Python Script

Data Modeling Part

In [1]:
```
#pip install tensorflow
#pip install pandas
#pip install openpyxl
#pip install scikit-learn
#pip install matplotlib
#pip install torch
#pip install scalecast
#pip install greykite
```

In [2]:
```
import sys
print(sys.version)
```

```
3.10.9 | packaged by Anaconda, Inc. | (main, Mar  1 2023, 18:18:15) [MSC v.1916 64 bi
t (AMD64)]
```

In [3]:
```
### Importing general libraries ###
import numpy as np
import pandas as pd
import os
```

Load Transformed Data from R Script

In [4]:
```
# Printing the current working directory
#print("The Current working directory is: {0}".format(os.getcwd()))

# Set the working directory
#os.chdir('your/path')
```

In [5]:
```
# Load Excel file
df = pd.read_excel('df_clean.xlsx')

#create time series object
#df.index = pd.to_datetime(df['date'])
#df = df.drop('date', axis=1)
df.head()
```

Out[5]:

	corn_diff	CPI_diff	Unemp_rate_diff	NASDAQ_diff	disposable_income_diff	Personal_consumption_
0	-0.010782	0.009302	-0.040822	-0.011461	0.004671	
1	0.045041	0.009217	0.040822	0.002110	-0.003888	
2	-0.058684	0.009132	-0.013423	-0.020147	-0.003097	
3	-0.008276	0.006795	0.000000	0.043883	0.002816	
4	0.016484	0.005627	-0.027399	0.055072	-0.002796	

In [6]:
```
## Feature selection based on granger causality test
columns_to_keep = ['corn_diff', 'CPI_diff', 'USA_Avg_Temp', 'interaction_ps_di_diff',
df = df[columns_to_keep]
```

Perform Data Modelling

In [7]:
```
import pandas as pd
import numpy as np
import pickle
import seaborn as sns
import matplotlib.pyplot as plt
from scalecast.Forecaster import Forecaster
from dateutil.relativedelta import relativedelta
```

In [8]:
```
#Create y and Yvars
y = df['corn_diff']
Xvars = df.drop(columns=['corn_diff'])
```

In [9]:
```
# create list-like items
CPI_diff = Xvars['CPI_diff'].tolist()
USA_Avg_Temp = Xvars['USA_Avg_Temp'].tolist()
interaction_ps_di_diff = Xvars['interaction_ps_di_diff'].tolist()
```

In [10]:
```
Xvars.head()
```

Out[10]:

	CPI_diff	USA_Avg_Temp	interaction_ps_di_diff	date
0	0.009302	37.000000	-0.000081	1980-12-01
1	0.009217	30.502083	0.000174	1981-01-01
2	0.009132	31.941667	0.000029	1981-02-01
3	0.006795	38.379167	0.000000	1981-03-01
4	0.005627	47.885417	-0.000026	1981-04-01

In [11]:
```
# Create forecaster
f = Forecaster(
```

```
    y=y,
    current_dates=Xvars['date'],
)
f
```

Out[11]:

```
Forecaster(
    DateStartActuals=1980-12-01T00:00:00.000000000
    DateEndActuals=2016-02-01T00:00:00.000000000
    Freq=MS
    N_actuals=423
    ForecastLength=0
    Xvars=[]
    TestLength=0
    ValidationMetric=rmse
    ForecastsEvaluated=[]
    CILevel=None
    CurrentEstimator=mlr
    GridsFile=Grids
)
```

In [12]:

```
# prepare the forecast function
f.ingest_Xvars_df(Xvars, date_col='date', use_future_dates=True) # Ingest external reg
f.set_test_length(48)       # 1. 48 observations to test the results
f.generate_future_dates(48) # 2. 48 future points to forecast
f.eval_cis(cilevel=0.95) # show confidence interval
```

In [13]:

```
f
```

Out[13]:

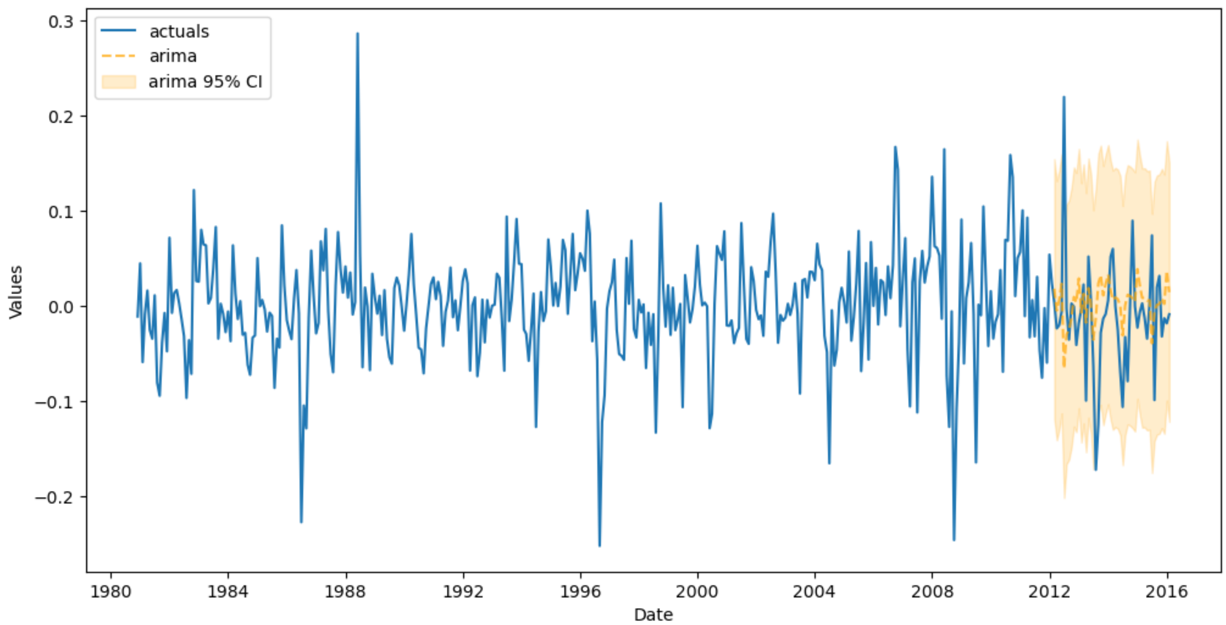
```
Forecaster(
    DateStartActuals=1980-12-01T00:00:00.000000000
    DateEndActuals=2016-02-01T00:00:00.000000000
    Freq=MS
    N_actuals=423
    ForecastLength=48
    Xvars=['CPI_diff', 'USA_Avg_Temp', 'interaction_ps_di_diff']
    TestLength=48
    ValidationMetric=rmse
    ForecastsEvaluated=[]
    CILevel=0.95
    CurrentEstimator=mlr
    GridsFile=Grids
)
```

In [14]:

```
f.set_estimator('arima')
f.manual_forecast(call_me='arima',seasonal_order=(2,1,1,12) )
f.plot_test_set(ci=True, models='arima')
```

Out[14]:

```
<Axes: xlabel='Date', ylabel='Values'>
```



In [15]:

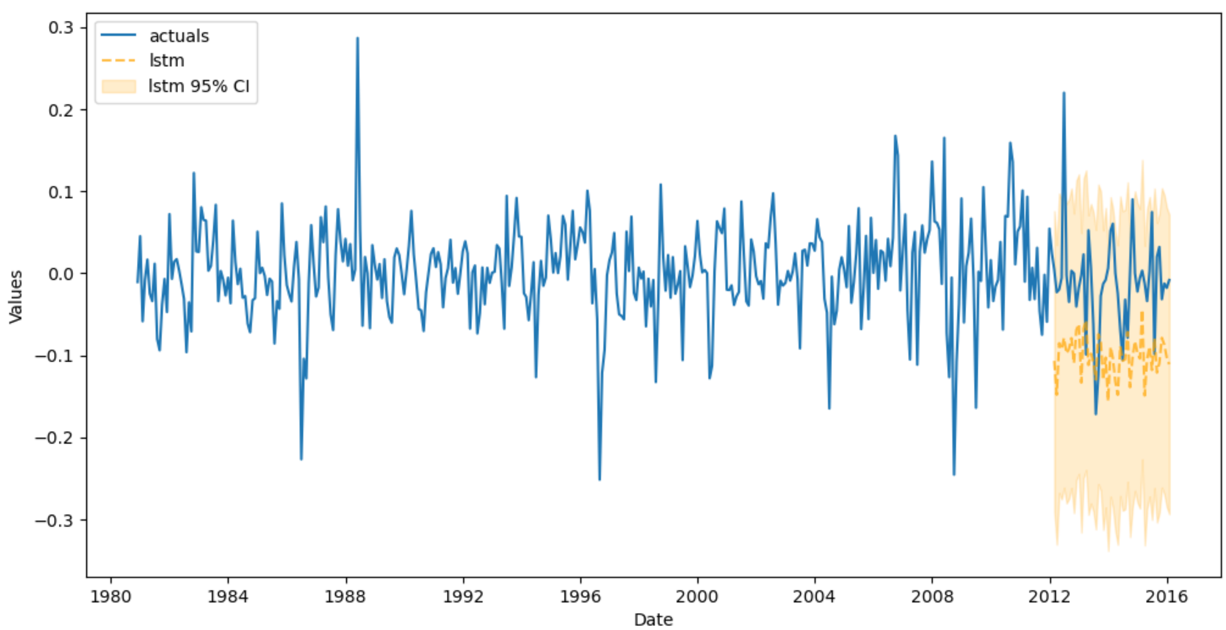
```
f.set_estimator('lstm')
f.manual_forecast(
    call_me='lstm',
    lags=1,
    epochs=15,
    validation_split=.2,
    shuffle=False,)
f.plot_test_set(ci=True, models='lstm')
```

```
Epoch 1/15
9/9 [==============================] - 3s 111ms/step - loss: 0.4625 - val_loss: 0.477
1
Epoch 2/15
9/9 [==============================] - 0s 13ms/step - loss: 0.4523 - val_loss: 0.4669
Epoch 3/15
9/9 [==============================] - 0s 12ms/step - loss: 0.4419 - val_loss: 0.4564
Epoch 4/15
9/9 [==============================] - 0s 12ms/step - loss: 0.4311 - val_loss: 0.4453
Epoch 5/15
9/9 [==============================] - 0s 12ms/step - loss: 0.4194 - val_loss: 0.4332
Epoch 6/15
9/9 [==============================] - 0s 12ms/step - loss: 0.4068 - val_loss: 0.4199
Epoch 7/15
9/9 [==============================] - 0s 10ms/step - loss: 0.3929 - val_loss: 0.4052
Epoch 8/15
9/9 [==============================] - 0s 7ms/step - loss: 0.3776 - val_loss: 0.3889
Epoch 9/15
9/9 [==============================] - 0s 10ms/step - loss: 0.3606 - val_loss: 0.3708
Epoch 10/15
9/9 [==============================] - 0s 8ms/step - loss: 0.3417 - val_loss: 0.3508
Epoch 11/15
9/9 [==============================] - 0s 10ms/step - loss: 0.3209 - val_loss: 0.3290
Epoch 12/15
9/9 [==============================] - 0s 9ms/step - loss: 0.2979 - val_loss: 0.3052
Epoch 13/15
9/9 [==============================] - 0s 9ms/step - loss: 0.2729 - val_loss: 0.2797
Epoch 14/15
9/9 [==============================] - 0s 9ms/step - loss: 0.2459 - val_loss: 0.2528
Epoch 15/15
9/9 [==============================] - 0s 8ms/step - loss: 0.2175 - val_loss: 0.2252
1/1 [==============================] - 1s 504ms/step
Epoch 1/15
10/10 [==============================] - 3s 88ms/step - loss: 0.4664 - val_loss: 0.46
50
Epoch 2/15
10/10 [==============================] - 0s 6ms/step - loss: 0.4538 - val_loss: 0.452
2
Epoch 3/15
10/10 [==============================] - 0s 7ms/step - loss: 0.4409 - val_loss: 0.439
0
Epoch 4/15
10/10 [==============================] - 0s 6ms/step - loss: 0.4275 - val_loss: 0.425
2
Epoch 5/15
10/10 [==============================] - 0s 6ms/step - loss: 0.4133 - val_loss: 0.410
4
Epoch 6/15
10/10 [==============================] - 0s 6ms/step - loss: 0.3981 - val_loss: 0.394
5
Epoch 7/15
10/10 [==============================] - 0s 7ms/step - loss: 0.3817 - val_loss: 0.377
1
Epoch 8/15
10/10 [==============================] - 0s 7ms/step - loss: 0.3639 - val_loss: 0.358
2
Epoch 9/15
10/10 [==============================] - 0s 6ms/step - loss: 0.3443 - val_loss: 0.337
6
Epoch 10/15
```

```
10/10 [==============================] - 0s 6ms/step - loss: 0.3230 - val_loss: 0.315
4
Epoch 11/15
10/10 [==============================] - 0s 6ms/step - loss: 0.2997 - val_loss: 0.291
3
Epoch 12/15
10/10 [==============================] - 0s 7ms/step - loss: 0.2745 - val_loss: 0.265
7
Epoch 13/15
10/10 [==============================] - 0s 6ms/step - loss: 0.2474 - val_loss: 0.238
7
Epoch 14/15
10/10 [==============================] - 0s 6ms/step - loss: 0.2190 - val_loss: 0.211
0
Epoch 15/15
10/10 [==============================] - 0s 5ms/step - loss: 0.1897 - val_loss: 0.183
7
1/1 [==============================] - 0s 343ms/step
12/12 [==============================] - 0s 1ms/step
```

