In [1]:
```
import pandas as pd
import numpy as np
from  math import *
from scipy.interpolate import interp1d

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter
import warnings
warnings.filterwarnings("ignore")
from sklearn.preprocessing import PowerTransformer
from sklearn.model_selection import GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn import neighbors
from sklearn.metrics import classification_report,confusion_matrix
from sklearn.model_selection import cross_val_score
import scipy.stats as stat
import pylab
from sklearn.model_selection import train_test_split, StratifiedKFold, GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier, VotingClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score
from sklearn.metrics import f1_score
from sklearn.metrics import classification_report
from sklearn.metrics import accuracy_score, roc_auc_score, recall_score, precision_score, confusion_matrix, f1_score, precision_rec
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import PowerTransformer
from sklearn.model_selection import GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn import neighbors
from sklearn.metrics import classification_report,confusion_matrix
from sklearn.model_selection import cross_val_score
from sklearn.preprocessing import PowerTransformer
from sklearn.model_selection import GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
```

```
from sklearn import neighbors
from sklearn.metrics import classification_report,confusion_matrix,plot_confusion_matrix
from sklearn.model_selection import cross_val_score
```

In [2]:
```
import numpy as np
import pandas as pd
from keras.models import Sequential
from keras.layers import LSTM, RepeatVector, TimeDistributed, Dense
from keras.optimizers import RMSprop
from sklearn.metrics import r2_score
```

In [26]:
```
import numpy as np
import pandas as pd
from keras.models import Sequential
from keras.layers import LSTM, RepeatVector, TimeDistributed, Dense
from keras.optimizers import RMSprop
from sklearn.metrics import r2_score
```

Different amplitude in chirp in different voltage

In [123]:
```
x1 = pd.read_csv('signal2.csv')[:-1]
x2 = pd.read_csv('signal2.5.csv')[:-1]
x3 = pd.read_csv('signal3.csv')[:-1]
x4 = pd.read_csv('signal3.5.csv')[:-1]
x5 = pd.read_csv('signal4.csv')[:-1]
```

In [124]:
```
dup = x2
```

In [28]:
```
x1 = np.concatenate((x1,x1,x1,x1,x1,x1,x1), axis = 0)
x2 = np.concatenate((x2,x2,x2,x2,x2,x2,x2), axis = 0)
x3 = np.concatenate((x3,x3,x3,x3,x3,x3,x3), axis = 0)
x4 = np.concatenate((x4,x4,x4,x4,x4,x4,x4), axis = 0)
x5 = np.concatenate((x5,x5,x5,x5,x5,x5,x5), axis = 0)
```

In [48]:
```
amps0 = np.array([0]*10000)
amps1 =np.array([0.5]*10000)
amps2 =np.array([1]*10000)
amps3 = np.array([1.5]*10000)
amps4 = np.array([2]*10000)
```

```
amps5 = np.array([2.5]*10000)
amps6 = np.array([3]*10000)
```

In [49]:
```
y2 = np.concatenate((amps0 , amps1,amps2 ,amps3 , amps4 , amps5 , amps6) )
```

In [117]:
```
t= pd.read_csv('time.csv')[:-1]
```

In [118]:
```
dt = t
```

The time for only one voltage

In [36]:
```
t = np.concatenate((t,t,t,t,t,t ,t))
```

time ready

In [52]:
```
t = np.concatenate((t,t,t,t,t) , axis=  0)
```

chirp ready

In [45]:
```
X = np.concatenate((x1, x2,x3,x4,x5) , axis= 0 )
```

current ready

In [50]:
```
y2 = np.concatenate((y2,y2,y2,y2,y2) , axis = 0 )
```

altitude ready excitation

In [54]:
```
alt1 = np.array([1.25]*70000)
alt2 =np.array([1.5]*70000)
alt3 =np.array([1.75]*70000)
alt4= np.array([2]*70000)
alt5 = np.array([2.25]*70000)
```

```
alt= np.concatenate((alt1 , alt2 , alt3 , alt4 , alt5 ) , axis = 0 )
```

Voltage ready

In [57]:
```
vol1 = np.array([2]*70000)
vol2 =np.array([2.5]*70000)
vol3 =np.array([3]*70000)
vol4= np.array([3.5]*70000)
vol5 = np.array([4]*70000)
```

In [58]:
```
vol= np.concatenate((vol1 , vol2 , vol3 , vol4 , vol5 ) , axis = 0 )
```

In [119]:
```
dv = np.array([2.5]*10000)
```

In [61]:
```
scores = (np.array(np.concatenate(( X.reshape(-1,1), y2.reshape(-1,1) , t.reshape(-1,1) , alt.reshape(-1,1) , vol.reshape(-1,1)) ,
X= pd.DataFrame(scores,columns=['chirp' ,'amps' , 'time' , 'altitude' , 'voltage'])
```

X ready

In [62]:
```
X
```

Out[62]:

	chirp	amps	time	altitude	voltage
0	0.000000	0.0	0.000	1.25	2.0
1	0.117657	0.0	0.001	1.25	2.0
2	0.234312	0.0	0.002	1.25	2.0
3	0.348926	0.0	0.003	1.25	2.0
4	0.460477	0.0	0.004	1.25	2.0
...	...	...	...	...	...
349995	-1.820859	3.0	9.995	2.25	4.0
349996	-2.210263	3.0	9.996	2.25	4.0
349997	-2.179225	3.0	9.997	2.25	4.0
349998	-1.733556	3.0	9.998	2.25	4.0
349999	-0.957968	3.0	9.999	2.25	4.0

