082
Epoch 757/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4406e-04 - mean_absolute_error:
0.0082
Epoch 758/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4391e-04 - mean_absolute_error:
0.0082
Epoch 759/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4324e-04 - mean_absolute_error:
0.0082
Epoch 760/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4385e-04 - mean_absolute_error:
0.0082
Epoch 761/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4385e-04 - mean_absolute_error:
0.0082
Epoch 762/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4350e-04 - mean_absolute_error:
0.0082
Epoch 763/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4359e-04 - mean_absolute_error:
0.0082
Epoch 764/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4333e-04 - mean_absolute_error:
0.0082
Epoch 765/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4305e-04 - mean_absolute_error:
0.0082
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Epoch 766/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 21ms/step - loss: 1.4334e-04 - mean_absolute_error:
0.0082
Epoch 767/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4352e-04 - mean_absolute_error:
0.0082
Epoch 768/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.4339e-04 - mean_absolute_error:
0.0082
Epoch 769/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.4311e-04 - mean_absolute_error: 0.
0082
Epoch 770/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4297e-04 - mean_absolute_error:
0.0082
Epoch 771/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4294e-04 - mean_absolute_error: 0.
0082
Epoch 772/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 57ms/step - loss: 1.4296e-04 - mean_absolute_error:
0.0082
Epoch 773/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4310e-04 - mean_absolute_error: 0.
0082
Epoch 774/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 39ms/step - loss: 1.4307e-04 - mean_absolute_error:
0.0082
Epoch 775/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4261e-04 - mean_absolute_error: 0.
0082
Epoch 776/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4252e-04 - mean_absolute_error:
0.0082
Epoch 777/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4264e-04 - mean_absolute_error: 0.
0082
Epoch 778/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.4254e-04 - mean_absolute_error:
0.0082
Epoch 779/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4264e-04 - mean_absolute_error:
0.0082
Epoch 780/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.4274e-04 - mean_absolute_error:
0.0082
Epoch 781/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4224e-04 - mean_absolute_error:
0.0081
Epoch 782/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4215e-04 - mean_absolute_error:
0.0081
Epoch 783/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4226e-04 - mean_absolute_error:
0.0082
Epoch 784/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 19ms/step - loss: 1.4206e-04 - mean_absolute_error:
0.0082
Epoch 785/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4224e-04 - mean_absolute_error:
0.0082
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Epoch 786/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4235e-04 - mean_absolute_error:
0.0082
Epoch 787/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.4178e-04 - mean_absolute_error:
0.0081
Epoch 788/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4173e-04 - mean_absolute_error: 0.
0081
Epoch 789/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4189e-04 - mean_absolute_error: 0.
0081
Epoch 790/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4158e-04 - mean_absolute_error: 0.
0081
Epoch 791/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4178e-04 - mean_absolute_error:
0.0081
Epoch 792/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4180e-04 - mean_absolute_error: 0.
0081
Epoch 793/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4142e-04 - mean_absolute_error: 0.
0081
Epoch 794/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4153e-04 - mean_absolute_error: 0.
0081
Epoch 795/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4132e-04 - mean_absolute_error:
0.0081
Epoch 796/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 35ms/step - loss: 1.4114e-04 - mean_absolute_error:
0.0081
Epoch 797/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.4135e-04 - mean_absolute_error: 0.0
081
Epoch 798/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.4133e-04 - mean_absolute_error: 0.
0081
Epoch 799/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4128e-04 - mean_absolute_error: 0.
0081
Epoch 800/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4102e-04 - mean_absolute_error:
0.0081
Epoch 801/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4080e-04 - mean_absolute_error: 0.
0081
Epoch 802/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.4081e-04 - mean_absolute_error: 0.
0081
Epoch 803/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4075e-04 - mean_absolute_error: 0.
0081
Epoch 804/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4091e-04 - mean_absolute_error: 0.
0081
Epoch 805/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.4080e-04 - mean_absolute_error:
0.0081
```

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Epoch 806/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.4047e-04 - mean_absolute_error: 0.
0081
Epoch 807/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4080e-04 - mean_absolute_error:
0.0081
Epoch 808/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.4071e-04 - mean_absolute_error:
0.0081
Epoch 809/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.4019e-04 - mean_absolute_error: 0.
0081
Epoch 810/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.4052e-04 - mean_absolute_error: 0.
0081
Epoch 811/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.4046e-04 - mean_absolute_error: 0.
0081
Epoch 812/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4019e-04 - mean_absolute_error: 0.
0081
Epoch 813/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.4022e-04 - mean_absolute_error:
0.0081
Epoch 814/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.4033e-04 - mean_absolute_error:
0.0081
Epoch 815/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3999e-04 - mean_absolute_error: 0.
0081
Epoch 816/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3988e-04 - mean_absolute_error:
0.0081
Epoch 817/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.4005e-04 - mean_absolute_error: 0.
0081
Epoch 818/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 18ms/step - loss: 1.3989e-04 - mean_absolute_error:
0.0081
Epoch 819/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3977e-04 - mean_absolute_error: 0.
0081
Epoch 820/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.3969e-04 - mean_absolute_error:
0.0081
Epoch 821/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3984e-04 - mean_absolute_error:
0.0081
Epoch 822/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3963e-04 - mean_absolute_error:
0.0081
Epoch 823/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3937e-04 - mean_absolute_error:
0.0080
Epoch 824/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3959e-04 - mean_absolute_error:
0.0081
Epoch 825/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3957e-04 - mean_absolute_error:
0.0081
```