Out[15]:

```
<Axes: xlabel='Date', ylabel='Values'>
```



In [16]:

```
f.set_estimator('lstm')
f.manual_forecast(
    call_me='lstm_test',
    lags=36,
    batch_size=16,
    epochs=300,
    validation_split=.2,
    shuffle=True,
    activation='tanh',
    optimizer='Adam',
    learning_rate=0.001,
    lstm_layer_sizes=(100,)*15,
    dropout=(0,)*15,
    plot_loss=True,
)
f.plot_test_set(ci=True, models='lstm')
```

```
Epoch 1/300
15/15 [==============================] - 31s 556ms/step - loss: 0.2776 - val_loss: 0.
1276
Epoch 2/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0848 - val_loss: 0.1
086
Epoch 3/300
15/15 [==============================] - 3s 232ms/step - loss: 0.0734 - val_loss: 0.1
066
Epoch 4/300
15/15 [==============================] - 4s 240ms/step - loss: 0.0723 - val_loss: 0.1
053
Epoch 5/300
15/15 [==============================] - 3s 221ms/step - loss: 0.0718 - val_loss: 0.1
069
Epoch 6/300
15/15 [==============================] - 4s 254ms/step - loss: 0.0721 - val_loss: 0.1
043
Epoch 7/300
15/15 [==============================] - 4s 245ms/step - loss: 0.0717 - val_loss: 0.1
073
Epoch 8/300
15/15 [==============================] - 4s 244ms/step - loss: 0.0714 - val_loss: 0.1
043
Epoch 9/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0715 - val_loss: 0.1
048
Epoch 10/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0718 - val_loss: 0.1
058
Epoch 11/300
15/15 [==============================] - 4s 262ms/step - loss: 0.0719 - val_loss: 0.1
053
Epoch 12/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0713 - val_loss: 0.1
062
Epoch 13/300
15/15 [==============================] - 4s 251ms/step - loss: 0.0723 - val_loss: 0.1
052
Epoch 14/300
15/15 [==============================] - 4s 241ms/step - loss: 0.0716 - val_loss: 0.1
058
Epoch 15/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0714 - val_loss: 0.1
069
Epoch 16/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0717 - val_loss: 0.1
042
Epoch 17/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0712 - val_loss: 0.1
057
Epoch 18/300
15/15 [==============================] - 4s 281ms/step - loss: 0.0711 - val_loss: 0.1
055
Epoch 19/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0713 - val_loss: 0.1
046
Epoch 20/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0711 - val_loss: 0.1
061
```

```
Epoch 21/300
15/15 [==============================] - 4s 280ms/step - loss: 0.0716 - val_loss: 0.1
053
Epoch 22/300
15/15 [==============================] - 4s 256ms/step - loss: 0.0709 - val_loss: 0.1
051
Epoch 23/300
15/15 [==============================] - 4s 275ms/step - loss: 0.0715 - val_loss: 0.1
061
Epoch 24/300
15/15 [==============================] - 4s 235ms/step - loss: 0.0718 - val_loss: 0.1
043
Epoch 25/300
15/15 [==============================] - 4s 247ms/step - loss: 0.0710 - val_loss: 0.1
048
Epoch 26/300
15/15 [==============================] - 4s 248ms/step - loss: 0.0711 - val_loss: 0.1
050
Epoch 27/300
15/15 [==============================] - 4s 261ms/step - loss: 0.0710 - val_loss: 0.1
052
Epoch 28/300
15/15 [==============================] - 4s 287ms/step - loss: 0.0710 - val_loss: 0.1
047
Epoch 29/300
15/15 [==============================] - 3s 216ms/step - loss: 0.0711 - val_loss: 0.1
047
Epoch 30/300
15/15 [==============================] - 3s 232ms/step - loss: 0.0711 - val_loss: 0.1
055
Epoch 31/300
15/15 [==============================] - 4s 244ms/step - loss: 0.0718 - val_loss: 0.1
055
Epoch 32/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0711 - val_loss: 0.1
044
Epoch 33/300
15/15 [==============================] - 4s 244ms/step - loss: 0.0708 - val_loss: 0.1
050
Epoch 34/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0709 - val_loss: 0.1
051
Epoch 35/300
15/15 [==============================] - 4s 247ms/step - loss: 0.0705 - val_loss: 0.1
053
Epoch 36/300
15/15 [==============================] - 4s 258ms/step - loss: 0.0706 - val_loss: 0.1
054
Epoch 37/300
15/15 [==============================] - 4s 263ms/step - loss: 0.0705 - val_loss: 0.1
046
Epoch 38/300
15/15 [==============================] - 3s 222ms/step - loss: 0.0707 - val_loss: 0.1
041
Epoch 39/300
15/15 [==============================] - 3s 230ms/step - loss: 0.0709 - val_loss: 0.1
072
Epoch 40/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0710 - val_loss: 0.1
049
```

```
Epoch 41/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0709 - val_loss: 0.1
054
Epoch 42/300
15/15 [==============================] - 3s 203ms/step - loss: 0.0710 - val_loss: 0.1
049
Epoch 43/300
15/15 [==============================] - 3s 202ms/step - loss: 0.0708 - val_loss: 0.1
049
Epoch 44/300
15/15 [==============================] - 4s 253ms/step - loss: 0.0707 - val_loss: 0.1
054
Epoch 45/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0709 - val_loss: 0.1
051
Epoch 46/300
15/15 [==============================] - 3s 228ms/step - loss: 0.0708 - val_loss: 0.1
059
Epoch 47/300
15/15 [==============================] - 3s 234ms/step - loss: 0.0707 - val_loss: 0.1
051
Epoch 48/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0708 - val_loss: 0.1
058
Epoch 49/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0712 - val_loss: 0.1
043
Epoch 50/300
15/15 [==============================] - 3s 220ms/step - loss: 0.0707 - val_loss: 0.1
050
Epoch 51/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0708 - val_loss: 0.1
049
Epoch 52/300
15/15 [==============================] - 3s 205ms/step - loss: 0.0706 - val_loss: 0.1
048
Epoch 53/300
15/15 [==============================] - 3s 206ms/step - loss: 0.0708 - val_loss: 0.1
048
Epoch 54/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0706 - val_loss: 0.1
055
Epoch 55/300
15/15 [==============================] - 3s 222ms/step - loss: 0.0709 - val_loss: 0.1
059
Epoch 56/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0709 - val_loss: 0.1
063
Epoch 57/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0707 - val_loss: 0.1
064
Epoch 58/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0707 - val_loss: 0.1
045
Epoch 59/300
15/15 [==============================] - 3s 218ms/step - loss: 0.0707 - val_loss: 0.1
056
Epoch 60/300
15/15 [==============================] - 3s 201ms/step - loss: 0.0705 - val_loss: 0.1
051
```

```
Epoch 61/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0705 - val_loss: 0.1
048
Epoch 62/300
15/15 [==============================] - 3s 200ms/step - loss: 0.0705 - val_loss: 0.1
047
Epoch 63/300
15/15 [==============================] - 3s 205ms/step - loss: 0.0704 - val_loss: 0.1
041
Epoch 64/300
15/15 [==============================] - 3s 223ms/step - loss: 0.0704 - val_loss: 0.1
045
Epoch 65/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0703 - val_loss: 0.1
044
Epoch 66/300
15/15 [==============================] - 3s 202ms/step - loss: 0.0707 - val_loss: 0.1
049
Epoch 67/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0709 - val_loss: 0.1
053
Epoch 68/300
15/15 [==============================] - 3s 200ms/step - loss: 0.0706 - val_loss: 0.1
048
Epoch 69/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0707 - val_loss: 0.1
050
Epoch 70/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0704 - val_loss: 0.1
050
Epoch 71/300
15/15 [==============================] - 3s 215ms/step - loss: 0.0704 - val_loss: 0.1
048
Epoch 72/300
15/15 [==============================] - 3s 208ms/step - loss: 0.0704 - val_loss: 0.1
055
Epoch 73/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0704 - val_loss: 0.1
052
Epoch 74/300
15/15 [==============================] - 3s 228ms/step - loss: 0.0704 - val_loss: 0.1
049
Epoch 75/300
15/15 [==============================] - 3s 207ms/step - loss: 0.0705 - val_loss: 0.1
049
Epoch 76/300
15/15 [==============================] - 3s 210ms/step - loss: 0.0703 - val_loss: 0.1
046
Epoch 77/300
15/15 [==============================] - 3s 213ms/step - loss: 0.0705 - val_loss: 0.1
041
Epoch 78/300
15/15 [==============================] - 4s 243ms/step - loss: 0.0709 - val_loss: 0.1
046
Epoch 79/300
15/15 [==============================] - 4s 271ms/step - loss: 0.0704 - val_loss: 0.1
053
Epoch 80/300
15/15 [==============================] - 4s 255ms/step - loss: 0.0704 - val_loss: 0.1
049
```

```
Epoch 81/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0705 - val_loss: 0.1
051
Epoch 82/300
15/15 [==============================] - 3s 213ms/step - loss: 0.0704 - val_loss: 0.1
054
Epoch 83/300
15/15 [==============================] - 3s 215ms/step - loss: 0.0704 - val_loss: 0.1
054
Epoch 84/300
15/15 [==============================] - 3s 216ms/step - loss: 0.0705 - val_loss: 0.1
051
Epoch 85/300
15/15 [==============================] - 3s 213ms/step - loss: 0.0704 - val_loss: 0.1
040
Epoch 86/300
15/15 [==============================] - 3s 203ms/step - loss: 0.0703 - val_loss: 0.1
047
Epoch 87/300
15/15 [==============================] - 4s 242ms/step - loss: 0.0701 - val_loss: 0.1
044
Epoch 88/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0702 - val_loss: 0.1
046
Epoch 89/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0705 - val_loss: 0.1
049
Epoch 90/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0704 - val_loss: 0.1
050
Epoch 91/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0705 - val_loss: 0.1
058
Epoch 92/300
15/15 [==============================] - 3s 231ms/step - loss: 0.0705 - val_loss: 0.1
058
Epoch 93/300
15/15 [==============================] - 3s 222ms/step - loss: 0.0705 - val_loss: 0.1
069
Epoch 94/300
15/15 [==============================] - 3s 210ms/step - loss: 0.0703 - val_loss: 0.1
055
Epoch 95/300
15/15 [==============================] - 3s 215ms/step - loss: 0.0707 - val_loss: 0.1
050
Epoch 96/300
15/15 [==============================] - 3s 208ms/step - loss: 0.0705 - val_loss: 0.1
052
Epoch 97/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0705 - val_loss: 0.1
050
Epoch 98/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0706 - val_loss: 0.1
052
Epoch 99/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0706 - val_loss: 0.1
052
Epoch 100/300
15/15 [==============================] - 3s 205ms/step - loss: 0.0704 - val_loss: 0.1
046
```

```
Epoch 101/300
15/15 [==============================] - 3s 198ms/step - loss: 0.0704 - val_loss: 0.1
051
Epoch 102/300
15/15 [==============================] - 3s 198ms/step - loss: 0.0701 - val_loss: 0.1
043
Epoch 103/300
15/15 [==============================] - 3s 220ms/step - loss: 0.0703 - val_loss: 0.1
043
Epoch 104/300
15/15 [==============================] - 3s 199ms/step - loss: 0.0702 - val_loss: 0.1
047
Epoch 105/300
15/15 [==============================] - 3s 189ms/step - loss: 0.0703 - val_loss: 0.1
055
Epoch 106/300
15/15 [==============================] - 3s 197ms/step - loss: 0.0703 - val_loss: 0.1
047
Epoch 107/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0702 - val_loss: 0.1
047
Epoch 108/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0704 - val_loss: 0.1
050
Epoch 109/300
15/15 [==============================] - 4s 271ms/step - loss: 0.0704 - val_loss: 0.1