350000 rows × 5 columns

y ready

In [78]:
```
# 2 voltage different current
df1 = pd.read_csv("0amps2.csv")[:-1]
df2 = pd.read_csv("0.5amps2.csv")[:-1]
df3 = pd.read_csv("1amps2.csv")[:-1]
df4 = pd.read_csv("1.5amps2.csv")[:-1]
df5 = pd.read_csv("2amps2.csv")[:-1]
df6 = pd.read_csv("2.5amps2.csv")[:-1]
df7 =pd.read_csv("3amps2.csv")[:-1]

# 2.5 voltage different current
df8 = pd.read_csv("0amps2.5.csv")[:-1]
df9 = pd.read_csv("0.5amps2.5.csv")[:-1]
df10 = pd.read_csv("1amps2.5.csv")[:-1]
df11 = pd.read_csv("1.5amps2.5.csv")[:-1]
df12 = pd.read_csv("2amps2.5.csv")[:-1]
df13 = pd.read_csv("2.5amps2.5.csv")[:-1]
```

```
df14 =pd.read_csv("3amps2.5.csv")[:-1]

# 3 voltage differrnt current

df15 = pd.read_csv("0amps3.csv")[:-1]
df16 = pd.read_csv("0.5amps3.csv")[:-1]
df17 = pd.read_csv("1amps3.csv")[:-1]
df18 = pd.read_csv("1.5amps3.csv")[:-1]
df19 = pd.read_csv("2amps3.csv")[:-1]
df20 = pd.read_csv("2.5amps3.csv")[:-1]
df21 =pd.read_csv("3amps3.csv")[:-1]


# 3.5 voltage differrent current

df22 = pd.read_csv("0amps3.5.csv")[:-1]
df23= pd.read_csv("0.5amps3.5.csv")[:-1]
df24 = pd.read_csv("1amps3.5.csv")[:-1]
df25 = pd.read_csv("1.5amps3.5.csv")[:-1]
df26 = pd.read_csv("2amps3.5.csv")[:-1]
df27 = pd.read_csv("2.5amps3.5.csv")[:-1]
df28 =pd.read_csv("3amps3.5.csv")[:-1]


# 4 voltage differrnt current

df29 = pd.read_csv("0amps4.csv")[:-1]
df30 = pd.read_csv("0.5amps4.csv")[:-1]
df31 = pd.read_csv("1amps4.csv")[:-1]
df32 = pd.read_csv("1.5amps4.csv")[:-1]
df33 = pd.read_csv("2amps4.csv")[:-1]
df34 = pd.read_csv("2.5amps4.csv")[:-1]
df35 =pd.read_csv("3amps4.csv")[:-1]
```

In [79]:
```
y5 = np.concatenate((df1 , df2 , df3 , df4 , df5 , df6 , df7 , df8 , df9 , df10 ,df11 , df12 , df13 , df14 , df15 , df16 , df17 , d
```

In [80]:
```
y5.
```

Out[80]:
```
(350000, 1)
```

In [81]:
```
run = y5
y= pd.DataFrame(run,columns=['altitude'])
```

In [111]:
```
y
```

Out[111]:

	altitude
0	0.000000
1	0.006286
2	0.026834
3	0.063618
4	0.117734
...	...
349995	1.987184
349996	1.497701
349997	0.723659
349998	-0.187682
349999	-1.062961

350000 rows × 1 columns

In [83]:
```
scaler= StandardScaler()
```

In [84]:
```
from sklearn.model_selection import train_test_split
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers import RepeatVector
from keras.layers import TimeDistributed
```

In [85]:
```
train_size = int(0.6*len(y))
test_size = int(0.2*len(y))
val_size = int(0.2*len(y))
#X = scaler.fit_transform(X)
X_train = X[:-test_size]
X_test = X[train_size:train_size + test_size]
X_val = X[:-val_size]
```

```
y_train = y[:-test_size]
y_test = y[train_size:train_size + test_size]
y_val = y[:-val_size]
```

In [86]:
```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
```

In [87]:
```
lookback = 10
```

In [89]:
```
X_train = np.array(X_train).reshape(-1 , 10 , 5)
```

In [90]:
```
y_train = np.array(y_train).reshape(-1 , 10 , 1)
```

In [91]:
```
X_test = np.array(X_test).reshape(-1 , 10 , 5)
```

In [92]:
```
y_test = np.array(y_test).reshape(-1 , 10 , 1)
```

In [93]:
```
learning_rate = 0.001
```

In [94]:
```
from tensorflow.keras import optimizers
import time
```

In [96]:
```
model = keras.Sequential()
model.add(layers.SimpleRNN(32, input_shape=(lookback, 5), return_sequences=True))
model.add(layers.SimpleRNN(128, return_sequences=True))
model.add(layers.Dense(1))
optimizer = optimizers.Adam(learning_rate=learning_rate)
model.compile(optimizer=optimizer, loss='mse')
```