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Epoch 826/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 23ms/step - loss: 1.3940e-04 - mean_absolute_error:
0.0081
Epoch 827/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - loss: 1.3934e-04 - mean_absolute_error:
0.0081
Epoch 828/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3954e-04 - mean_absolute_error: 0.
0081
Epoch 829/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3924e-04 - mean_absolute_error:
0.0080
Epoch 830/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3905e-04 - mean_absolute_error: 0.
0080
Epoch 831/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3934e-04 - mean_absolute_error:
0.0081
Epoch 832/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3924e-04 - mean_absolute_error:
0.0081
Epoch 833/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3909e-04 - mean_absolute_error:
0.0080
Epoch 834/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3900e-04 - mean_absolute_error:
0.0080
Epoch 835/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3908e-04 - mean_absolute_error: 0.
0080
Epoch 836/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3909e-04 - mean_absolute_error:
0.0080
Epoch 837/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3896e-04 - mean_absolute_error:
0.0080
Epoch 838/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3871e-04 - mean_absolute_error: 0.
0080
Epoch 839/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3894e-04 - mean_absolute_error:
0.0080
Epoch 840/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3875e-04 - mean_absolute_error: 0.
0080
Epoch 841/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3846e-04 - mean_absolute_error:
0.0080
Epoch 842/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3879e-04 - mean_absolute_error:
0.0080
Epoch 843/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3871e-04 - mean_absolute_error:
0.0080
Epoch 844/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3852e-04 - mean_absolute_error:
0.0080
Epoch 845/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3850e-04 - mean_absolute_error: 0.
0080
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```
Epoch 846/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3855e-04 - mean_absolute_error:
0.0080
Epoch 847/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3851e-04 - mean_absolute_error: 0.
0080
Epoch 848/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3869e-04 - mean_absolute_error: 0.
0080
Epoch 849/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3826e-04 - mean_absolute_error: 0.0
080
Epoch 850/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 16ms/step - loss: 1.3803e-04 - mean_absolute_error:
0.0080
Epoch 851/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3818e-04 - mean_absolute_error:
0.0080
Epoch 852/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3807e-04 - mean_absolute_error: 0.
0080
Epoch 853/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3837e-04 - mean_absolute_error:
0.0080
Epoch 854/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - loss: 1.3826e-04 - mean_absolute_error:
0.0080
Epoch 855/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3787e-04 - mean_absolute_error:
0.0080
Epoch 856/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3836e-04 - mean_absolute_error:
0.0080
Epoch 857/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3810e-04 - mean_absolute_error: 0.
0080
Epoch 858/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3755e-04 - mean_absolute_error: 0.
0080
Epoch 859/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3798e-04 - mean_absolute_error:
0.0080
Epoch 860/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3792e-04 - mean_absolute_error:
0.0080
Epoch 861/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - loss: 1.3774e-04 - mean_absolute_error:
0.0080
Epoch 862/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3781e-04 - mean_absolute_error:
0.0080
Epoch 863/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3779e-04 - mean_absolute_error: 0.
0080
Epoch 864/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3780e-04 - mean_absolute_error:
0.0080
Epoch 865/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3782e-04 - mean_absolute_error: 0.
0080
```

```
Epoch 866/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3738e-04 - mean_absolute_error:
0.0080
Epoch 867/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3757e-04 - mean_absolute_error:
0.0080
Epoch 868/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3771e-04 - mean_absolute_error:
0.0080
Epoch 869/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3746e-04 - mean_absolute_error:
0.0080
Epoch 870/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.3727e-04 - mean_absolute_error: 0.
0080
Epoch 871/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3741e-04 - mean_absolute_error: 0.0
080
Epoch 872/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3740e-04 - mean_absolute_error:
0.0080
Epoch 873/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.3735e-04 - mean_absolute_error:
0.0080
Epoch 874/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3707e-04 - mean_absolute_error:
0.0080
Epoch 875/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3729e-04 - mean_absolute_error: 0.
0080
Epoch 876/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.3712e-04 - mean_absolute_error:
0.0080
Epoch 877/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3688e-04 - mean_absolute_error: 0.
0079
Epoch 878/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3712e-04 - mean_absolute_error: 0.
0080
Epoch 879/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3702e-04 - mean_absolute_error: 0.
0080
Epoch 880/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3714e-04 - mean_absolute_error: 0.
0080
Epoch 881/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3739e-04 - mean_absolute_error:
0.0080
Epoch 882/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3669e-04 - mean_absolute_error:
0.0079
Epoch 883/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3666e-04 - mean_absolute_error:
0.0079
Epoch 884/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 35ms/step - loss: 1.3680e-04 - mean_absolute_error:
0.0080
Epoch 885/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3653e-04 - mean_absolute_error: 0.
0079
```