052
Epoch 110/300
15/15 [==============================] - 4s 280ms/step - loss: 0.0704 - val_loss: 0.1
042
Epoch 111/300
15/15 [==============================] - 4s 267ms/step - loss: 0.0703 - val_loss: 0.1
053
Epoch 112/300
15/15 [==============================] - 4s 283ms/step - loss: 0.0703 - val_loss: 0.1
047
Epoch 113/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0701 - val_loss: 0.1
046
Epoch 114/300
15/15 [==============================] - 3s 202ms/step - loss: 0.0702 - val_loss: 0.1
045
Epoch 115/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0704 - val_loss: 0.1
052
Epoch 116/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0701 - val_loss: 0.1
058
Epoch 117/300
15/15 [==============================] - 3s 226ms/step - loss: 0.0706 - val_loss: 0.1
050
Epoch 118/300
15/15 [==============================] - 3s 207ms/step - loss: 0.0703 - val_loss: 0.1
046
Epoch 119/300
15/15 [==============================] - 3s 207ms/step - loss: 0.0705 - val_loss: 0.1
053
Epoch 120/300
15/15 [==============================] - 3s 206ms/step - loss: 0.0702 - val_loss: 0.1
044
```

```
Epoch 121/300
15/15 [==============================] - 3s 226ms/step - loss: 0.0704 - val_loss: 0.1
040
Epoch 122/300
15/15 [==============================] - 3s 220ms/step - loss: 0.0705 - val_loss: 0.1
043
Epoch 123/300
15/15 [==============================] - 3s 203ms/step - loss: 0.0705 - val_loss: 0.1
046
Epoch 124/300
15/15 [==============================] - 3s 234ms/step - loss: 0.0704 - val_loss: 0.1
048
Epoch 125/300
15/15 [==============================] - 4s 255ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 126/300
15/15 [==============================] - 4s 278ms/step - loss: 0.0699 - val_loss: 0.1
052
Epoch 127/300
15/15 [==============================] - 4s 274ms/step - loss: 0.0701 - val_loss: 0.1
051
Epoch 128/300
15/15 [==============================] - 4s 235ms/step - loss: 0.0701 - val_loss: 0.1
053
Epoch 129/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0702 - val_loss: 0.1
055
Epoch 130/300
15/15 [==============================] - 4s 243ms/step - loss: 0.0702 - val_loss: 0.1
051
Epoch 131/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0701 - val_loss: 0.1
046
Epoch 132/300
15/15 [==============================] - 3s 221ms/step - loss: 0.0702 - val_loss: 0.1
053
Epoch 133/300
15/15 [==============================] - 3s 216ms/step - loss: 0.0702 - val_loss: 0.1
053
Epoch 134/300
15/15 [==============================] - 3s 193ms/step - loss: 0.0702 - val_loss: 0.1
048
Epoch 135/300
15/15 [==============================] - 3s 206ms/step - loss: 0.0704 - val_loss: 0.1
051
Epoch 136/300
15/15 [==============================] - 3s 204ms/step - loss: 0.0700 - val_loss: 0.1
057
Epoch 137/300
15/15 [==============================] - 3s 192ms/step - loss: 0.0702 - val_loss: 0.1
051
Epoch 138/300
15/15 [==============================] - 3s 201ms/step - loss: 0.0703 - val_loss: 0.1
054
Epoch 139/300
15/15 [==============================] - 3s 190ms/step - loss: 0.0703 - val_loss: 0.1
053
Epoch 140/300
15/15 [==============================] - 3s 222ms/step - loss: 0.0704 - val_loss: 0.1
048
```

```
Epoch 141/300
15/15 [==============================] - 3s 226ms/step - loss: 0.0703 - val_loss: 0.1
050
Epoch 142/300
15/15 [==============================] - 4s 233ms/step - loss: 0.0705 - val_loss: 0.1
051
Epoch 143/300
15/15 [==============================] - 3s 204ms/step - loss: 0.0704 - val_loss: 0.1
051
Epoch 144/300
15/15 [==============================] - 3s 206ms/step - loss: 0.0701 - val_loss: 0.1
051
Epoch 145/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0702 - val_loss: 0.1
050
Epoch 146/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0702 - val_loss: 0.1
048
Epoch 147/300
15/15 [==============================] - 3s 200ms/step - loss: 0.0702 - val_loss: 0.1
044
Epoch 148/300
15/15 [==============================] - 3s 218ms/step - loss: 0.0702 - val_loss: 0.1
046
Epoch 149/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0700 - val_loss: 0.1
045
Epoch 150/300
15/15 [==============================] - 3s 211ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 151/300
15/15 [==============================] - 3s 207ms/step - loss: 0.0700 - val_loss: 0.1
048
Epoch 152/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0702 - val_loss: 0.1
050
Epoch 153/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0703 - val_loss: 0.1
049
Epoch 154/300
15/15 [==============================] - 3s 205ms/step - loss: 0.0702 - val_loss: 0.1
049
Epoch 155/300
15/15 [==============================] - 3s 232ms/step - loss: 0.0704 - val_loss: 0.1
052
Epoch 156/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0702 - val_loss: 0.1
053
Epoch 157/300
15/15 [==============================] - 3s 202ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 158/300
15/15 [==============================] - 3s 204ms/step - loss: 0.0702 - val_loss: 0.1
053
Epoch 159/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0701 - val_loss: 0.1
048
Epoch 160/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0703 - val_loss: 0.1
054
```

```
Epoch 161/300
15/15 [==============================] - 3s 232ms/step - loss: 0.0704 - val_loss: 0.1
051
Epoch 162/300
15/15 [==============================] - 3s 220ms/step - loss: 0.0704 - val_loss: 0.1
054
Epoch 163/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0701 - val_loss: 0.1
046
Epoch 164/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0699 - val_loss: 0.1
053
Epoch 165/300
15/15 [==============================] - 4s 235ms/step - loss: 0.0700 - val_loss: 0.1
047
Epoch 166/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0701 - val_loss: 0.1
054
Epoch 167/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0701 - val_loss: 0.1
052
Epoch 168/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0701 - val_loss: 0.1
056
Epoch 169/300
15/15 [==============================] - 3s 232ms/step - loss: 0.0701 - val_loss: 0.1
057
Epoch 170/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0702 - val_loss: 0.1
051
Epoch 171/300
15/15 [==============================] - 3s 230ms/step - loss: 0.0699 - val_loss: 0.1
053
Epoch 172/300
15/15 [==============================] - 4s 234ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 173/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0699 - val_loss: 0.1
053
Epoch 174/300
15/15 [==============================] - 3s 210ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 175/300
15/15 [==============================] - 3s 207ms/step - loss: 0.0701 - val_loss: 0.1
046
Epoch 176/300
15/15 [==============================] - 3s 216ms/step - loss: 0.0700 - val_loss: 0.1
040
Epoch 177/300
15/15 [==============================] - 3s 197ms/step - loss: 0.0701 - val_loss: 0.1
041
Epoch 178/300
15/15 [==============================] - 3s 191ms/step - loss: 0.0701 - val_loss: 0.1
043
Epoch 179/300
15/15 [==============================] - 3s 201ms/step - loss: 0.0701 - val_loss: 0.1
052
Epoch 180/300
15/15 [==============================] - 3s 200ms/step - loss: 0.0702 - val_loss: 0.1
053
```

```
Epoch 181/300
15/15 [==============================] - 3s 199ms/step - loss: 0.0702 - val_loss: 0.1
050
Epoch 182/300
15/15 [==============================] - 3s 196ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 183/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0701 - val_loss: 0.1
048
Epoch 184/300
15/15 [==============================] - 3s 210ms/step - loss: 0.0702 - val_loss: 0.1
056
Epoch 185/300
15/15 [==============================] - 3s 203ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 186/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0701 - val_loss: 0.1
052
Epoch 187/300
15/15 [==============================] - 3s 192ms/step - loss: 0.0700 - val_loss: 0.1
046
Epoch 188/300
15/15 [==============================] - 3s 193ms/step - loss: 0.0700 - val_loss: 0.1
048
Epoch 189/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0700 - val_loss: 0.1
053
Epoch 190/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 191/300
15/15 [==============================] - 3s 223ms/step - loss: 0.0700 - val_loss: 0.1
049
Epoch 192/300
15/15 [==============================] - 3s 216ms/step - loss: 0.0699 - val_loss: 0.1
050
Epoch 193/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 194/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0701 - val_loss: 0.1
049
Epoch 195/300
15/15 [==============================] - 4s 276ms/step - loss: 0.0702 - val_loss: 0.1
047
Epoch 196/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0701 - val_loss: 0.1
044
Epoch 197/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0702 - val_loss: 0.1
045
Epoch 198/300
15/15 [==============================] - 3s 223ms/step - loss: 0.0701 - val_loss: 0.1
043
Epoch 199/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0702 - val_loss: 0.1
052
Epoch 200/300
15/15 [==============================] - 4s 252ms/step - loss: 0.0701 - val_loss: 0.1
048
```

```
Epoch 201/300
15/15 [==============================] - 4s 238ms/step - loss: 0.0701 - val_loss: 0.1
047
Epoch 202/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0702 - val_loss: 0.1
051
Epoch 203/300
15/15 [==============================] - 3s 204ms/step - loss: 0.0700 - val_loss: 0.1
048
Epoch 204/300
15/15 [==============================] - 3s 212ms/step - loss: 0.0699 - val_loss: 0.1
046
Epoch 205/300
15/15 [==============================] - 3s 219ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 206/300
15/15 [==============================] - 3s 211ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 207/300
15/15 [==============================] - 3s 195ms/step - loss: 0.0700 - val_loss: 0.1
052
Epoch 208/300
15/15 [==============================] - 3s 221ms/step - loss: 0.0702 - val_loss: 0.1
050
Epoch 209/300
15/15 [==============================] - 3s 220ms/step - loss: 0.0702 - val_loss: 0.1
051
Epoch 210/300
15/15 [==============================] - 3s 204ms/step - loss: 0.0703 - val_loss: 0.1
041
Epoch 211/300
15/15 [==============================] - 3s 193ms/step - loss: 0.0699 - val_loss: 0.1
039
Epoch 212/300
15/15 [==============================] - 3s 190ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 213/300
15/15 [==============================] - 3s 197ms/step - loss: 0.0700 - val_loss: 0.1
045
Epoch 214/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0700 - val_loss: 0.1
053
Epoch 215/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0701 - val_loss: 0.1
053
Epoch 216/300
15/15 [==============================] - 4s 249ms/step - loss: 0.0699 - val_loss: 0.1
050
Epoch 217/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0699 - val_loss: 0.1
049
Epoch 218/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0700 - val_loss: 0.1
050
Epoch 219/300
15/15 [==============================] - 3s 229ms/step - loss: 0.0698 - val_loss: 0.1
052
Epoch 220/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0700 - val_loss: 0.1
048
```