In [98]:
```
start_time = time.time()
model.fit(X_train, y_train, epochs=1000, batch_size=64)
training_time = time.time() - start_time
```

```
Epoch 1/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.4832
Epoch 2/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.3998
Epoch 3/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.3535
Epoch 4/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.3258
Epoch 5/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.3010
Epoch 6/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2801
Epoch 7/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2650
Epoch 8/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2538
Epoch 9/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2428
Epoch 10/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2339
Epoch 11/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2900
Epoch 12/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2231
Epoch 13/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2184
Epoch 14/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2140
Epoch 15/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2117
Epoch 16/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2069
Epoch 17/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2031
Epoch 18/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.2006
Epoch 19/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.1969
Epoch 20/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.1946
Epoch 21/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.1910
Epoch 22/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.1877
```

```
Epoch 23/1000
438/438 [==============================] - 2s 5ms/step - loss: 0.1855
Epoch 24/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1831
Epoch 25/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1809
Epoch 26/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1784
Epoch 27/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1788
Epoch 28/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1770
Epoch 29/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1759
Epoch 30/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1766
Epoch 31/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1755
Epoch 32/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1747
Epoch 33/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1747
Epoch 34/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1746
Epoch 35/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1736
Epoch 36/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1737
Epoch 37/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1728
Epoch 38/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1731
Epoch 39/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1727
Epoch 40/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1727
Epoch 41/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1718
Epoch 42/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1724
Epoch 43/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1720
Epoch 44/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1724
```

```
Epoch 45/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1727
Epoch 46/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1708
Epoch 47/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1706
Epoch 48/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1711
Epoch 49/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1708
Epoch 50/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1708
Epoch 51/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1707
Epoch 52/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1711
Epoch 53/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1709
Epoch 54/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1704
Epoch 55/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1699
Epoch 56/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1704
Epoch 57/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1696
Epoch 58/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1708
Epoch 59/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1705
Epoch 60/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1693
Epoch 61/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1694
Epoch 62/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1693
Epoch 63/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1696
Epoch 64/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1691
Epoch 65/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1689
Epoch 66/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1687
```

```
Epoch 67/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1693
Epoch 68/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1689
Epoch 69/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1685
Epoch 70/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1690
Epoch 71/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1683
Epoch 72/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1682
Epoch 73/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1687
Epoch 74/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1685
Epoch 75/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1681
Epoch 76/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1682
Epoch 77/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1680
Epoch 78/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1682
Epoch 79/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1676
Epoch 80/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1670
Epoch 81/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1679
Epoch 82/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1681
Epoch 83/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1672
Epoch 84/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1670
Epoch 85/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1669
Epoch 86/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1669
Epoch 87/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1671
Epoch 88/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1671
```

```
Epoch 89/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1673
Epoch 90/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1669
Epoch 91/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1661
Epoch 92/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1665
Epoch 93/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1669
Epoch 94/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1663
Epoch 95/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1664
Epoch 96/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1662
Epoch 97/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1664
Epoch 98/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1660
Epoch 99/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1655
Epoch 100/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1660
Epoch 101/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1663
Epoch 102/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1661
Epoch 103/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1654
Epoch 104/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1654
Epoch 105/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1658
Epoch 106/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1656
Epoch 107/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1652
Epoch 108/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1660
Epoch 109/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1648
Epoch 110/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1651
```

```
Epoch 111/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1655
Epoch 112/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1653
Epoch 113/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1653
Epoch 114/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1647
Epoch 115/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1644
Epoch 116/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1650
Epoch 117/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1645
Epoch 118/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1650
Epoch 119/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1647
Epoch 120/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1648
Epoch 121/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1644
Epoch 122/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1653
Epoch 123/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1636
Epoch 124/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1643
Epoch 125/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1642
Epoch 126/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1641
Epoch 127/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1642
Epoch 128/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1638
Epoch 129/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1639
Epoch 130/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1640
Epoch 131/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1640
Epoch 132/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1636
```

```
Epoch 133/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1633
Epoch 134/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1635
Epoch 135/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1637
Epoch 136/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1638
Epoch 137/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1636
Epoch 138/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1631
Epoch 139/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1632
Epoch 140/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1632
Epoch 141/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1637
Epoch 142/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1628
Epoch 143/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1631
Epoch 144/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1635
Epoch 145/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1626
Epoch 146/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1626
Epoch 147/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1633
Epoch 148/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1628
Epoch 149/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1624
Epoch 150/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1628
Epoch 151/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1626
Epoch 152/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1630
Epoch 153/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1624
Epoch 154/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1625
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Epoch 155/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1626
Epoch 156/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1625
Epoch 157/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1625
Epoch 158/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1622
Epoch 159/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1623
Epoch 160/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1621
Epoch 161/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1618
Epoch 162/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1625
Epoch 163/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1620
Epoch 164/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1619
Epoch 165/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1618
Epoch 166/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1621
Epoch 167/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1617
Epoch 168/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1619
Epoch 169/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1616
Epoch 170/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1617
Epoch 171/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1618
Epoch 172/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1616
Epoch 173/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1618
Epoch 174/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1620
Epoch 175/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
Epoch 176/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
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Epoch 177/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1612
Epoch 178/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1616
Epoch 179/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1614
Epoch 180/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
Epoch 181/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1615
Epoch 182/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1616
Epoch 183/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1613
Epoch 184/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1610
Epoch 185/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
Epoch 186/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1610
Epoch 187/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1608
Epoch 188/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1609
Epoch 189/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
Epoch 190/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 191/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1609
Epoch 192/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 193/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1610
Epoch 194/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1607
Epoch 195/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1611
Epoch 196/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1607
Epoch 197/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1602
Epoch 198/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1609
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Epoch 199/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1606
Epoch 200/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 201/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1605
Epoch 202/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1605
Epoch 203/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 204/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1607
Epoch 205/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1603
Epoch 206/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 207/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1601
Epoch 208/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1599
Epoch 209/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1599
Epoch 210/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1604
Epoch 211/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1600
Epoch 212/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1602
Epoch 213/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1598
Epoch 214/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1598
Epoch 215/1000
438/438 [==============================] - 1s 3ms/step - loss: 0.1601
Epoch 216/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1599
Epoch 217/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1599
Epoch 218/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1597
Epoch 219/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1593
Epoch 220/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1598
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Epoch 221/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1601
Epoch 222/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1596
Epoch 223/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1597
Epoch 224/1000
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Epoch 225/1000
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Epoch 236/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1593
Epoch 237/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1585
Epoch 238/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1592
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Epoch 241/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1588
Epoch 242/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1588
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Epoch 243/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1589
Epoch 244/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1589
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438/438 [==============================] - 1s 2ms/step - loss: 0.1586
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438/438 [==============================] - 1s 2ms/step - loss: 0.1582
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Epoch 265/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1580
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438/438 [==============================] - 1s 2ms/step - loss: 0.1582
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Epoch 286/1000
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Epoch 287/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1574
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Epoch 309/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1565
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Epoch 331/1000
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Epoch 353/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1551
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Epoch 374/1000
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Epoch 375/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1546
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Epoch 397/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1542
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Epoch 419/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1532
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438/438 [==============================] - 1s 2ms/step - loss: 0.1534
Epoch 421/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1531
Epoch 422/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1533
Epoch 423/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1532
Epoch 424/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1534
Epoch 425/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1533
Epoch 426/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1528
Epoch 427/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1531
Epoch 428/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1531
Epoch 429/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1529
Epoch 430/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1532
Epoch 431/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1529
Epoch 432/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1528
Epoch 433/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1529
Epoch 434/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1526
Epoch 435/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1527
Epoch 436/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1524
Epoch 437/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1528
Epoch 438/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1533
Epoch 439/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1530
Epoch 440/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1524
```