```
Epoch 886/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3700e-04 - mean_absolute_error: 0.
0080
Epoch 887/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3711e-04 - mean_absolute_error: 0.
0080
Epoch 888/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3680e-04 - mean_absolute_error:
0.0079
Epoch 889/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3668e-04 - mean_absolute_error: 0.
0079
Epoch 890/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3647e-04 - mean_absolute_error: 0.0
079
Epoch 891/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3631e-04 - mean_absolute_error: 0.
0079
Epoch 892/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3632e-04 - mean_absolute_error:
0.0079
Epoch 893/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3657e-04 - mean_absolute_error: 0.
0079
Epoch 894/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3668e-04 - mean_absolute_error: 0.
0079
Epoch 895/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3665e-04 - mean_absolute_error: 0.
0079
Epoch 896/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3629e-04 - mean_absolute_error: 0.
0079
Epoch 897/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3619e-04 - mean_absolute_error:
0.0079
Epoch 898/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3617e-04 - mean_absolute_error:
0.0079
Epoch 899/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3597e-04 - mean_absolute_error:
0.0079
Epoch 900/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3630e-04 - mean_absolute_error:
0.0079
Epoch 901/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3639e-04 - mean_absolute_error:
0.0079
Epoch 902/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3628e-04 - mean_absolute_error: 0.
0079
Epoch 903/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3606e-04 - mean_absolute_error:
0.0079
Epoch 904/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3589e-04 - mean_absolute_error: 0.
0079
Epoch 905/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3579e-04 - mean_absolute_error: 0.
0079
```

```
Epoch 906/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 34ms/step - loss: 1.3573e-04 - mean_absolute_error:
0.0079
Epoch 907/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3600e-04 - mean_absolute_error: 0.
0079
Epoch 908/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3613e-04 - mean_absolute_error:
0.0079
Epoch 909/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 64ms/step - loss: 1.3604e-04 - mean_absolute_error:
0.0079
Epoch 910/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3572e-04 - mean_absolute_error:
0.0079
Epoch 911/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3561e-04 - mean_absolute_error:
0.0079
Epoch 912/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3551e-04 - mean_absolute_error:
0.0079
Epoch 913/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3538e-04 - mean_absolute_error: 0.
0079
Epoch 914/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3568e-04 - mean_absolute_error:
0.0079
Epoch 915/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3577e-04 - mean_absolute_error: 0.
0079
Epoch 916/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3571e-04 - mean_absolute_error:
0.0079
Epoch 917/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3545e-04 - mean_absolute_error: 0.
0079
Epoch 918/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 1.3529e-04 - mean_absolute_error: 0.
0079
Epoch 919/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3521e-04 - mean_absolute_error: 0.
0079
Epoch 920/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3510e-04 - mean_absolute_error:
0.0079
Epoch 921/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3536e-04 - mean_absolute_error: 0.
0079
Epoch 922/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3545e-04 - mean_absolute_error: 0.
0079
Epoch 923/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 811us/step - loss: 1.3542e-04 - mean_absolute_error:
0.0079
Epoch 924/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3520e-04 - mean_absolute_error: 0.
0079
Epoch 925/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.3500e-04 - mean_absolute_error: 0.
0079
```

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Epoch 926/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 14ms/step - loss: 1.3488e-04 - mean_absolute_error:
0.0079
Epoch 927/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3481e-04 - mean_absolute_error:
0.0079
Epoch 928/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 13ms/step - loss: 1.3507e-04 - mean_absolute_error:
0.0079
Epoch 929/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3517e-04 - mean_absolute_error: 0.
0079
Epoch 930/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 37ms/step - loss: 1.3499e-04 - mean_absolute_error:
0.0079
Epoch 931/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3489e-04 - mean_absolute_error: 0.
0079
Epoch 932/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3504e-04 - mean_absolute_error:
0.0079
Epoch 933/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3491e-04 - mean_absolute_error: 0.
0079
Epoch 934/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3471e-04 - mean_absolute_error: 0.
0079
Epoch 935/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3448e-04 - mean_absolute_error:
0.0078
Epoch 936/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3453e-04 - mean_absolute_error:
0.0079
Epoch 937/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3461e-04 - mean_absolute_error:
0.0079
Epoch 938/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3480e-04 - mean_absolute_error: 0.
0079
Epoch 939/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3457e-04 - mean_absolute_error: 0.
0078
Epoch 940/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3422e-04 - mean_absolute_error:
0.0078
Epoch 941/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3445e-04 - mean_absolute_error: 0.0
078
Epoch 942/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3447e-04 - mean_absolute_error:
0.0078
Epoch 943/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3414e-04 - mean_absolute_error: 0.
0078
Epoch 944/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3397e-04 - mean_absolute_error: 0.
0078
Epoch 945/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3403e-04 - mean_absolute_error: 0.
0078
```

```
Epoch 946/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.3411e-04 - mean_absolute_error: 0.
0078
Epoch 947/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3432e-04 - mean_absolute_error: 0.
0078
Epoch 948/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - loss: 1.3398e-04 - mean_absolute_error: 0.
0078
Epoch 949/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3372e-04 - mean_absolute_error:
0.0078
Epoch 950/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3403e-04 - mean_absolute_error: 0.
0078
Epoch 951/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 70ms/step - loss: 1.3397e-04 - mean_absolute_error:
0.0078
Epoch 952/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3369e-04 - mean_absolute_error: 0.
0078
Epoch 953/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3355e-04 - mean_absolute_error: 0.
0078
Epoch 954/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3360e-04 - mean_absolute_error: 0.
0078
Epoch 955/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3370e-04 - mean_absolute_error: 0.
0078
Epoch 956/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3387e-04 - mean_absolute_error:
0.0078
Epoch 957/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3353e-04 - mean_absolute_error: 0.
0078
Epoch 958/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3330e-04 - mean_absolute_error: 0.
0078
Epoch 959/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3355e-04 - mean_absolute_error: 0.
0078
Epoch 960/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3355e-04 - mean_absolute_error:
0.0078
Epoch 961/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3329e-04 - mean_absolute_error: 0.
0078
Epoch 962/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3314e-04 - mean_absolute_error: 0.
0078
Epoch 963/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - loss: 1.3324e-04 - mean_absolute_error: 0.
0078
Epoch 964/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3338e-04 - mean_absolute_error: 0.
0078
Epoch 965/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3349e-04 - mean_absolute_error:
0.0078
```