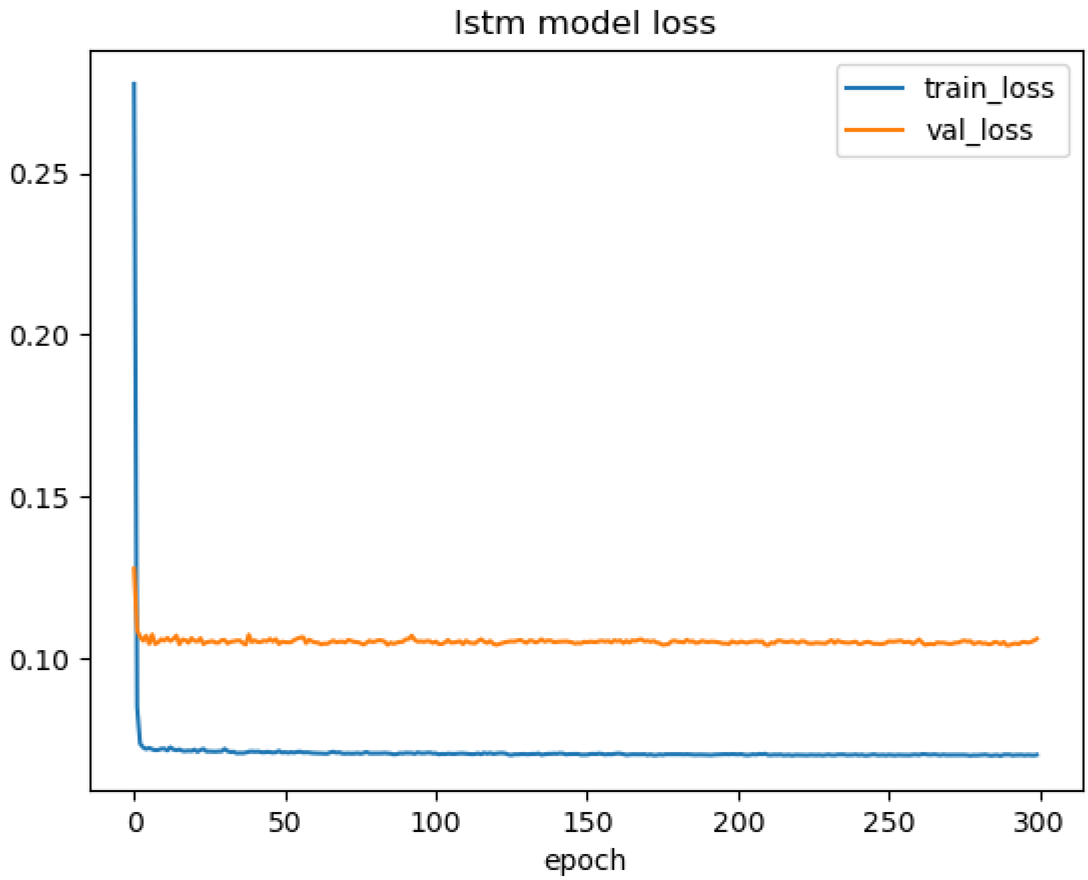
```
Epoch 221/300
15/15 [==============================] - 3s 206ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 222/300
15/15 [==============================] - 3s 218ms/step - loss: 0.0699 - val_loss: 0.1
052
Epoch 223/300
15/15 [==============================] - 3s 234ms/step - loss: 0.0700 - val_loss: 0.1
051
Epoch 224/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 225/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0700 - val_loss: 0.1
045
Epoch 226/300
15/15 [==============================] - 4s 256ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 227/300
15/15 [==============================] - 4s 241ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 228/300
15/15 [==============================] - 3s 231ms/step - loss: 0.0700 - val_loss: 0.1
046
Epoch 229/300
15/15 [==============================] - 4s 256ms/step - loss: 0.0698 - val_loss: 0.1
045
Epoch 230/300
15/15 [==============================] - 4s 248ms/step - loss: 0.0700 - val_loss: 0.1
044
Epoch 231/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 232/300
15/15 [==============================] - 4s 251ms/step - loss: 0.0699 - val_loss: 0.1
054
Epoch 233/300
15/15 [==============================] - 4s 265ms/step - loss: 0.0699 - val_loss: 0.1
046
Epoch 234/300
15/15 [==============================] - 4s 270ms/step - loss: 0.0701 - val_loss: 0.1
053
Epoch 235/300
15/15 [==============================] - 4s 269ms/step - loss: 0.0701 - val_loss: 0.1
050
Epoch 236/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0701 - val_loss: 0.1
048
Epoch 237/300
15/15 [==============================] - 4s 260ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 238/300
15/15 [==============================] - 3s 231ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 239/300
15/15 [==============================] - 4s 247ms/step - loss: 0.0699 - val_loss: 0.1
049
Epoch 240/300
15/15 [==============================] - 4s 248ms/step - loss: 0.0701 - val_loss: 0.1
050
```

```
Epoch 241/300
15/15 [==============================] - 4s 239ms/step - loss: 0.0699 - val_loss: 0.1
043
Epoch 242/300
15/15 [==============================] - 3s 234ms/step - loss: 0.0700 - val_loss: 0.1
044
Epoch 243/300
15/15 [==============================] - 3s 233ms/step - loss: 0.0698 - val_loss: 0.1
048
Epoch 244/300
15/15 [==============================] - 4s 303ms/step - loss: 0.0698 - val_loss: 0.1
050
Epoch 245/300
15/15 [==============================] - 4s 275ms/step - loss: 0.0700 - val_loss: 0.1
047
Epoch 246/300
15/15 [==============================] - 4s 233ms/step - loss: 0.0701 - val_loss: 0.1
043
Epoch 247/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0699 - val_loss: 0.1
044
Epoch 248/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0699 - val_loss: 0.1
043
Epoch 249/300
15/15 [==============================] - 4s 237ms/step - loss: 0.0700 - val_loss: 0.1
043
Epoch 250/300
15/15 [==============================] - 3s 222ms/step - loss: 0.0698 - val_loss: 0.1
046
Epoch 251/300
15/15 [==============================] - 4s 236ms/step - loss: 0.0700 - val_loss: 0.1
052
Epoch 252/300
15/15 [==============================] - 3s 213ms/step - loss: 0.0699 - val_loss: 0.1
050
Epoch 253/300
15/15 [==============================] - 3s 218ms/step - loss: 0.0698 - val_loss: 0.1
051
Epoch 254/300
15/15 [==============================] - 4s 250ms/step - loss: 0.0700 - val_loss: 0.1
052
Epoch 255/300
15/15 [==============================] - 3s 227ms/step - loss: 0.0699 - val_loss: 0.1
053
Epoch 256/300
15/15 [==============================] - 3s 196ms/step - loss: 0.0699 - val_loss: 0.1
048
Epoch 257/300
15/15 [==============================] - 3s 193ms/step - loss: 0.0699 - val_loss: 0.1
050
Epoch 258/300
15/15 [==============================] - 3s 196ms/step - loss: 0.0699 - val_loss: 0.1
050
Epoch 259/300
15/15 [==============================] - 4s 254ms/step - loss: 0.0700 - val_loss: 0.1
043
Epoch 260/300
15/15 [==============================] - 4s 263ms/step - loss: 0.0700 - val_loss: 0.1
050
```

```
Epoch 261/300
15/15 [==============================] - 4s 270ms/step - loss: 0.0699 - val_loss: 0.1
057
Epoch 262/300
15/15 [==============================] - 4s 244ms/step - loss: 0.0702 - val_loss: 0.1
048
Epoch 263/300
15/15 [==============================] - 4s 273ms/step - loss: 0.0702 - val_loss: 0.1
040
Epoch 264/300
15/15 [==============================] - 4s 263ms/step - loss: 0.0700 - val_loss: 0.1
043
Epoch 265/300
15/15 [==============================] - 4s 265ms/step - loss: 0.0700 - val_loss: 0.1
043
Epoch 266/300
15/15 [==============================] - 4s 252ms/step - loss: 0.0701 - val_loss: 0.1
042
Epoch 267/300
15/15 [==============================] - 3s 225ms/step - loss: 0.0700 - val_loss: 0.1
048
Epoch 268/300
15/15 [==============================] - 4s 275ms/step - loss: 0.0699 - val_loss: 0.1
046
Epoch 269/300
15/15 [==============================] - 5s 308ms/step - loss: 0.0700 - val_loss: 0.1
047
Epoch 270/300
15/15 [==============================] - 4s 262ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 271/300
15/15 [==============================] - 4s 250ms/step - loss: 0.0699 - val_loss: 0.1
043
Epoch 272/300
15/15 [==============================] - 4s 303ms/step - loss: 0.0699 - val_loss: 0.1
044
Epoch 273/300
15/15 [==============================] - 4s 293ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 274/300
15/15 [==============================] - 4s 264ms/step - loss: 0.0700 - val_loss: 0.1
047
Epoch 275/300
15/15 [==============================] - 4s 267ms/step - loss: 0.0700 - val_loss: 0.1
051
Epoch 276/300
15/15 [==============================] - 4s 242ms/step - loss: 0.0699 - val_loss: 0.1
054
Epoch 277/300
15/15 [==============================] - 4s 253ms/step - loss: 0.0699 - val_loss: 0.1
051
Epoch 278/300
15/15 [==============================] - 3s 231ms/step - loss: 0.0697 - val_loss: 0.1
052
Epoch 279/300
15/15 [==============================] - 4s 239ms/step - loss: 0.0699 - val_loss: 0.1
043
Epoch 280/300
15/15 [==============================] - 4s 247ms/step - loss: 0.0698 - val_loss: 0.1
046
```

```
Epoch 281/300
15/15 [==============================] - 4s 245ms/step - loss: 0.0699 - val_loss: 0.1
048
Epoch 282/300
15/15 [==============================] - 3s 224ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 283/300
15/15 [==============================] - 3s 217ms/step - loss: 0.0700 - val_loss: 0.1
046
Epoch 284/300
15/15 [==============================] - 3s 230ms/step - loss: 0.0698 - val_loss: 0.1
042
Epoch 285/300
15/15 [==============================] - 3s 214ms/step - loss: 0.0697 - val_loss: 0.1
043
Epoch 286/300
15/15 [==============================] - 3s 208ms/step - loss: 0.0699 - val_loss: 0.1
049
Epoch 287/300
15/15 [==============================] - 3s 231ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 288/300
15/15 [==============================] - 4s 235ms/step - loss: 0.0696 - val_loss: 0.1
043
Epoch 289/300
15/15 [==============================] - 4s 276ms/step - loss: 0.0700 - val_loss: 0.1
049
Epoch 290/300
15/15 [==============================] - 5s 367ms/step - loss: 0.0700 - val_loss: 0.1
039
Epoch 291/300
15/15 [==============================] - 6s 387ms/step - loss: 0.0700 - val_loss: 0.1
040
Epoch 292/300
15/15 [==============================] - 5s 323ms/step - loss: 0.0698 - val_loss: 0.1
043
Epoch 293/300
15/15 [==============================] - 4s 285ms/step - loss: 0.0699 - val_loss: 0.1
045
Epoch 294/300
15/15 [==============================] - 5s 307ms/step - loss: 0.0699 - val_loss: 0.1
042
Epoch 295/300
15/15 [==============================] - 4s 288ms/step - loss: 0.0700 - val_loss: 0.1
048
Epoch 296/300
15/15 [==============================] - 5s 313ms/step - loss: 0.0698 - val_loss: 0.1
049
Epoch 297/300
15/15 [==============================] - 4s 283ms/step - loss: 0.0699 - val_loss: 0.1
047
Epoch 298/300
15/15 [==============================] - 4s 271ms/step - loss: 0.0699 - val_loss: 0.1
049
Epoch 299/300
15/15 [==============================] - 4s 246ms/step - loss: 0.0698 - val_loss: 0.1
053
Epoch 300/300
15/15 [==============================] - 4s 261ms/step - loss: 0.0700 - val_loss: 0.1
```

```
059
1/1 [==============================] - 6s 6s/step
```



```
Epoch 1/300
17/17 [==============================] - 35s 608ms/step - loss: 0.2646 - val_loss: 0.
1163
Epoch 2/300
17/17 [==============================] - 5s 319ms/step - loss: 0.0856 - val_loss: 0.1
008
Epoch 3/300
17/17 [==============================] - 5s 325ms/step - loss: 0.0774 - val_loss: 0.0
977
Epoch 4/300
17/17 [==============================] - 6s 372ms/step - loss: 0.0764 - val_loss: 0.0
970
Epoch 5/300
17/17 [==============================] - 7s 395ms/step - loss: 0.0756 - val_loss: 0.0
979
Epoch 6/300
17/17 [==============================] - 6s 371ms/step - loss: 0.0757 - val_loss: 0.0
967
Epoch 7/300
17/17 [==============================] - 7s 398ms/step - loss: 0.0763 - val_loss: 0.0
969
Epoch 8/300
17/17 [==============================] - 6s 381ms/step - loss: 0.0755 - val_loss: 0.0
973
Epoch 9/300
17/17 [==============================] - 6s 383ms/step - loss: 0.0757 - val_loss: 0.0
973
Epoch 10/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0760 - val_loss: 0.0
972
Epoch 11/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0755 - val_loss: 0.0
981
Epoch 12/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0756 - val_loss: 0.0
964
Epoch 13/300
17/17 [==============================] - 6s 376ms/step - loss: 0.0758 - val_loss: 0.0
957
Epoch 14/300
17/17 [==============================] - 5s 311ms/step - loss: 0.0754 - val_loss: 0.0
973
Epoch 15/300
17/17 [==============================] - 6s 333ms/step - loss: 0.0754 - val_loss: 0.0
963
Epoch 16/300
17/17 [==============================] - 6s 332ms/step - loss: 0.0756 - val_loss: 0.0
964
Epoch 17/300
17/17 [==============================] - 6s 351ms/step - loss: 0.0754 - val_loss: 0.0
963
Epoch 18/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0754 - val_loss: 0.0
966
Epoch 19/300
17/17 [==============================] - 5s 296ms/step - loss: 0.0756 - val_loss: 0.0
966
Epoch 20/300
17/17 [==============================] - 5s 302ms/step - loss: 0.0750 - val_loss: 0.0
955
```

```
Epoch 21/300
17/17 [==============================] - 5s 312ms/step - loss: 0.0750 - val_loss: 0.0
972
Epoch 22/300
17/17 [==============================] - 5s 288ms/step - loss: 0.0752 - val_loss: 0.0
955
Epoch 23/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0756 - val_loss: 0.0
966
Epoch 24/300
17/17 [==============================] - 5s 289ms/step - loss: 0.0753 - val_loss: 0.0
968
Epoch 25/300
17/17 [==============================] - 5s 304ms/step - loss: 0.0753 - val_loss: 0.0
965
Epoch 26/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0753 - val_loss: 0.0
976
Epoch 27/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0756 - val_loss: 0.0
965
Epoch 28/300
17/17 [==============================] - 6s 356ms/step - loss: 0.0751 - val_loss: 0.0
976
Epoch 29/300
17/17 [==============================] - 7s 422ms/step - loss: 0.0752 - val_loss: 0.0
961
Epoch 30/300
17/17 [==============================] - 7s 385ms/step - loss: 0.0750 - val_loss: 0.0
961
Epoch 31/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0751 - val_loss: 0.0
969
Epoch 32/300
17/17 [==============================] - 7s 391ms/step - loss: 0.0752 - val_loss: 0.0
984
Epoch 33/300
17/17 [==============================] - 7s 403ms/step - loss: 0.0753 - val_loss: 0.0
968
Epoch 34/300
17/17 [==============================] - 6s 344ms/step - loss: 0.0754 - val_loss: 0.0
974
Epoch 35/300
17/17 [==============================] - 6s 383ms/step - loss: 0.0752 - val_loss: 0.0
966
Epoch 36/300
17/17 [==============================] - 6s 364ms/step - loss: 0.0760 - val_loss: 0.0
964
Epoch 37/300
17/17 [==============================] - 6s 355ms/step - loss: 0.0755 - val_loss: 0.0
978
Epoch 38/300
17/17 [==============================] - 5s 315ms/step - loss: 0.0747 - val_loss: 0.0
957
Epoch 39/300
17/17 [==============================] - 5s 315ms/step - loss: 0.0748 - val_loss: 0.0
963
Epoch 40/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0749 - val_loss: 0.0
968
```