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Epoch 441/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1524
Epoch 442/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1524
Epoch 443/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1525
Epoch 444/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1526
Epoch 445/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1527
Epoch 446/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 447/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1525
Epoch 448/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 449/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 450/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1525
Epoch 451/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 452/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1521
Epoch 453/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1521
Epoch 454/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 455/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1522
Epoch 456/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1524
Epoch 457/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1520
Epoch 458/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1523
Epoch 459/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1520
Epoch 460/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1519
Epoch 461/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1520
Epoch 462/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1517
```

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Epoch 463/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1522
Epoch 464/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1520
Epoch 465/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1518
Epoch 466/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1516
Epoch 467/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1517
Epoch 468/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1519
Epoch 469/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1519
Epoch 470/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1517
Epoch 471/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1515
Epoch 472/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1516
Epoch 473/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1518
Epoch 474/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1517
Epoch 475/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1514
Epoch 476/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1514
Epoch 477/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1516
Epoch 478/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1517
Epoch 479/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1518
Epoch 480/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1511
Epoch 481/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1511
Epoch 482/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1512
Epoch 483/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1515
Epoch 484/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1512
```

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Epoch 485/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1514
Epoch 486/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1511
Epoch 487/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1510
Epoch 488/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1510
Epoch 489/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1513
Epoch 490/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1513
Epoch 491/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1512
Epoch 492/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1507
Epoch 493/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1514
Epoch 494/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1508
Epoch 495/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1510
Epoch 496/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1512
Epoch 497/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1511
Epoch 498/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1508
Epoch 499/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1507
Epoch 500/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1506
Epoch 501/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1508
Epoch 502/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1507
Epoch 503/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1509
Epoch 504/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1504
Epoch 505/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1507
Epoch 506/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1504
```

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Epoch 507/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1503
Epoch 508/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1506
Epoch 509/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1510
Epoch 510/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 511/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1507
Epoch 512/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1503
Epoch 513/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1504
Epoch 514/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1506
Epoch 515/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1499
Epoch 516/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1504
Epoch 517/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1505
Epoch 518/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1503
Epoch 519/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1506
Epoch 520/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 521/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1498
Epoch 522/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1501
Epoch 523/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1499
Epoch 524/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 525/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1506
Epoch 526/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1498
Epoch 527/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 528/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1496
```

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Epoch 529/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1500
Epoch 530/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 531/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1498
Epoch 532/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1500
Epoch 533/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1499
Epoch 534/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1502
Epoch 535/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1498
Epoch 536/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1501
Epoch 537/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1495
Epoch 538/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1495
Epoch 539/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1495
Epoch 540/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1497
Epoch 541/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1496
Epoch 542/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1495
Epoch 543/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1496
Epoch 544/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1497
Epoch 545/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 546/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1499
Epoch 547/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1495
Epoch 548/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1496
Epoch 549/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 550/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
```

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Epoch 551/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 552/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1497
Epoch 553/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1490
Epoch 554/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1491
Epoch 555/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 556/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 557/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1492
Epoch 558/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1494
Epoch 559/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1488
Epoch 560/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1488
Epoch 561/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1493
Epoch 562/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1491
Epoch 563/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1487
Epoch 564/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1488
Epoch 565/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1493
Epoch 566/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1487
Epoch 567/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1490
Epoch 568/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1490
Epoch 569/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1491
Epoch 570/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1487
Epoch 571/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1486
Epoch 572/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1484
```