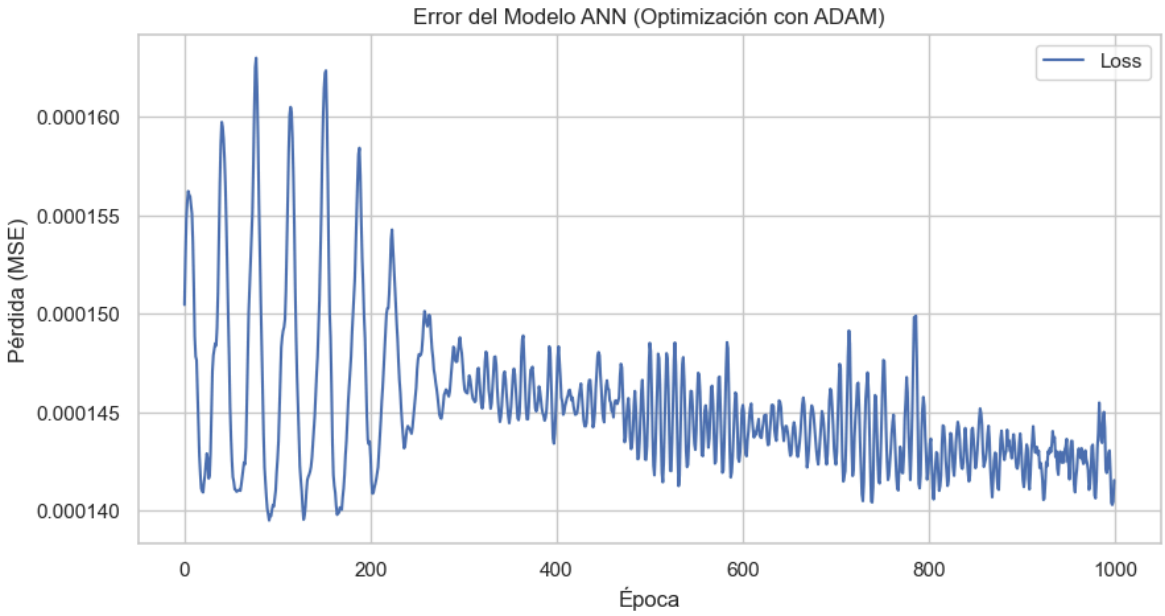
```
Epoch 966/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3320e-04 - mean_absolute_error: 0.
0078
Epoch 967/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3295e-04 - mean_absolute_error:
0.0078
Epoch 968/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3325e-04 - mean_absolute_error: 0.
0078
Epoch 969/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 30ms/step - loss: 1.3311e-04 - mean_absolute_error:
0.0078
Epoch 970/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 15ms/step - loss: 1.3326e-04 - mean_absolute_error:
0.0078
Epoch 971/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3308e-04 - mean_absolute_error:
0.0078
Epoch 972/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3273e-04 - mean_absolute_error:
0.0078
Epoch 973/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3313e-04 - mean_absolute_error:
0.0078
Epoch 974/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3304e-04 - mean_absolute_error: 0.
0078
Epoch 975/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3277e-04 - mean_absolute_error: 0.0
078
Epoch 976/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3277e-04 - mean_absolute_error: 0.
0078
Epoch 977/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3274e-04 - mean_absolute_error: 0.
0078
Epoch 978/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3286e-04 - mean_absolute_error: 0.
0078
Epoch 979/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3308e-04 - mean_absolute_error:
0.0078
Epoch 980/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3264e-04 - mean_absolute_error: 0.0
078
Epoch 981/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 1.3251e-04 - mean_absolute_error: 0.
0078
Epoch 982/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3275e-04 - mean_absolute_error: 0.
0078
Epoch 983/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3264e-04 - mean_absolute_error: 0.
0078
Epoch 984/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 1.3248e-04 - mean_absolute_error:
0.0077
Epoch 985/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.3231e-04 - mean_absolute_error:
0.0077
```