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Epoch 41/300
17/17 [==============================] - 5s 317ms/step - loss: 0.0749 - val_loss: 0.0
965
Epoch 42/300
17/17 [==============================] - 5s 313ms/step - loss: 0.0750 - val_loss: 0.0
963
Epoch 43/300
17/17 [==============================] - 6s 352ms/step - loss: 0.0750 - val_loss: 0.0
965
Epoch 44/300
17/17 [==============================] - 5s 319ms/step - loss: 0.0749 - val_loss: 0.0
965
Epoch 45/300
17/17 [==============================] - 6s 361ms/step - loss: 0.0749 - val_loss: 0.0
959
Epoch 46/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0749 - val_loss: 0.0
958
Epoch 47/300
17/17 [==============================] - 6s 325ms/step - loss: 0.0752 - val_loss: 0.0
965
Epoch 48/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0748 - val_loss: 0.0
967
Epoch 49/300
17/17 [==============================] - 6s 340ms/step - loss: 0.0749 - val_loss: 0.0
964
Epoch 50/300
17/17 [==============================] - 5s 305ms/step - loss: 0.0747 - val_loss: 0.0
961
Epoch 51/300
17/17 [==============================] - 6s 351ms/step - loss: 0.0748 - val_loss: 0.0
969
Epoch 52/300
17/17 [==============================] - 6s 326ms/step - loss: 0.0751 - val_loss: 0.0
960
Epoch 53/300
17/17 [==============================] - 6s 375ms/step - loss: 0.0750 - val_loss: 0.0
964
Epoch 54/300
17/17 [==============================] - 7s 415ms/step - loss: 0.0749 - val_loss: 0.0
955
Epoch 55/300
17/17 [==============================] - 6s 330ms/step - loss: 0.0748 - val_loss: 0.0
965
Epoch 56/300
17/17 [==============================] - 5s 320ms/step - loss: 0.0746 - val_loss: 0.0
965
Epoch 57/300
17/17 [==============================] - 6s 347ms/step - loss: 0.0748 - val_loss: 0.0
956
Epoch 58/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0747 - val_loss: 0.0
962
Epoch 59/300
17/17 [==============================] - 6s 365ms/step - loss: 0.0746 - val_loss: 0.0
959
Epoch 60/300
17/17 [==============================] - 6s 327ms/step - loss: 0.0748 - val_loss: 0.0
958
```

```
Epoch 61/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0748 - val_loss: 0.0
970
Epoch 62/300
17/17 [==============================] - 6s 367ms/step - loss: 0.0748 - val_loss: 0.0
961
Epoch 63/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0747 - val_loss: 0.0
964
Epoch 64/300
17/17 [==============================] - 6s 360ms/step - loss: 0.0745 - val_loss: 0.0
954
Epoch 65/300
17/17 [==============================] - 6s 378ms/step - loss: 0.0751 - val_loss: 0.0
965
Epoch 66/300
17/17 [==============================] - 6s 327ms/step - loss: 0.0748 - val_loss: 0.0
957
Epoch 67/300
17/17 [==============================] - 6s 367ms/step - loss: 0.0746 - val_loss: 0.0
965
Epoch 68/300
17/17 [==============================] - 6s 377ms/step - loss: 0.0747 - val_loss: 0.0
956
Epoch 69/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0746 - val_loss: 0.0
960
Epoch 70/300
17/17 [==============================] - 6s 380ms/step - loss: 0.0748 - val_loss: 0.0
961
Epoch 71/300
17/17 [==============================] - 6s 377ms/step - loss: 0.0745 - val_loss: 0.0
968
Epoch 72/300
17/17 [==============================] - 7s 384ms/step - loss: 0.0746 - val_loss: 0.0
961
Epoch 73/300
17/17 [==============================] - 6s 374ms/step - loss: 0.0748 - val_loss: 0.0
953
Epoch 74/300
17/17 [==============================] - 6s 371ms/step - loss: 0.0748 - val_loss: 0.0
966
Epoch 75/300
17/17 [==============================] - 6s 349ms/step - loss: 0.0749 - val_loss: 0.0
960
Epoch 76/300
17/17 [==============================] - 6s 362ms/step - loss: 0.0746 - val_loss: 0.0
959
Epoch 77/300
17/17 [==============================] - 6s 344ms/step - loss: 0.0749 - val_loss: 0.0
975
Epoch 78/300
17/17 [==============================] - 6s 332ms/step - loss: 0.0747 - val_loss: 0.0
962
Epoch 79/300
17/17 [==============================] - 5s 298ms/step - loss: 0.0747 - val_loss: 0.0
962
Epoch 80/300
17/17 [==============================] - 5s 297ms/step - loss: 0.0745 - val_loss: 0.0
963
```

```
Epoch 81/300
17/17 [==============================] - 6s 354ms/step - loss: 0.0746 - val_loss: 0.0
958
Epoch 82/300
17/17 [==============================] - 5s 322ms/step - loss: 0.0745 - val_loss: 0.0
956
Epoch 83/300
17/17 [==============================] - 5s 312ms/step - loss: 0.0748 - val_loss: 0.0
962
Epoch 84/300
17/17 [==============================] - 5s 319ms/step - loss: 0.0747 - val_loss: 0.0
963
Epoch 85/300
17/17 [==============================] - 5s 294ms/step - loss: 0.0748 - val_loss: 0.0
960
Epoch 86/300
17/17 [==============================] - 5s 318ms/step - loss: 0.0747 - val_loss: 0.0
958
Epoch 87/300
17/17 [==============================] - 5s 313ms/step - loss: 0.0747 - val_loss: 0.0
958
Epoch 88/300
17/17 [==============================] - 5s 300ms/step - loss: 0.0746 - val_loss: 0.0
969
Epoch 89/300
17/17 [==============================] - 6s 373ms/step - loss: 0.0746 - val_loss: 0.0
958
Epoch 90/300
17/17 [==============================] - 7s 394ms/step - loss: 0.0747 - val_loss: 0.0
964
Epoch 91/300
17/17 [==============================] - 8s 462ms/step - loss: 0.0746 - val_loss: 0.0
952
Epoch 92/300
17/17 [==============================] - 8s 482ms/step - loss: 0.0745 - val_loss: 0.0
954
Epoch 93/300
17/17 [==============================] - 8s 455ms/step - loss: 0.0745 - val_loss: 0.0
965
Epoch 94/300
17/17 [==============================] - 7s 419ms/step - loss: 0.0746 - val_loss: 0.0
962
Epoch 95/300
17/17 [==============================] - 7s 429ms/step - loss: 0.0748 - val_loss: 0.0
958
Epoch 96/300
17/17 [==============================] - 8s 466ms/step - loss: 0.0747 - val_loss: 0.0
959
Epoch 97/300
17/17 [==============================] - 7s 386ms/step - loss: 0.0747 - val_loss: 0.0
956
Epoch 98/300
17/17 [==============================] - 7s 390ms/step - loss: 0.0746 - val_loss: 0.0
963
Epoch 99/300
17/17 [==============================] - 7s 401ms/step - loss: 0.0747 - val_loss: 0.0
958
Epoch 100/300
17/17 [==============================] - 7s 384ms/step - loss: 0.0746 - val_loss: 0.0
958
```

```
Epoch 101/300
17/17 [==============================] - 7s 395ms/step - loss: 0.0746 - val_loss: 0.0
971
Epoch 102/300
17/17 [==============================] - 6s 378ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 103/300
17/17 [==============================] - 6s 365ms/step - loss: 0.0746 - val_loss: 0.0
956
Epoch 104/300
17/17 [==============================] - 6s 359ms/step - loss: 0.0747 - val_loss: 0.0
956
Epoch 105/300
17/17 [==============================] - 6s 379ms/step - loss: 0.0745 - val_loss: 0.0
958
Epoch 106/300
17/17 [==============================] - 6s 341ms/step - loss: 0.0744 - val_loss: 0.0
960
Epoch 107/300
17/17 [==============================] - 6s 328ms/step - loss: 0.0747 - val_loss: 0.0
951
Epoch 108/300
17/17 [==============================] - 6s 353ms/step - loss: 0.0746 - val_loss: 0.0
953
Epoch 109/300
17/17 [==============================] - 6s 334ms/step - loss: 0.0746 - val_loss: 0.0
965
Epoch 110/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0746 - val_loss: 0.0
958
Epoch 111/300
17/17 [==============================] - 6s 361ms/step - loss: 0.0747 - val_loss: 0.0
956
Epoch 112/300
17/17 [==============================] - 7s 416ms/step - loss: 0.0746 - val_loss: 0.0
956
Epoch 113/300
17/17 [==============================] - 6s 371ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 114/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0746 - val_loss: 0.0
957
Epoch 115/300
17/17 [==============================] - 6s 367ms/step - loss: 0.0744 - val_loss: 0.0
960
Epoch 116/300
17/17 [==============================] - 6s 382ms/step - loss: 0.0747 - val_loss: 0.0
956
Epoch 117/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0744 - val_loss: 0.0
958
Epoch 118/300
17/17 [==============================] - 6s 346ms/step - loss: 0.0744 - val_loss: 0.0
961
Epoch 119/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0744 - val_loss: 0.0
965
Epoch 120/300
17/17 [==============================] - 6s 366ms/step - loss: 0.0746 - val_loss: 0.0
956
```

```
Epoch 121/300
17/17 [==============================] - 6s 373ms/step - loss: 0.0743 - val_loss: 0.0
955
Epoch 122/300
17/17 [==============================] - 6s 360ms/step - loss: 0.0744 - val_loss: 0.0
959
Epoch 123/300
17/17 [==============================] - 6s 359ms/step - loss: 0.0744 - val_loss: 0.0
962
Epoch 124/300
17/17 [==============================] - 5s 326ms/step - loss: 0.0745 - val_loss: 0.0
951
Epoch 125/300
17/17 [==============================] - 6s 326ms/step - loss: 0.0746 - val_loss: 0.0
955
Epoch 126/300
17/17 [==============================] - 5s 317ms/step - loss: 0.0745 - val_loss: 0.0
958
Epoch 127/300
17/17 [==============================] - 7s 408ms/step - loss: 0.0745 - val_loss: 0.0
957
Epoch 128/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0745 - val_loss: 0.0
961
Epoch 129/300
17/17 [==============================] - 6s 332ms/step - loss: 0.0743 - val_loss: 0.0
958
Epoch 130/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0745 - val_loss: 0.0
958
Epoch 131/300
17/17 [==============================] - 6s 327ms/step - loss: 0.0746 - val_loss: 0.0
963
Epoch 132/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0747 - val_loss: 0.0
962
Epoch 133/300
17/17 [==============================] - 6s 370ms/step - loss: 0.0743 - val_loss: 0.0
953
Epoch 134/300
17/17 [==============================] - 7s 398ms/step - loss: 0.0745 - val_loss: 0.0
957
Epoch 135/300
17/17 [==============================] - 6s 371ms/step - loss: 0.0745 - val_loss: 0.0
970
Epoch 136/300
17/17 [==============================] - 6s 357ms/step - loss: 0.0747 - val_loss: 0.0
968
Epoch 137/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0745 - val_loss: 0.0
954
Epoch 138/300
17/17 [==============================] - 6s 330ms/step - loss: 0.0745 - val_loss: 0.0
962
Epoch 139/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0745 - val_loss: 0.0
955
Epoch 140/300
17/17 [==============================] - 6s 332ms/step - loss: 0.0743 - val_loss: 0.0
953
```

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Epoch 141/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 142/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0743 - val_loss: 0.0
957
Epoch 143/300
17/17 [==============================] - 6s 341ms/step - loss: 0.0744 - val_loss: 0.0
960
Epoch 144/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 145/300
17/17 [==============================] - 6s 355ms/step - loss: 0.0744 - val_loss: 0.0
961
Epoch 146/300
17/17 [==============================] - 6s 360ms/step - loss: 0.0743 - val_loss: 0.0
957
Epoch 147/300
17/17 [==============================] - 6s 348ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 148/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 149/300
17/17 [==============================] - 6s 351ms/step - loss: 0.0743 - val_loss: 0.0
963
Epoch 150/300
17/17 [==============================] - 6s 336ms/step - loss: 0.0745 - val_loss: 0.0
954
Epoch 151/300
17/17 [==============================] - 6s 340ms/step - loss: 0.0744 - val_loss: 0.0
964
Epoch 152/300
17/17 [==============================] - 6s 344ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 153/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0743 - val_loss: 0.0
959
Epoch 154/300
17/17 [==============================] - 5s 322ms/step - loss: 0.0744 - val_loss: 0.0
960
Epoch 155/300
17/17 [==============================] - 6s 325ms/step - loss: 0.0743 - val_loss: 0.0
952
Epoch 156/300
17/17 [==============================] - 6s 354ms/step - loss: 0.0742 - val_loss: 0.0
952
Epoch 157/300
17/17 [==============================] - 7s 380ms/step - loss: 0.0742 - val_loss: 0.0
955
Epoch 158/300
17/17 [==============================] - 6s 359ms/step - loss: 0.0741 - val_loss: 0.0
956
Epoch 159/300
17/17 [==============================] - 5s 313ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 160/300
17/17 [==============================] - 6s 325ms/step - loss: 0.0742 - val_loss: 0.0
956
```

```
Epoch 161/300
17/17 [==============================] - 5s 297ms/step - loss: 0.0743 - val_loss: 0.0
961
Epoch 162/300
17/17 [==============================] - 5s 324ms/step - loss: 0.0743 - val_loss: 0.0
963
Epoch 163/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0744 - val_loss: 0.0
958
Epoch 164/300
17/17 [==============================] - 5s 295ms/step - loss: 0.0743 - val_loss: 0.0
953
Epoch 165/300
17/17 [==============================] - 5s 296ms/step - loss: 0.0744 - val_loss: 0.0
955
Epoch 166/300
17/17 [==============================] - 5s 304ms/step - loss: 0.0744 - val_loss: 0.0
961
Epoch 167/300
17/17 [==============================] - 5s 326ms/step - loss: 0.0744 - val_loss: 0.0
956
Epoch 168/300
17/17 [==============================] - 7s 411ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 169/300
17/17 [==============================] - 7s 386ms/step - loss: 0.0743 - val_loss: 0.0
952
Epoch 170/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0744 - val_loss: 0.0
951
Epoch 171/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0742 - val_loss: 0.0
957
Epoch 172/300
17/17 [==============================] - 5s 309ms/step - loss: 0.0743 - val_loss: 0.0
949
Epoch 173/300
17/17 [==============================] - 5s 305ms/step - loss: 0.0744 - val_loss: 0.0
958
Epoch 174/300
17/17 [==============================] - 6s 345ms/step - loss: 0.0743 - val_loss: 0.0
958
Epoch 175/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0744 - val_loss: 0.0
955
Epoch 176/300
17/17 [==============================] - 6s 381ms/step - loss: 0.0745 - val_loss: 0.0
958
Epoch 177/300
17/17 [==============================] - 6s 365ms/step - loss: 0.0743 - val_loss: 0.0
960
Epoch 178/300
17/17 [==============================] - 6s 328ms/step - loss: 0.0745 - val_loss: 0.0
958
Epoch 179/300
17/17 [==============================] - 6s 333ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 180/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0742 - val_loss: 0.0
956
```

```
Epoch 181/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0744 - val_loss: 0.0
959
Epoch 182/300
17/17 [==============================] - 6s 331ms/step - loss: 0.0744 - val_loss: 0.0
952
Epoch 183/300
17/17 [==============================] - 6s 326ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 184/300
17/17 [==============================] - 5s 297ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 185/300
17/17 [==============================] - 6s 327ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 186/300
17/17 [==============================] - 5s 304ms/step - loss: 0.0743 - val_loss: 0.0
959
Epoch 187/300
17/17 [==============================] - 6s 340ms/step - loss: 0.0744 - val_loss: 0.0
964
Epoch 188/300
17/17 [==============================] - 6s 359ms/step - loss: 0.0743 - val_loss: 0.0
955
Epoch 189/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 190/300
17/17 [==============================] - 6s 331ms/step - loss: 0.0743 - val_loss: 0.0
963
Epoch 191/300
17/17 [==============================] - 6s 350ms/step - loss: 0.0746 - val_loss: 0.0
955
Epoch 192/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0741 - val_loss: 0.0
949
Epoch 193/300
17/17 [==============================] - 6s 332ms/step - loss: 0.0744 - val_loss: 0.0
953
Epoch 194/300
17/17 [==============================] - 6s 352ms/step - loss: 0.0745 - val_loss: 0.0
956
Epoch 195/300
17/17 [==============================] - 6s 334ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 196/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0743 - val_loss: 0.0
961
Epoch 197/300
17/17 [==============================] - 5s 304ms/step - loss: 0.0744 - val_loss: 0.0
950
Epoch 198/300
17/17 [==============================] - 5s 290ms/step - loss: 0.0744 - val_loss: 0.0
959
Epoch 199/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0744 - val_loss: 0.0
953
Epoch 200/300
17/17 [==============================] - 6s 373ms/step - loss: 0.0744 - val_loss: 0.0
954
```

```
Epoch 201/300
17/17 [==============================] - 5s 317ms/step - loss: 0.0744 - val_loss: 0.0
956
Epoch 202/300
17/17 [==============================] - 5s 314ms/step - loss: 0.0745 - val_loss: 0.0
951
Epoch 203/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0746 - val_loss: 0.0
955
Epoch 204/300
17/17 [==============================] - 6s 343ms/step - loss: 0.0744 - val_loss: 0.0
955
Epoch 205/300
17/17 [==============================] - 5s 321ms/step - loss: 0.0743 - val_loss: 0.0
952
Epoch 206/300
17/17 [==============================] - 6s 335ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 207/300
17/17 [==============================] - 6s 328ms/step - loss: 0.0743 - val_loss: 0.0
954
Epoch 208/300
17/17 [==============================] - 5s 314ms/step - loss: 0.0742 - val_loss: 0.0
951
Epoch 209/300
17/17 [==============================] - 5s 317ms/step - loss: 0.0743 - val_loss: 0.0
949
Epoch 210/300
17/17 [==============================] - 5s 311ms/step - loss: 0.0742 - val_loss: 0.0
956
Epoch 211/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 212/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0743 - val_loss: 0.0
960
Epoch 213/300
17/17 [==============================] - 6s 350ms/step - loss: 0.0744 - val_loss: 0.0
952
Epoch 214/300
17/17 [==============================] - 7s 411ms/step - loss: 0.0741 - val_loss: 0.0
955
Epoch 215/300
17/17 [==============================] - 6s 362ms/step - loss: 0.0743 - val_loss: 0.0
957
Epoch 216/300
17/17 [==============================] - 6s 347ms/step - loss: 0.0743 - val_loss: 0.0
958
Epoch 217/300
17/17 [==============================] - 7s 397ms/step - loss: 0.0742 - val_loss: 0.0
956
Epoch 218/300
17/17 [==============================] - 6s 382ms/step - loss: 0.0740 - val_loss: 0.0
961
Epoch 219/300
17/17 [==============================] - 7s 396ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 220/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0742 - val_loss: 0.0
954
```

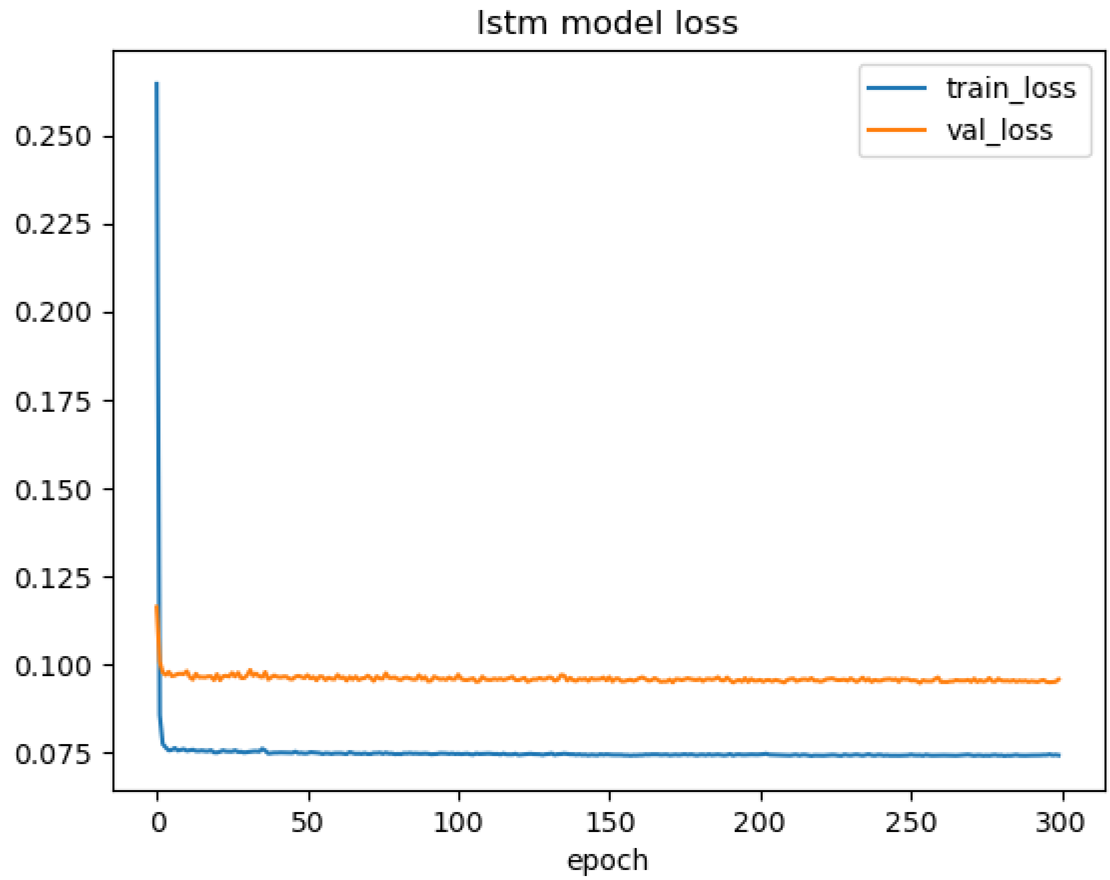
```
Epoch 221/300
17/17 [==============================] - 6s 370ms/step - loss: 0.0741 - val_loss: 0.0
951
Epoch 222/300
17/17 [==============================] - 6s 333ms/step - loss: 0.0741 - val_loss: 0.0
954
Epoch 223/300
17/17 [==============================] - 6s 344ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 224/300
17/17 [==============================] - 6s 334ms/step - loss: 0.0743 - val_loss: 0.0
959
Epoch 225/300
17/17 [==============================] - 6s 370ms/step - loss: 0.0743 - val_loss: 0.0
960
Epoch 226/300
17/17 [==============================] - 5s 325ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 227/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0741 - val_loss: 0.0
955
Epoch 228/300
17/17 [==============================] - 5s 312ms/step - loss: 0.0741 - val_loss: 0.0
956
Epoch 229/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0744 - val_loss: 0.0
957
Epoch 230/300
17/17 [==============================] - 6s 321ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 231/300
17/17 [==============================] - 6s 326ms/step - loss: 0.0742 - val_loss: 0.0
960
Epoch 232/300
17/17 [==============================] - 6s 376ms/step - loss: 0.0743 - val_loss: 0.0
955
Epoch 233/300
17/17 [==============================] - 6s 377ms/step - loss: 0.0744 - val_loss: 0.0
951
Epoch 234/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 235/300
17/17 [==============================] - 6s 341ms/step - loss: 0.0741 - val_loss: 0.0
962
Epoch 236/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0743 - val_loss: 0.0
953
Epoch 237/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0745 - val_loss: 0.0
959
Epoch 238/300
17/17 [==============================] - 6s 362ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 239/300
17/17 [==============================] - 6s 336ms/step - loss: 0.0741 - val_loss: 0.0
956
Epoch 240/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0743 - val_loss: 0.0
954
```

```
Epoch 241/300
17/17 [==============================] - 7s 400ms/step - loss: 0.0743 - val_loss: 0.0
953
Epoch 242/300
17/17 [==============================] - 6s 335ms/step - loss: 0.0741 - val_loss: 0.0
957
Epoch 243/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 244/300
17/17 [==============================] - 6s 358ms/step - loss: 0.0741 - val_loss: 0.0
959
Epoch 245/300
17/17 [==============================] - 5s 312ms/step - loss: 0.0742 - val_loss: 0.0
956
Epoch 246/300
17/17 [==============================] - 5s 308ms/step - loss: 0.0741 - val_loss: 0.0
958
Epoch 247/300
17/17 [==============================] - 6s 329ms/step - loss: 0.0741 - val_loss: 0.0
950
Epoch 248/300
17/17 [==============================] - 5s 291ms/step - loss: 0.0742 - val_loss: 0.0
959
Epoch 249/300
17/17 [==============================] - 5s 303ms/step - loss: 0.0742 - val_loss: 0.0
957
Epoch 250/300
17/17 [==============================] - 5s 304ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 251/300
17/17 [==============================] - 5s 323ms/step - loss: 0.0744 - val_loss: 0.0
954
Epoch 252/300
17/17 [==============================] - 6s 378ms/step - loss: 0.0742 - val_loss: 0.0
955
Epoch 253/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 254/300
17/17 [==============================] - 5s 313ms/step - loss: 0.0742 - val_loss: 0.0
947
Epoch 255/300
17/17 [==============================] - 5s 317ms/step - loss: 0.0741 - val_loss: 0.0
955
Epoch 256/300
17/17 [==============================] - 6s 328ms/step - loss: 0.0743 - val_loss: 0.0
953
Epoch 257/300
17/17 [==============================] - 5s 316ms/step - loss: 0.0742 - val_loss: 0.0
952
Epoch 258/300
17/17 [==============================] - 6s 334ms/step - loss: 0.0741 - val_loss: 0.0
952
Epoch 259/300
17/17 [==============================] - 5s 320ms/step - loss: 0.0742 - val_loss: 0.0
958
Epoch 260/300
17/17 [==============================] - 6s 328ms/step - loss: 0.0742 - val_loss: 0.0
963
```

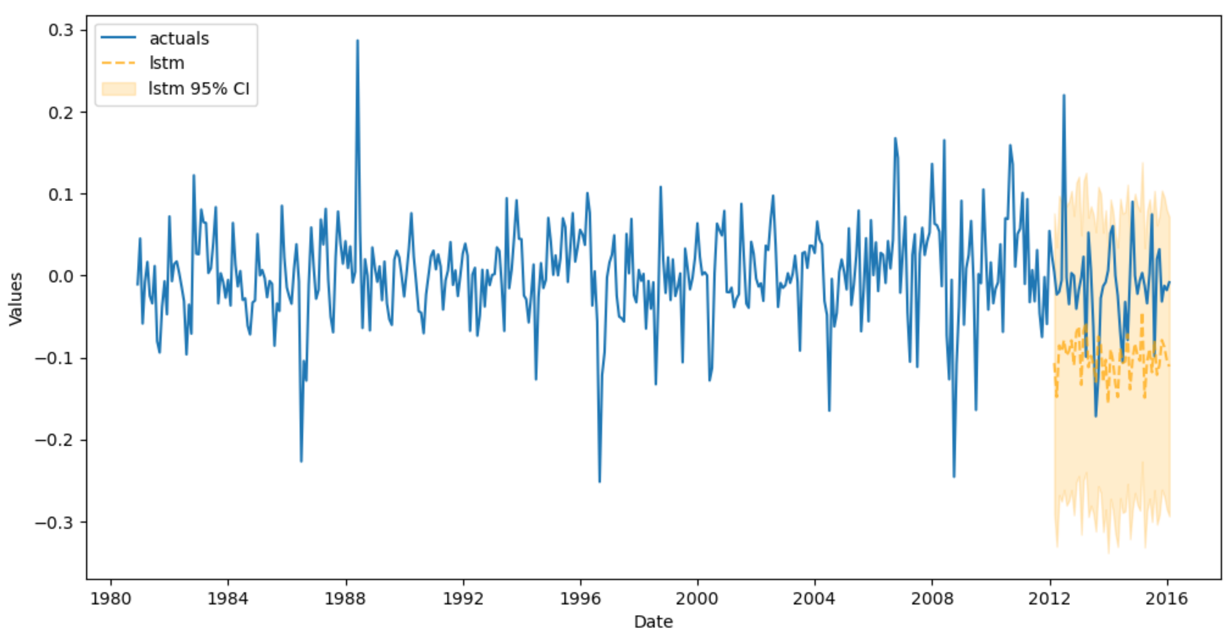
```
Epoch 261/300
17/17 [==============================] - 6s 337ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 262/300
17/17 [==============================] - 6s 342ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 263/300
17/17 [==============================] - 6s 338ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 264/300
17/17 [==============================] - 6s 360ms/step - loss: 0.0742 - val_loss: 0.0
952
Epoch 265/300
17/17 [==============================] - 6s 341ms/step - loss: 0.0741 - val_loss: 0.0
952
Epoch 266/300
17/17 [==============================] - 6s 386ms/step - loss: 0.0741 - val_loss: 0.0
955
Epoch 267/300
17/17 [==============================] - 6s 376ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 268/300
17/17 [==============================] - 6s 356ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 269/300
17/17 [==============================] - 6s 378ms/step - loss: 0.0743 - val_loss: 0.0
954
Epoch 270/300
17/17 [==============================] - 6s 369ms/step - loss: 0.0744 - val_loss: 0.0
956
Epoch 271/300
17/17 [==============================] - 7s 388ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 272/300
17/17 [==============================] - 7s 386ms/step - loss: 0.0741 - val_loss: 0.0
960
Epoch 273/300
17/17 [==============================] - 6s 379ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 274/300
17/17 [==============================] - 6s 357ms/step - loss: 0.0742 - val_loss: 0.0
955
Epoch 275/300
17/17 [==============================] - 6s 331ms/step - loss: 0.0741 - val_loss: 0.0
951
Epoch 276/300
17/17 [==============================] - 6s 359ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 277/300
17/17 [==============================] - 7s 394ms/step - loss: 0.0741 - val_loss: 0.0
961
Epoch 278/300
17/17 [==============================] - 7s 389ms/step - loss: 0.0742 - val_loss: 0.0
952
Epoch 279/300
17/17 [==============================] - 6s 384ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 280/300
17/17 [==============================] - 6s 383ms/step - loss: 0.0741 - val_loss: 0.0
959
```

```
Epoch 281/300
17/17 [==============================] - 7s 399ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 282/300
17/17 [==============================] - 7s 403ms/step - loss: 0.0740 - val_loss: 0.0
953
Epoch 283/300
17/17 [==============================] - 6s 339ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 284/300
17/17 [==============================] - 6s 363ms/step - loss: 0.0741 - val_loss: 0.0
952
Epoch 285/300
17/17 [==============================] - 6s 322ms/step - loss: 0.0742 - val_loss: 0.0
955
Epoch 286/300
17/17 [==============================] - 6s 361ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 287/300
17/17 [==============================] - 7s 396ms/step - loss: 0.0741 - val_loss: 0.0
954
Epoch 288/300
17/17 [==============================] - 6s 379ms/step - loss: 0.0741 - val_loss: 0.0
952
Epoch 289/300
17/17 [==============================] - 6s 380ms/step - loss: 0.0741 - val_loss: 0.0
954
Epoch 290/300
17/17 [==============================] - 6s 366ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 291/300
17/17 [==============================] - 6s 368ms/step - loss: 0.0742 - val_loss: 0.0
953
Epoch 292/300
17/17 [==============================] - 6s 334ms/step - loss: 0.0742 - val_loss: 0.0
951
Epoch 293/300
17/17 [==============================] - 6s 333ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 294/300
17/17 [==============================] - 6s 357ms/step - loss: 0.0742 - val_loss: 0.0
954
Epoch 295/300
17/17 [==============================] - 6s 341ms/step - loss: 0.0743 - val_loss: 0.0
956
Epoch 296/300
17/17 [==============================] - 6s 372ms/step - loss: 0.0743 - val_loss: 0.0
950
Epoch 297/300
17/17 [==============================] - 6s 371ms/step - loss: 0.0745 - val_loss: 0.0
949
Epoch 298/300
17/17 [==============================] - 6s 362ms/step - loss: 0.0742 - val_loss: 0.0
950
Epoch 299/300
17/17 [==============================] - 6s 382ms/step - loss: 0.0743 - val_loss: 0.0
951
Epoch 300/300
17/17 [==============================] - 6s 376ms/step - loss: 0.0742 - val_loss: 0.0
957
```

```
1/1 [==============================] - 6s 6s/step
11/11 [==============================] - 1s 128ms/step
```



Out[16]: `<Axes: xlabel='Date', ylabel='Values'>`



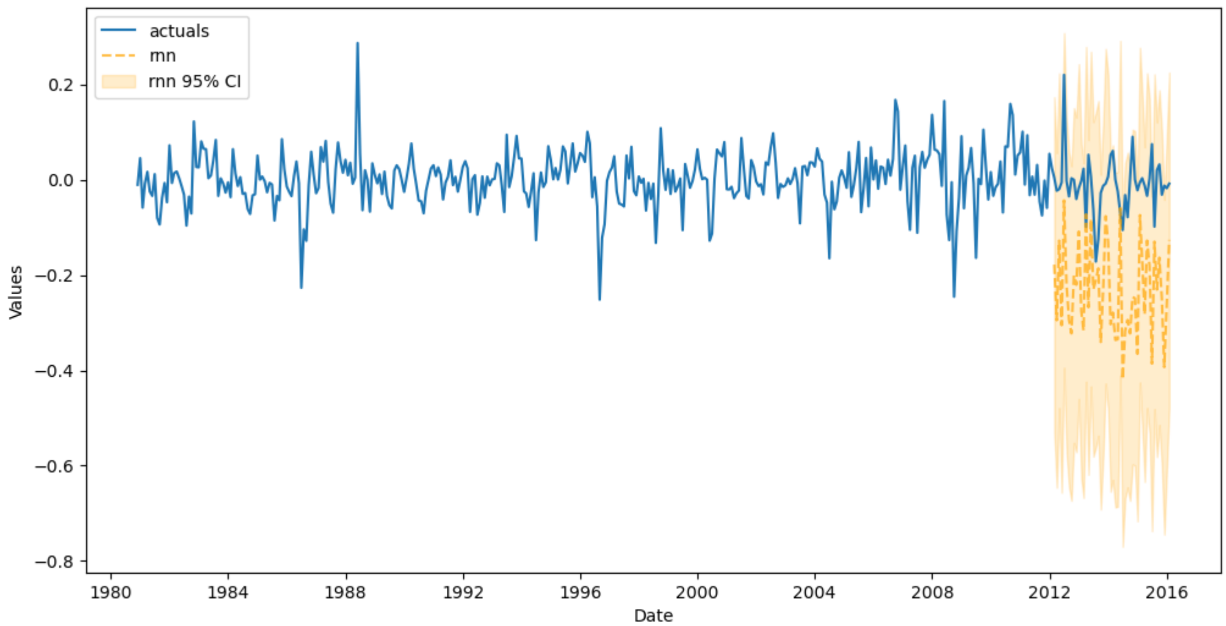
In [17]:
```
f.set_estimator('rnn')
f.manual_forecast(
    call_me='rnn',
    lags=6,

)
f.plot_test_set(ci=True, models='rnn')
```

```
11/11 [==============================] - 1s 2ms/step - loss: 0.4486
1/1 [==============================] - 0s 149ms/step
12/12 [==============================] - 1s 2ms/step - loss: 0.4470
1/1 [==============================] - 0s 127ms/step
12/12 [==============================] - 0s 1ms/step
```

Out[17]:

```
<Axes: xlabel='Date', ylabel='Values'>
```



In [18]:

```
import matplotlib
matplotlib.use("nbAgg")
%matplotlib inline

f.set_estimator('silverkite')
f.manual_forecast(
    call_me='silverkite',

)
f.plot_test_set(ci=True, models='silverkite')
```

Out[18]:

```
<Axes: xlabel='Date', ylabel='Values'>
```

In [19]:

```
#check the current forecasting model
f
```

Out[19]:
```
Forecaster(
    DateStartActuals=1980-12-01T00:00:00.000000000
    DateEndActuals=2016-02-01T00:00:00.000000000
    Freq=MS
    N_actuals=423
    ForecastLength=48
    Xvars=['CPI_diff', 'USA_Avg_Temp', 'interaction_ps_di_diff', 'AR1', 'AR2', 'AR3', 'AR4', 'AR5', 'AR6', 'AR7', 'AR8', 'AR9', 'AR10', 'AR11', 'AR12', 'AR13', 'AR14', 'AR15', 'AR16', 'AR17', 'AR18', 'AR19', 'AR20', 'AR21', 'AR22', 'AR23', 'AR24', 'AR25', 'AR26', 'AR27', 'AR28', 'AR29', 'AR30', 'AR31', 'AR32', 'AR33', 'AR34', 'AR35', 'AR36']
    TestLength=48
    ValidationMetric=rmse
    ForecastsEvaluated=['arima', 'lstm', 'lstm_test', 'rnn', 'silverkite']
    CILevel=0.95
    CurrentEstimator=silverkite
    GridsFile=Grids
)
```

Evaluation

In [20]:
```
f.export('model_summaries',determine_best_by='TestSetMAPE')[
    ['ModelNickname',
     'TestSetMAPE',
     'TestSetRMSE',
     'TestSetR2',
     'best_model']
]
```

Out[20]:

	ModelNickname	TestSetMAPE	TestSetRMSE	TestSetR2	best_model
0	lstm_test	9.500492	0.059380	-0.010701	True
1	arima	10.526358	0.067358	-0.300556	False
2	silverkite	46.328376	0.066486	-0.267082	False
3	lstm	151.536190	0.110654	-2.509805	False
4	rnn	428.203656	0.245166	-16.229365	False

In [21]:
```
ts_preds = f.export('lvl_test_set_predictions')
ts_preds.head()
```

Out[21]:

	DATE	actual	arima	lstm	lstm_test	rnn	silverkite
0	2012-03-01	0.004287	0.018425	-0.106893	-0.006243	-0.178248	0.025546
1	2012-04-01	-0.023255	-0.004498	-0.148176	-0.007602	-0.295018	0.021793
2	2012-05-01	-0.019975	0.006551	-0.085352	-0.008330	-0.128039	0.019367
3	2012-06-01	-0.005823	0.023598	-0.093062	-0.001215	-0.305437	0.017667
4	2012-07-01	0.219890	-0.065216	-0.078934	0.000299	-0.043556	-0.008388

In [22]:
```
ts_preds['actual_move'] = ts_preds['actual'].diff()
ts_preds['rnn_move'] = ts_preds['rnn'].diff()
ts_preds['silverkite_move'] = ts_preds['silverkite'].diff()
```

```
ts_preds['lstm_move'] = ts_preds['lstm'].diff()
ts_preds['arima_move'] = ts_preds['arima'].diff()
ts_preds = ts_preds.drop(0).reset_index(drop=True)
ts_preds.head()
```

Out[22]:

	DATE	actual	arima	lstm	lstm_test	rnn	silverkite	actual_move	rnn_move	sil
0	2012-04-01	-0.023255	-0.004498	-0.148176	-0.007602	-0.295018	0.021793	-0.027542	-0.116770	
1	2012-05-01	-0.019975	0.006551	-0.085352	-0.008330	-0.128039	0.019367	0.003280	0.166979	
2	2012-06-01	-0.005823	0.023598	-0.093062	-0.001215	-0.305437	0.017667	0.014152	-0.177398	
3	2012-07-01	0.219890	-0.065216	-0.078934	0.000299	-0.043556	-0.008388	0.225713	0.261881	
4	2012-08-01	-0.002339	-0.029598	-0.097974	-0.004258	-0.221059	-0.000455	-0.222230	-0.177503	

In [23]:

```
ts_preds['actual_classification'] = ts_preds['actual_move'].apply(lambda x: 1 if x >=
ts_preds['rnn_classification'] = ts_preds['rnn_move'].apply(lambda x: 1 if x >= 0 else
ts_preds['silverkite_classification'] = ts_preds['silverkite_move'].apply(lambda x: 1
ts_preds['lstm_classification'] = ts_preds['lstm_move'].apply(lambda x: 1 if x >= 0 el
ts_preds['arima_classification'] = ts_preds['arima_move'].apply(lambda x: 1 if x >= 0
ts_preds.head()
```

Out[23]:

	DATE	actual	arima	lstm	lstm_test	rnn	silverkite	actual_move	rnn_move	sil
0	2012-04-01	-0.023255	-0.004498	-0.148176	-0.007602	-0.295018	0.021793	-0.027542	-0.116770	
1	2012-05-01	-0.019975	0.006551	-0.085352	-0.008330	-0.128039	0.019367	0.003280	0.166979	
2	2012-06-01	-0.005823	0.023598	-0.093062	-0.001215	-0.305437	0.017667	0.014152	-0.177398	
3	2012-07-01	0.219890	-0.065216	-0.078934	0.000299	-0.043556	-0.008388	0.225713	0.261881	
4	2012-08-01	-0.002339	-0.029598	-0.097974	-0.004258	-0.221059	-0.000455	-0.222230	-0.177503	

In [24]:

```
from sklearn.metrics import confusion_matrix
# Confusion matrix: actual vs rnn
confusion_rnn = confusion_matrix(ts_preds['actual_classification'], ts_preds['rnn_clas
print("Confusion matrix (actual vs rnn):")
print(confusion_rnn)

# Confusion matrix: actual vs silverkite
confusion_silverkite = confusion_matrix(ts_preds['actual_classification'], ts_preds['s
print("Confusion matrix (actual vs silverkite):")
print(confusion_silverkite)

# Confusion matrix: actual vs lstm
```

```
confusion_lstm = confusion_matrix(ts_preds['actual_classification'], ts_preds['lstm_cl
print("Confusion matrix (actual vs lstm):")
print(confusion_lstm)

# Confusion matrix: actual vs arima
confusion_arima = confusion_matrix(ts_preds['actual_classification'], ts_preds['arima_
print("Confusion matrix (actual vs arima):")
print(confusion_arima)
```

```
Confusion matrix (actual vs rnn):
[[11 10]
 [14 12]]
Confusion matrix (actual vs silverkite):
[[12  9]
 [ 9 17]]
Confusion matrix (actual vs lstm):
[[11 10]
 [13 13]]
Confusion matrix (actual vs arima):
[[10 11]
 [12 14]]
```

In [25]:

```
# Calculate evaluation metrics: actual vs mlr_default
tn_mlr, fp_mlr, fn_mlr, tp_mlr = confusion_rnn.ravel()

accuracy_rnn = (tp_mlr + tn_mlr) / (tp_mlr + tn_mlr + fp_mlr + fn_mlr)
precision_rnn = tp_mlr / (tp_mlr + fp_mlr)
recall_rnn = tp_mlr / (tp_mlr + fn_mlr)
f1_score_rnn = 2 * (precision_rnn * recall_rnn) / (precision_rnn + recall_rnn)

print("Evaluation metrics (actual vs rnn):")
print("Accuracy:", accuracy_rnn)
print("Precision:", precision_rnn)
print("Recall:", recall_rnn)
print("F1 Score:", f1_score_rnn)
print("")
```

```
Evaluation metrics (actual vs rnn):
Accuracy: 0.48936170212765956
Precision: 0.5454545454545454
Recall: 0.46153846153846156
F1 Score: 0.4999999999999999
```

In [26]:

```
# Calculate evaluation metrics: actual vs silverkit
tn_mlr, fp_mlr, fn_mlr, tp_mlr = confusion_silverkite.ravel()

accuracy_silverkite = (tp_mlr + tn_mlr) / (tp_mlr + tn_mlr + fp_mlr + fn_mlr)
precision_silverkite = tp_mlr / (tp_mlr + fp_mlr)
recall_silverkite = tp_mlr / (tp_mlr + fn_mlr)
f1_score_silverkite = 2 * (precision_silverkite * recall_silverkite) / (precision_silv

print("Evaluation metrics (actual vs silverkit):")
print("Accuracy:", accuracy_silverkite)
print("Precision:", precision_silverkite)
print("Recall:", recall_silverkite)
print("F1 Score:", f1_score_silverkite)
print("")
```

```
Evaluation metrics (actual vs silverkit):
Accuracy: 0.6170212765957447
Precision: 0.6538461538461539
Recall: 0.6538461538461539
F1 Score: 0.6538461538461539
```

In [27]:

```
# Calculate evaluation metrics: actual vs lstm
tn_mlr, fp_mlr, fn_mlr, tp_mlr = confusion_lstm.ravel()

accuracy_lstm = (tp_mlr + tn_mlr) / (tp_mlr + tn_mlr + fp_mlr + fn_mlr)
precision_lstm = tp_mlr / (tp_mlr + fp_mlr)
recall_lstm = tp_mlr / (tp_mlr + fn_mlr)
f1_score_lstm = 2 * (precision_lstm * recall_lstm) / (precision_lstm + recall_lstm)

print("Evaluation metrics (actual vs lstm):")
print("Accuracy:", accuracy_lstm)
print("Precision:", precision_lstm)
print("Recall:", recall_lstm)
print("F1 Score:", f1_score_lstm)
print("")
```

```
Evaluation metrics (actual vs lstm):
Accuracy: 0.5106382978723404
Precision: 0.5652173913043478
Recall: 0.5
F1 Score: 0.5306122448979592
```

In [28]:

```
# Calculate evaluation metrics: actual vs arima
tn_mlr, fp_mlr, fn_mlr, tp_mlr = confusion_arima.ravel()

accuracy_arima = (tp_mlr + tn_mlr) / (tp_mlr + tn_mlr + fp_mlr + fn_mlr)
precision_arima = tp_mlr / (tp_mlr + fp_mlr)
recall_arima = tp_mlr / (tp_mlr + fn_mlr)
f1_score_arima = 2 * (precision_arima * recall_arima) / (precision_arima + recall_arin

print("Evaluation metrics (actual vs arima):")
print("Accuracy:", accuracy_arima)
print("Precision:", precision_arima)
print("Recall:", recall_arima)
print("F1 Score:", f1_score_arima)
print("")
```

```
Evaluation metrics (actual vs arima):
Accuracy: 0.5106382978723404
Precision: 0.56
Recall: 0.5384615384615384
F1 Score: 0.5490196078431373
```