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Epoch 573/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1484
Epoch 574/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1490
Epoch 575/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1485
Epoch 576/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1488
Epoch 577/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1485
Epoch 578/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1485
Epoch 579/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1485
Epoch 580/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1486
Epoch 581/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1484
Epoch 582/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1483
Epoch 583/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1483
Epoch 584/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 585/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1487
Epoch 586/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 587/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1482
Epoch 588/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1483
Epoch 589/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1482
Epoch 590/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 591/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1482
Epoch 592/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1481
Epoch 593/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1479
Epoch 594/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1479
```

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Epoch 595/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1479
Epoch 596/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 597/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1483
Epoch 598/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 599/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1478
Epoch 600/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1477
Epoch 601/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1482
Epoch 602/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1476
Epoch 603/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 604/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1475
Epoch 605/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1478
Epoch 606/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1481
Epoch 607/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 608/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 609/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1475
Epoch 610/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 611/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1475
Epoch 612/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1476
Epoch 613/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1480
Epoch 614/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 615/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1476
Epoch 616/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1471
```

```
Epoch 617/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1471
Epoch 618/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1473
Epoch 619/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 620/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 621/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1471
Epoch 622/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1471
Epoch 623/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1475
Epoch 624/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1470
Epoch 625/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1474
Epoch 626/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1473
Epoch 627/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1473
Epoch 628/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1469
Epoch 629/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1477
Epoch 630/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1471
Epoch 631/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1468
Epoch 632/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1470
Epoch 633/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1468
Epoch 634/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1467
Epoch 635/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1467
Epoch 636/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1468
Epoch 637/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1468
Epoch 638/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1467
```

```
Epoch 639/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1466
Epoch 640/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1470
Epoch 641/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1462
Epoch 642/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1468
Epoch 643/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1469
Epoch 644/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1466
Epoch 645/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1465
Epoch 646/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1465
Epoch 647/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1463
Epoch 648/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1466
Epoch 649/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1461
Epoch 650/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1466
Epoch 651/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1462
Epoch 652/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1463
Epoch 653/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1462
Epoch 654/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1465
Epoch 655/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1464
Epoch 656/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1463
Epoch 657/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 658/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1463
Epoch 659/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1461
Epoch 660/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1458
```

```
Epoch 661/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 662/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1460
Epoch 663/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1460
Epoch 664/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1462
Epoch 665/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1458
Epoch 666/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1460
Epoch 667/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 668/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 669/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1458
Epoch 670/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1453
Epoch 671/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1456
Epoch 672/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 673/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1459
Epoch 674/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
Epoch 675/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1455
Epoch 676/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1455
Epoch 677/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 678/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1456
Epoch 679/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1456
Epoch 680/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
Epoch 681/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
Epoch 682/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
```

```
Epoch 683/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1455
Epoch 684/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1453
Epoch 685/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1451
Epoch 686/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
Epoch 687/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1455
Epoch 688/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1451
Epoch 689/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 690/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1455
Epoch 691/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1448
Epoch 692/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 693/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1454
Epoch 694/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 695/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1447
Epoch 696/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1453
Epoch 697/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 698/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1450
Epoch 699/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1443
Epoch 700/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1449
Epoch 701/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1448
Epoch 702/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1450
Epoch 703/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 704/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
```

```
Epoch 705/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1447
Epoch 706/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1448
Epoch 707/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1444
Epoch 708/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1442
Epoch 709/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1444
Epoch 710/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 711/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1443
Epoch 712/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1446
Epoch 713/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 714/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1442
Epoch 715/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1447
Epoch 716/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1442
Epoch 717/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 718/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1438
Epoch 719/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1441
Epoch 720/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1441
Epoch 721/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 722/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1442
Epoch 723/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1439
Epoch 724/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1440
Epoch 725/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1438
Epoch 726/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1435
```

```
Epoch 727/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 728/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
Epoch 729/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1438
Epoch 730/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1440
Epoch 731/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 732/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1440
Epoch 733/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1437
Epoch 734/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1436
Epoch 735/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1438
Epoch 736/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1441
Epoch 737/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
Epoch 738/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1436
Epoch 739/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 740/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1433
Epoch 741/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1452
Epoch 742/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 743/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1432
Epoch 744/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 745/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 746/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 747/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
Epoch 748/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
```

```
Epoch 749/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1432
Epoch 750/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 751/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1432
Epoch 752/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 753/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1429
Epoch 754/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1428
Epoch 755/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1428
Epoch 756/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 757/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1432
Epoch 758/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1424
Epoch 759/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1429
Epoch 760/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1426
Epoch 761/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 762/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 763/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1428
Epoch 764/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
Epoch 765/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1432
Epoch 766/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1424
Epoch 767/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1425
Epoch 768/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1426
Epoch 769/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1422
Epoch 770/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1425
```

```
Epoch 771/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1436
Epoch 772/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1426
Epoch 773/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1425
Epoch 774/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1420
Epoch 775/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1421
Epoch 776/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1420
Epoch 777/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1431
Epoch 778/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1425
Epoch 779/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 780/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1421
Epoch 781/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1430
Epoch 782/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 783/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1423
Epoch 784/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1418
Epoch 785/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1420
Epoch 786/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1443
Epoch 787/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1420