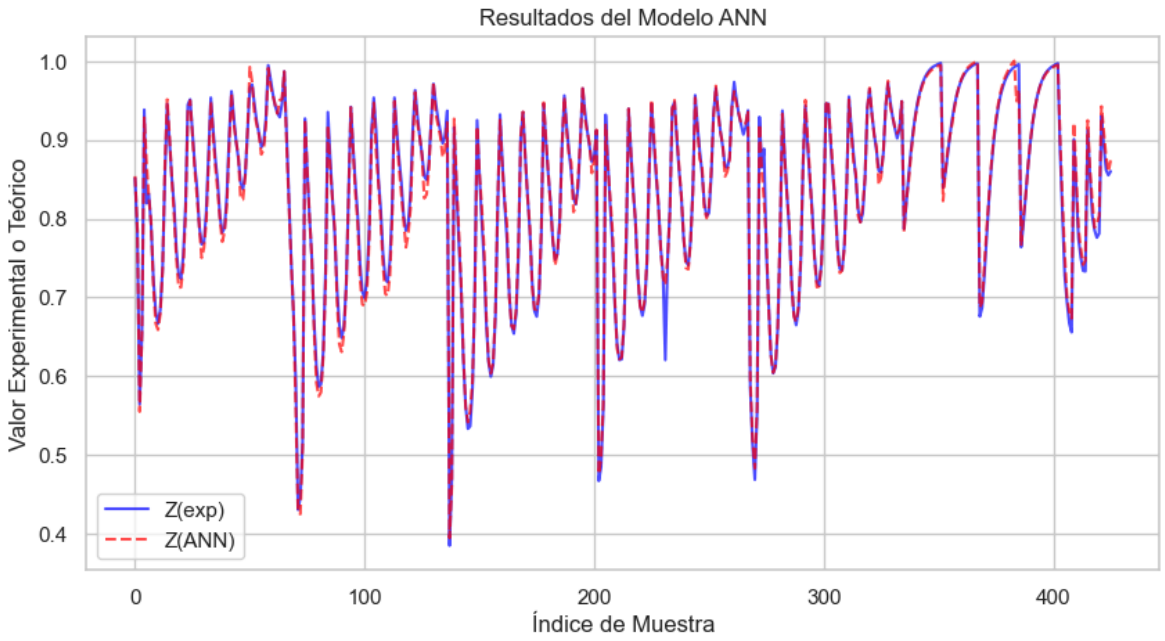
```
Epoch 986/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3242e-04 - mean_absolute_error: 0.
0078
Epoch 987/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 47ms/step - loss: 1.3250e-04 - mean_absolute_error:
0.0078
Epoch 988/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3261e-04 - mean_absolute_error: 0.
0078
Epoch 989/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3232e-04 - mean_absolute_error: 0.
0077
Epoch 990/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 1.3209e-04 - mean_absolute_error: 0.
0077
Epoch 991/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 1.3232e-04 - mean_absolute_error: 0.
0077
Epoch 992/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3222e-04 - mean_absolute_error: 0.
0077
Epoch 993/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3197e-04 - mean_absolute_error: 0.
0077
Epoch 994/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3181e-04 - mean_absolute_error: 0.
0077
Epoch 995/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - loss: 1.3190e-04 - mean_absolute_error: 0.
0077
Epoch 996/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3196e-04 - mean_absolute_error: 0.
0077
Epoch 997/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 1.3214e-04 - mean_absolute_error:
0.0077
Epoch 998/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - loss: 1.3179e-04 - mean_absolute_error: 0.0
077
Epoch 999/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 1.3152e-04 - mean_absolute_error: 0.
0077
Epoch 1000/1000
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step - loss: 1.3178e-04 - mean_absolute_error:
0.0077
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step
Predicciones finalizadas
```

In [89]:

```python
# Graficar el error del entrenamiento ANN (historia de entrenamiento)
plt.figure(figsize=(10, 5))
plt.plot(history.history['loss'], label='Loss')
plt.xlabel('Época')
plt.ylabel('Pérdida (MSE)')
plt.title('Error del Modelo ANN (Optimización con ADAM)')
plt.legend()
plt.show()

# Mostrar los resultados del modelo ANN comparados con Z(exp)
plt.figure(figsize=(10, 5))
plt.plot(data['Z(exp)'], label='Z(exp)', color='blue', linestyle='-', alpha=0.7)
```

```
plt.plot(data['Z(ANN)'], label='Z(ANN)', color='red', linestyle='--', alpha=0.7)
plt.xlabel('Índice de Muestra')
plt.ylabel('Valor Experimental o Teórico')
plt.title('Resultados del Modelo ANN')
plt.legend()
plt.show()
```





In [90]:
```
data.head()
```

Out[90]:

	Ppr	Tpr	X	Z(exp)	Z(PR)	Z(SRK)	Z(ANN)
0	-0.918927	-1.514769	-0.845877	0.85127	0.831137	0.851514	0.853999
1	-0.758450	-1.514769	-0.651715	0.78334	0.758910	0.785745	0.786481
2	0.495533	-1.514769	0.865487	0.56427	0.553238	0.600779	0.555012
3	1.091028	-1.514769	1.585981	0.65462	0.626810	0.685755	0.652548
4	-1.064584	-0.714518	-1.051493	0.93835	0.925536	0.937494	0.928310

Redes Neuronales Artificiales Difusas (ANFIS)

El modelo ANFIS (Sistema de Inferencia Adaptativa Basado en Redes Neuronales) es óptimo para la predicción del factor de compresibilidad Z debido a su integración de la lógica difusa y las redes neuronales, lo que le permite modelar relaciones no lineales complejas en los datos con mayor precisión. Esta combinación ofrece interpretabilidad a través de reglas difusas que explican la relación entre las variables de entrada P_{pr},T_{pr} y X la salida, facilitando la comprensión del modelo. La lógica difusa es esencial porque captura la incertidumbre e imprecisión de los datos, representando las variables en un espectro continuo y estableciendo reglas de inferencia que reflejan relaciones complejas. Con funciones de membresía que evalúan grados de pertenencia, ANFIS se adapta eficazmente a las variaciones en los datos y permite incorporar conocimiento experto en sus reglas, resultando en predicciones más precisas y confiables. En comparación con modelos tradicionales como ANN, PR y SRK, ANFIS destaca al abordar no solo patrones lineales, sino también interacciones complejas, convirtiéndose en una herramienta poderosa en contextos donde la incertidumbre es significativa.

In [91]:
```
# Definimos los valores estadísticos para poder establecer las funciones de memb
data.describe()
```

Out[91]:

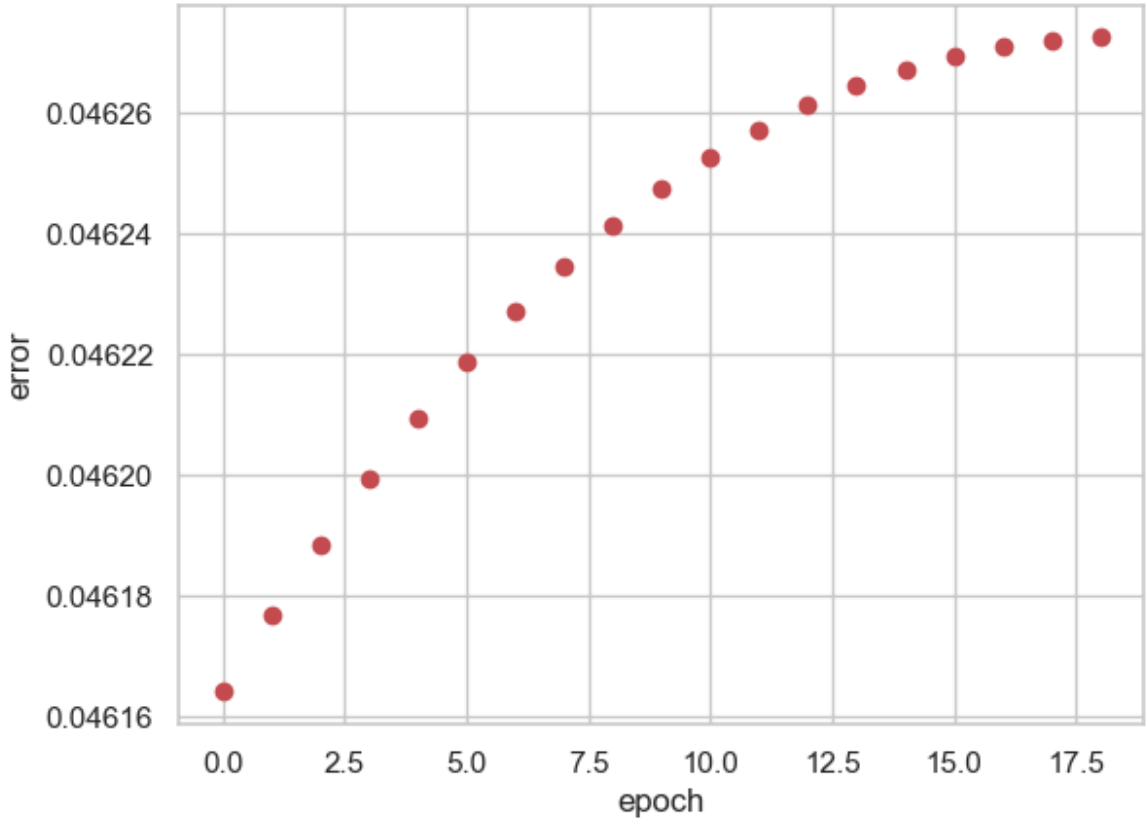
	Ppr	Tpr	X	Z(exp)	Z(PR)	Z(SRK)
count	4.260000e+02	4.260000e+02	4.260000e+02	426.000000	426.000000	426.000000
mean	1.167558e-16	-9.173674e-16	1.334353e-16	0.830186	0.812970	0.848090
std	1.001176e+00	1.001176e+00	1.001176e+00	0.120819	0.120516	0.112477
min	-1.293167e+00	-2.175385e+00	-1.302035e+00	0.385000	0.380997	0.417298
25%	-8.052580e-01	-6.524621e-01	-8.089775e-01	0.752370	0.734174	0.782861
50%	-2.380152e-01	-4.924795e-02	-2.894237e-01	0.854520	0.831778	0.869998
75%	5.848586e-01	5.698793e-01	6.286379e-01	0.927115	0.906826	0.936520
max	2.908447e+00	2.485878e+00	2.921182e+00	0.997580	0.996806	1.024800

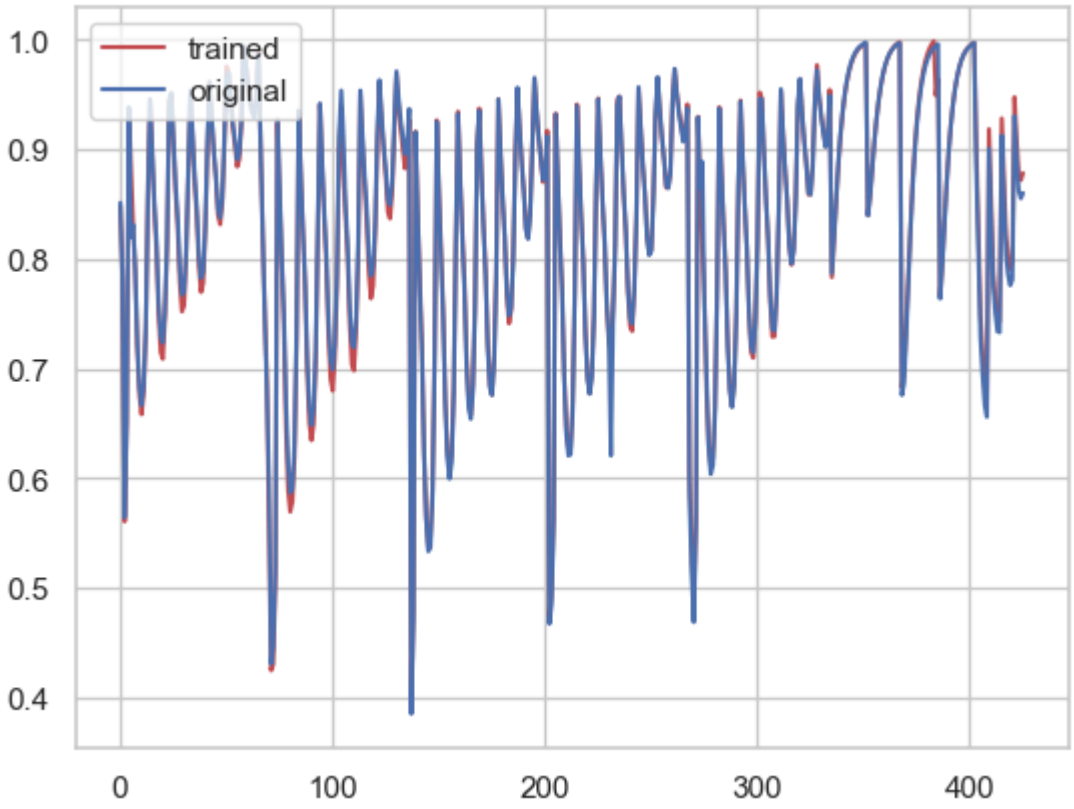
In [92]:
```
# RED NEURONAL ARTIFICAL DIFUSA(ANFIS)
#Importación de la libreria anfis(modificada debido a la presencia de errores)
#Ref: https://github.com/twmeggs/anfis
import sys
sys.path.append("..")
import anfis_ejm as anfys

# Seleccionar las primeras tres columnas como entradas (Ppr, Tpr, X)
X = data.iloc[:, 0:3].values
# Seleccionar la cuarta columna como salida (Z_exp)
Y = data.iloc[:, 3].values

# Diseñar las funciones de membresía especificando la media y sigma
mf = [
    [['gaussmf', {'mean': 1, 'sigma': 0.5}],   # Función para Ppr
```

```
     ['gaussmf', {'mean': 0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': 0, 'sigma': 0.5}],
     ['gaussmf', {'mean': -0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': -1, 'sigma': 0.5}]],

    [['gaussmf', {'mean': 1, 'sigma': 0.5}],   # Función para Tpr
     ['gaussmf', {'mean': 0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': 0, 'sigma': 0.5}],
     ['gaussmf', {'mean': -0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': -1, 'sigma': 0.5}]],

    [['gaussmf', {'mean': 1, 'sigma': 0.5}],   # Función para X
     ['gaussmf', {'mean': 0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': 0, 'sigma': 0.5}],
     ['gaussmf', {'mean': -0.5, 'sigma': 0.5}],
     ['gaussmf', {'mean': -1, 'sigma': 0.5}]]
]

# Crear un objeto para las funciones de membresía
mfc = anfys.MemFuncs(mf)

# Crear un objeto ANFIS
anf = anfys.ANFIS(X, Y, mfc)

# Método de entrenamiento híbrido fuera de línea
print("Entrenando el modelo ANFIS...")
Pred = anf.trainHybridJangOffLine(epochs=20)
print("Entrenamiento completo.")

#Agregar predicciones al DataFrame
data['Z(ANFIS)'] = Pred
```

```
Entrenando el modelo ANFIS...
current error:  0.04616408090081334
current error:  0.04617677371347302
current error:  0.04618858842765071
current error:  0.046199515710508676
current error:  0.04620956062860439
current error:  0.04621873965429193
current error:  0.04622707772609749
current error:  0.04623460547048351
current error:  0.046241356674300724
current error:  0.04624736607665959
current error:  0.04625266752686934
current error:  0.046257292532819655
current error:  0.0462612692028471
current error:  0.04626462156481703
current error:  0.04626736923012219
current error:  0.0462695273577654
current error:  0.0462711068654446
current error:  0.046272114830179414
current error:  0.04627255502050972
Entrenamiento completo.
```

In [93]:
```
# Graficar el error del modelo
anf.plotErrors()
# Mostrando los resultados
anf.plotResults()
```





In [94]:
```
data.head()
```

Out[94]:

	Ppr	Tpr	X	Z(exp)	Z(PR)	Z(SRK)	Z(ANN)	Z(ANFIS)
0	-0.918927	-1.514769	-0.845877	0.85127	0.831137	0.851514	0.853999	0.848266
1	-0.758450	-1.514769	-0.651715	0.78334	0.758910	0.785745	0.786481	0.780725
2	0.495533	-1.514769	0.865487	0.56427	0.553238	0.600779	0.555012	0.560475
3	1.091028	-1.514769	1.585981	0.65462	0.626810	0.685755	0.652548	0.649682
4	-1.064584	-0.714518	-1.051493	0.93835	0.925536	0.937494	0.928310	0.937233

Gráficas de Comparación de los modelos respecto a los valores teóricos

Las gráficas de comparación de los modelos respecto a los valores teóricos se utilizan para evaluar visualmente la precisión y la validez de distintos modelos predictivos en relación con los valores experimentales o teóricos. En el contexto de la predicción del factor de compresibilidad Z, estas gráficas permiten comparar cómo se comportan los diferentes métodos (en este caso, los modelos PR, SRK, ANN y ANFIS) en su capacidad para replicar los datos observados. Estas gráficas nos proporcionan una forma efectiva de identificar patrones y discrepancias entre las predicciones y los datos reales. Al incluir una línea de referencia (generalmente la línea de identidad $y = x$), se puede ver cuán cerca están las predicciones de los valores esperados. Además, calcular y mostrar el coeficiente de determinación R^2 nos ayuda a cuantificar la correlación y el ajuste entre los valores predichos y los experimentales, proporcionando una medida objetiva del rendimiento del modelo. En resumen, estas gráficas son esenciales para comparar la eficacia de los modelos y tomar decisiones fundamentadas sobre cuál de ellos se desempeña mejor en términos de precisión y consistencia.

In [95]:
```
# Estableciendo el estilo de las gráficas
sns.set_theme(style='whitegrid')

# Creando un gráfico de dispersión para cada método en relación a 'Z(exp)'
plt.figure(figsize=(16, 12))

# Función para calcular y mostrar R^2 en los gráficos
def plot_with_r2(ax, x, y, title, xlabel, ylabel):
    # Calcular la regresión lineal
    slope, intercept, r_value, _, _ = linregress(x, y)
    r_squared = r_value**2

    # Crear el gráfico de dispersión
    sns.scatterplot(x=x, y=y, ax=ax)
    ax.set_title(title)
    ax.set_xlabel(xlabel)
    ax.set_ylabel(ylabel)

    # Añadir línea de regresión
    ax.plot(x, slope * x + intercept, color='red', linestyle='--')

    # Mostrar el valor de R^2
    ax.text(0.05, 0.95, f'$R^2 = {r_squared:.4f}$', transform=ax.transAxes, font
```

```python
# Gráficando para Z(PR)
ax1 = plt.subplot(2, 2, 1)
plot_with_r2(ax1, data['Z(exp)'], data['Z(PR)'], 'Correlación entre Z(exp) y Z(P

# Gráficando para Z(SRK)
ax2 = plt.subplot(2, 2, 2)
plot_with_r2(ax2, data['Z(exp)'], data['Z(SRK)'], 'Correlación entre Z(exp) y Z(

# Gráficando para Z(ANN)
ax3 = plt.subplot(2, 2, 3)
plot_with_r2(ax3, data['Z(exp)'], data['Z(ANN)'], 'Correlación entre Z(exp) y Z(

# Gráficando para Z(ANFIS)
ax4 = plt.subplot(2, 2, 4)
plot_with_r2(ax4, data['Z(exp)'], data['Z(ANFIS)'], 'Correlación entre Z(exp) y

# Ajustando el layout
plt.tight_layout()
plt.show()
```