Epoch 788/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1423
Epoch 789/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 790/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1413
Epoch 791/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1418
Epoch 792/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1415
```

```
Epoch 793/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1417
Epoch 794/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1417
Epoch 795/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 796/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1429
Epoch 797/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1415
Epoch 798/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 799/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1413
Epoch 800/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1412
Epoch 801/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1414
Epoch 802/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1417
Epoch 803/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1416
Epoch 804/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1411
Epoch 805/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1414
Epoch 806/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1411
Epoch 807/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1409
Epoch 808/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1412
Epoch 809/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1409
Epoch 810/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1413
Epoch 811/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1410
Epoch 812/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1408
Epoch 813/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1407
Epoch 814/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1408
```

```
Epoch 815/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1412
Epoch 816/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1408
Epoch 817/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1413
Epoch 818/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1414
Epoch 819/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1410
Epoch 820/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1404
Epoch 821/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1406
Epoch 822/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1411
Epoch 823/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1408
Epoch 824/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1404
Epoch 825/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1402
Epoch 826/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1407
Epoch 827/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1404
Epoch 828/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1404
Epoch 829/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1434
Epoch 830/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1408
Epoch 831/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1418
Epoch 832/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1402
Epoch 833/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1412
Epoch 834/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1400
Epoch 835/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1401
Epoch 836/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1399
```

```
Epoch 837/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1402
Epoch 838/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1401
Epoch 839/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1409
Epoch 840/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1402
Epoch 841/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1403
Epoch 842/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1401
Epoch 843/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1398
Epoch 844/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1397
Epoch 845/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1413
Epoch 846/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1409
Epoch 847/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1395
Epoch 848/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1399
Epoch 849/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1402
Epoch 850/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1398
Epoch 851/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1397
Epoch 852/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1397
Epoch 853/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1397
Epoch 854/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1397
Epoch 855/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1421
Epoch 856/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1393
Epoch 857/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 858/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1394
```

```
Epoch 859/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1399
Epoch 860/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1394
Epoch 861/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1392
Epoch 862/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1396
Epoch 863/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1393
Epoch 864/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1393
Epoch 865/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1395
Epoch 866/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1396
Epoch 867/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1393
Epoch 868/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1396
Epoch 869/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1406
Epoch 870/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1409
Epoch 871/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1386
Epoch 872/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1388
Epoch 873/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1389
Epoch 874/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1391
Epoch 875/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1390
Epoch 876/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1390
Epoch 877/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1387
Epoch 878/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1410
Epoch 879/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1388
Epoch 880/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1389
```

```
Epoch 881/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1387
Epoch 882/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1381
Epoch 883/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1388
Epoch 884/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 885/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1387
Epoch 886/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1388
Epoch 887/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1385
Epoch 888/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1392
Epoch 889/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1386
Epoch 890/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1392
Epoch 891/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1391
Epoch 892/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1388
Epoch 893/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1381
Epoch 894/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1385
Epoch 895/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1381
Epoch 896/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1389
Epoch 897/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1392
Epoch 898/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 899/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 900/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1407
Epoch 901/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1380
Epoch 902/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
```

```
Epoch 903/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1393
Epoch 904/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1387
Epoch 905/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 906/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1380
Epoch 907/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1383
Epoch 908/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1390
Epoch 909/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 910/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1383
Epoch 911/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1377
Epoch 912/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1384
Epoch 913/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1385
Epoch 914/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1383
Epoch 915/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1385
Epoch 916/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1384
Epoch 917/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1379
Epoch 918/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1394
Epoch 919/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1380
Epoch 920/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1376
Epoch 921/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1372
Epoch 922/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1376
Epoch 923/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1375
Epoch 924/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
```

```
Epoch 925/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1386
Epoch 926/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1376
Epoch 927/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1371
Epoch 928/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1375
Epoch 929/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1435
Epoch 930/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1372
Epoch 931/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1371
Epoch 932/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1369
Epoch 933/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1369
Epoch 934/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1374
Epoch 935/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1375
Epoch 936/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1379
Epoch 937/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1377
Epoch 938/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1372
Epoch 939/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1373
Epoch 940/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1369
Epoch 941/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 942/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1376
Epoch 943/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1377
Epoch 944/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1373
Epoch 945/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1370
Epoch 946/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1370
```

```
Epoch 947/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1370
Epoch 948/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 949/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1368
Epoch 950/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1382
Epoch 951/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
Epoch 952/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1367
Epoch 953/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 954/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1370
Epoch 955/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1367
Epoch 956/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 957/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
Epoch 958/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1365
Epoch 959/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1438
Epoch 960/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1392
Epoch 961/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1360
Epoch 962/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 963/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 964/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1365
Epoch 965/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 966/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
Epoch 967/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1363
Epoch 968/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
```

```
Epoch 969/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1363
Epoch 970/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1365
Epoch 971/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1362
Epoch 972/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1360
Epoch 973/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1365
Epoch 974/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 975/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
Epoch 976/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 977/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1362
Epoch 978/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1361
Epoch 979/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 980/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1362
Epoch 981/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 982/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 983/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 984/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 985/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1358
Epoch 986/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1354
Epoch 987/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 988/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1361
Epoch 989/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1365
Epoch 990/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1357
```

```
Epoch 991/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1359
Epoch 992/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1354
Epoch 993/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1368
Epoch 994/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1351
Epoch 995/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1353
Epoch 996/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1364
Epoch 997/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1439
Epoch 998/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1380
Epoch 999/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1351
Epoch 1000/1000
438/438 [==============================] - 1s 2ms/step - loss: 0.1360
```

In [110]:
```
print("the time taken  for 350000 samples to be trained  with  1000 epochs in  seconds is : " , training_time)
```

```
the time taken  for 350000 samples to be trained  with  1000 epochs in  seconds is :  977.0010762214661
```

In [99]:
```
tdp = model.predict(X_test)
```

```
219/219 [==============================] - 0s 901us/step
```

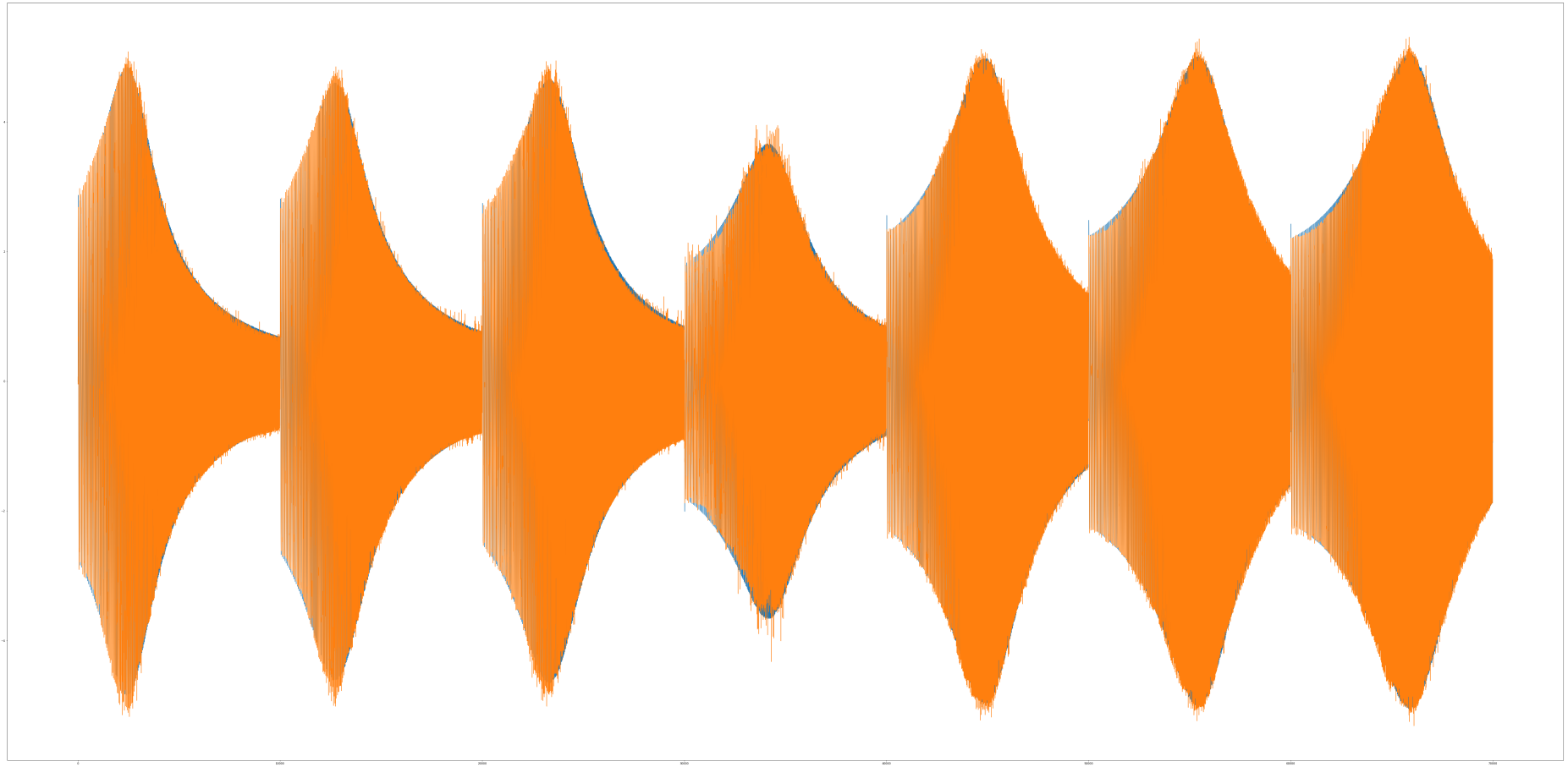
In [100]:
```
r2 = r2_score(y_test.ravel() , tdp.ravel())
```

In [102]:
```
print("the r2 score is " , r2)
```

```
the r2 score is  0.9569042234461305
```

In [107]:
```
plt.figure(figsize=(100, 50))
plt.plot(np.linspace(1,70000,70000) , y_test.ravel())
plt.plot(np.linspace(1,70000,70000) , tdp.ravel())
```

Out[107]:
```
[<matplotlib.lines.Line2D at 0x20599be36d0>]
```



In [113]:
```
pl = np.array([0]*10000)
```

In [125]:
```
dup.shape
```

Out[125]:
```
(10000, 1)
```

In [126]:
```
dal = np.array([1.5]*10000)
```

In [127]:
```
dt.shape
```

Out[127]:
```
(10000, 1)
```

In [129]:
```
dv.shape
```

Out[129]:
```
(10000,)
```

In [133]:
```
scnew = np.concatenate((np.array(dup).reshape(-1,1) , pl.reshape(-1,1) ,np.array(dt).reshape(-1,1) ,dal.reshape(-1,1) , dv.reshape(
```

In [134]:
```
scnew.shape
```

Out[134]:
```
(10000, 5)
```

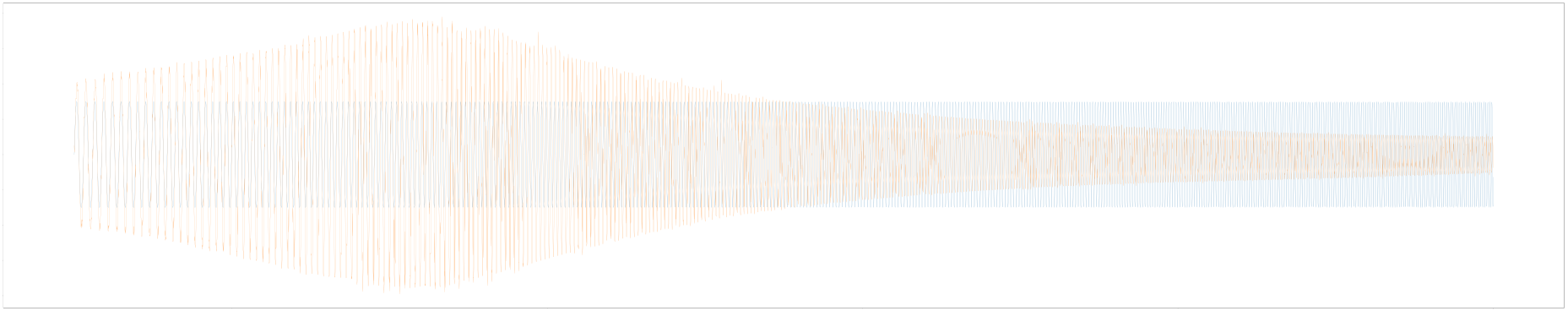
In [136]:
```
scnew = scnew.reshape(-1,10,5)
```

In [137]:
```
dtp = model.predict(scnew)
```

```
32/32 [==============================] - 0s 938us/step
```

In [141]:
```
plt.figure(figsize=(500, 100))
plt.plot(np.linspace(1,10,10000) , np.array(dup).reshape(-1,1))
plt.plot(np.linspace(1,10,10000) , np.array(dtp).reshape(-1,1))
```

Out[141]:
```
[<matplotlib.lines.Line2D at 0x205a623d700>]
```



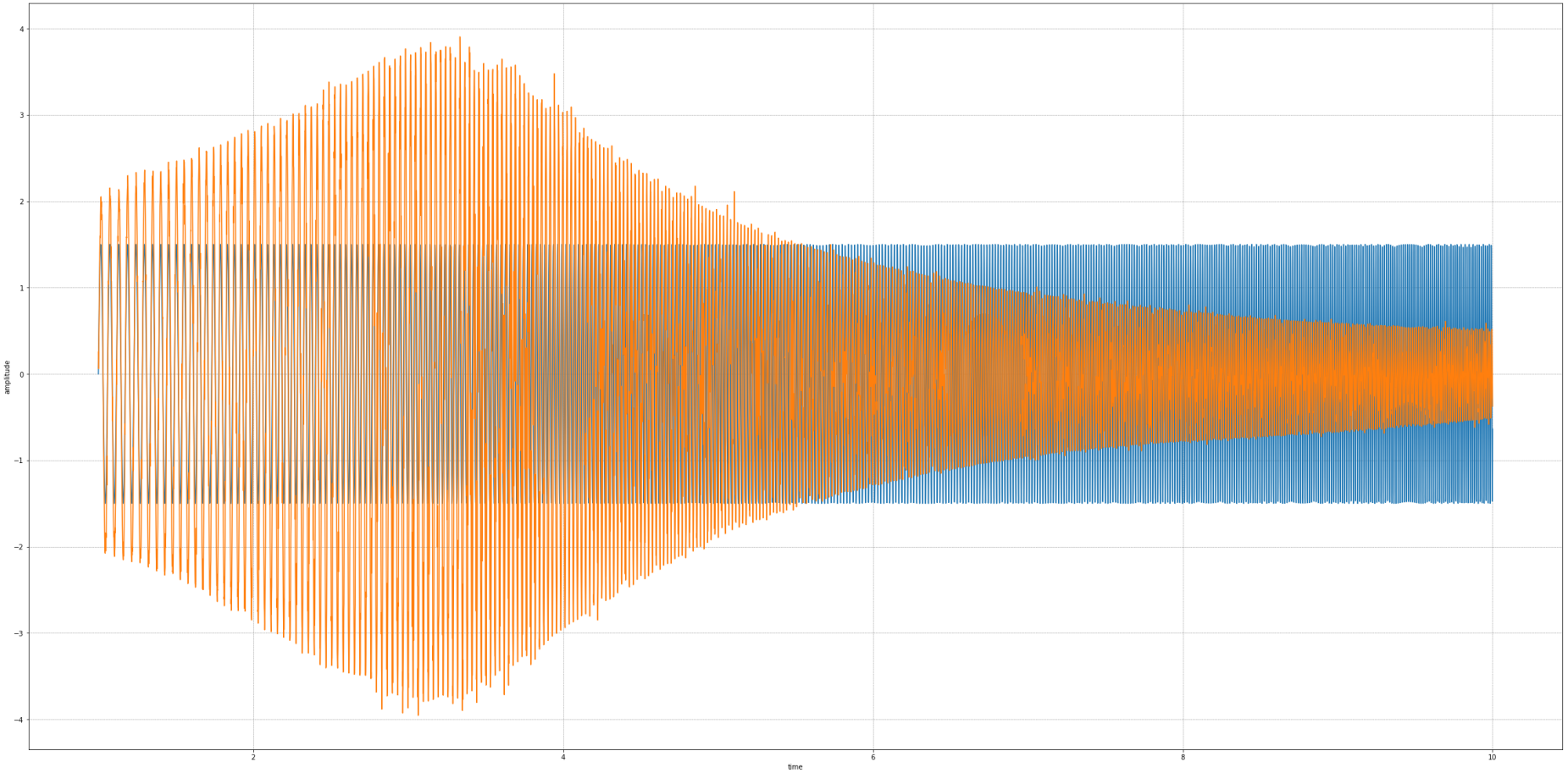
In [151]:
```
fig, ax = plt.subplots(figsize=(40, 20))
ax.plot(np.linspace(1,10,10000), np.array(dup).reshape(-1,1))
ax.plot(np.linspace(1,10,10000) , np.array(dtp).reshape(-1,1))
ax.grid(True)
# Customize the grid
ax.grid(color='gray', linestyle='--', linewidth=0.5)

# Set the x-axis and y-axis labels
```

```
ax.set_xlabel('time')
ax.set_ylabel('amplitude')
```

Out[151]:

```
Text(0, 0.5, 'amplitude')
```



In [ ]: