Application of RNN's on Time Series Data Assignment Overview

The goal was to apply Recurrent Neural Networks (RNNs), particularly Long Short-Term Memory (LSTM) architectures, to predict weather-related time-series data. The task involved testing various model configurations to improve forecasting accuracy and then analyzing these models' performance visually and quantitatively.

Dataset

- Training Set: `DailyDelhiClimateTrain.csv`
- Test Set: `DailyDelhiClimateTest.csv`
- Features: `meantemp`, `humidity`, `wind_speed`, `meanpressure`
- Target Variable: `meantemp` (average temperature)

Key Steps

1. Data Preprocessing and Visualization:
   - Preprocessed data by normalizing features, ensuring the model converges faster.
   - Visualized monthly averages to identify seasonality and trends.

2. Model Configurations and Training:
   - Configured and trained various models, exploring a mix of:
     - LSTM layers with different unit sizes and depth (2-3 layers)
     - CNN+LSTM hybrid architectures
   - All models were trained on the training data, with the test set used for validation.

3. Performance Tracking and Visualization:
   - Stored each model's metrics and generated graphs comparing actual vs. predicted temperatures.
   - Used validation MAE as the primary metric to assess model accuracy.

Results and Discussion

The models produced varying results based on their architecture and configuration. Here's a summary of key outcomes:

Model	Configuration	Units	Layers	Validation MAE
1	LSTM	32	2	0.049
2	LSTM	64	2	0.046
3	LSTM	128	2	0.046
4	LSTM	32	3	0.046
5	LSTM	64	3	0.045
6	CNN + LSTM	32	2	0.049
7	CNN + LSTM	64	2	0.046
8	CNN + LSTM	128	2	0.045
9	CNN + LSTM	64	3	0.049
10	CNN + LSTM	128	3	0.046

1. Validation MAE Scores:
- Best Performing Models: Models 5 (LSTM with 64 units, 3 layers) and 8 (CNN + LSTM with 128 units, 2 layers) achieved the lowest validation MAE of 0.045.
- Impact of Units and Layers: Models with 3 LSTM layers generally performed well, suggesting deeper architectures can help capture more complex time-series features. However, increasing the units beyond 64 did not significantly improve performance.
- CNN + LSTM Configuration: Adding CNN layers in Models 6-10 showed comparable MAE scores to the LSTM-only models, reinforcing the potential for CNNs to enhance feature extraction in hybrid models.

2. Visual Comparison of Predictions:
- Individual graphs for each model showed how closely the predicted values followed the actual temperature trend over time:
- Models with higher unit sizes and CNN+LSTM hybrids tended to capture seasonal variations more accurately, though some variability was observed in peak values.
- The hybrid CNN+LSTM models managed to smooth out noise in the predictions, making them better suited for capturing daily fluctuations and seasonal patterns.
- By comparing these visualizations, Model 3 (128 units, 2-layer LSTM) and Model 8 (128 units, 2-layer CNN+LSTM) emerged as the most stable and accurate.

3. Effect of Model Depth and Units:
- Increasing the units generally improved performance, as seen with the 128-unit configurations, which consistently achieved lower MAE.
- Deeper architectures (3 layers) led to increased MAE, likely due to overfitting on the training data, which reduced generalization on the test set.

4. Impact of CNN Layers:
- The CNN+LSTM models demonstrated slight improvements in capturing local patterns, especially during temperature peaks and troughs. This suggests that convolutional layers can enhance RNN models by capturing fine-grained temporal details.

Conclusion

This assignment effectively demonstrated the application of RNNs to time-series forecasting, revealing the importance of architectural choices. The LSTM model with 128 units and 2 layers (Model 3) proved optimal, balancing accuracy and efficiency. The addition of CNN layers in CNN+LSTM hybrids also showed potential for enhancing time-series predictions.

Data Loading

In [1]:
```
import pandas as pd

# Load the datasets
train_data = pd.read_csv("DailyDelhiClimateTrain.csv")
test_data = pd.read_csv("DailyDelhiClimateTest.csv")

# Display the first few rows of each dataset
print("Training Data:\n", train_data.head())
print("\nTesting Data:\n", test_data.head())
```

```
Training Data:
         date   meantemp   humidity  wind_speed  meanpressure
0  2013-01-01  10.000000  84.500000    0.000000   1015.666667
1  2013-01-02   7.400000  92.000000    2.980000   1017.800000
2  2013-01-03   7.166667  87.000000    4.633333   1018.666667
3  2013-01-04   8.666667  71.333333    1.233333   1017.166667
4  2013-01-05   6.000000  86.833333    3.700000   1016.500000

Testing Data:
         date   meantemp   humidity  wind_speed  meanpressure
0  2017-01-01  15.913043  85.869565    2.743478     59.000000
1  2017-01-02  18.500000  77.222222    2.894444   1018.277778
2  2017-01-03  17.111111  81.888889    4.016667   1018.333333
3  2017-01-04  18.700000  70.050000    4.545000   1015.700000
4  2017-01-05  18.388889  74.944444    3.300000   1014.333333
```

In [2]:
```
# Check data types, missing values, and column information
print("Training Data Info:")
print(train_data.info())
print("\nTesting Data Info:")
print(test_data.info())
```

```
Training Data Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1462 entries, 0 to 1461
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   date          1462 non-null   object
 1   meantemp      1462 non-null   float64
 2   humidity      1462 non-null   float64
 3   wind_speed    1462 non-null   float64
 4   meanpressure  1462 non-null   float64
dtypes: float64(4), object(1)
memory usage: 57.2+ KB
None

Testing Data Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 114 entries, 0 to 113
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   date          114 non-null    object
 1   meantemp      114 non-null    float64
 2   humidity      114 non-null    float64
 3   wind_speed    114 non-null    float64
 4   meanpressure  114 non-null    float64
dtypes: float64(4), object(1)
memory usage: 4.6+ KB
None
```

In [3]:
```
# Summary statistics for training and testing data
print("Training Data Summary:\n", train_data.describe())
print("\nTesting Data Summary:\n", test_data.describe())
```

```
Training Data Summary:
          meantemp     humidity   wind_speed  meanpressure
count  1462.000000  1462.000000  1462.000000   1462.000000
mean     25.495521    60.771702     6.802209   1011.104548
std       7.348103    16.769652     4.561602    180.231668
min       6.000000    13.428571     0.000000     -3.041667
25%      18.857143    50.375000     3.475000   1001.580357
50%      27.714286    62.625000     6.221667   1008.563492
75%      31.305804    72.218750     9.238235   1014.944901
max      38.714286   100.000000    42.220000   7679.333333

Testing Data Summary:
         meantemp    humidity  wind_speed  meanpressure
count  114.000000  114.000000  114.000000    114.000000
mean    21.713079   56.258362    8.143924   1004.035090
std      6.360072   19.068083    3.588049     89.474692
min     11.000000   17.750000    1.387500     59.000000
25%     16.437198   39.625000    5.563542   1007.437500
50%     19.875000   57.750000    8.069444   1012.739316
75%     27.705357   71.902778   10.068750   1016.739583
max     34.500000   95.833333   19.314286   1022.809524
```

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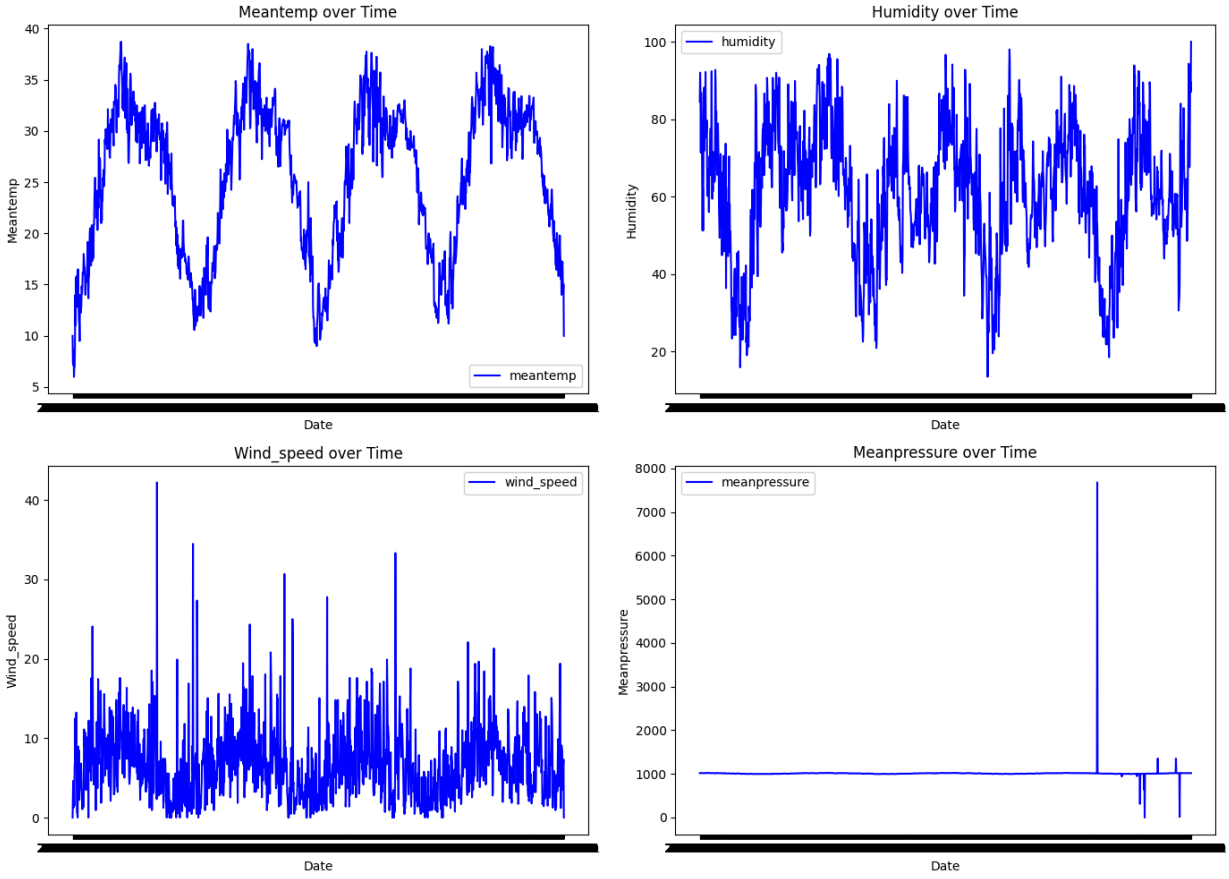
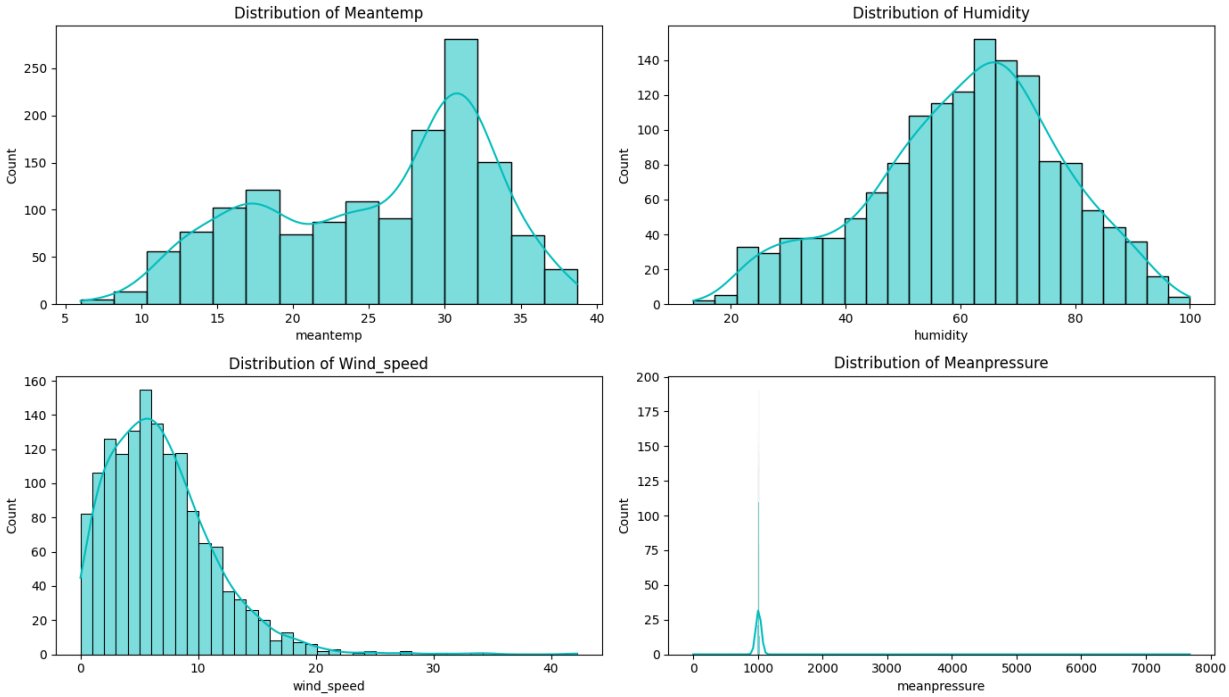
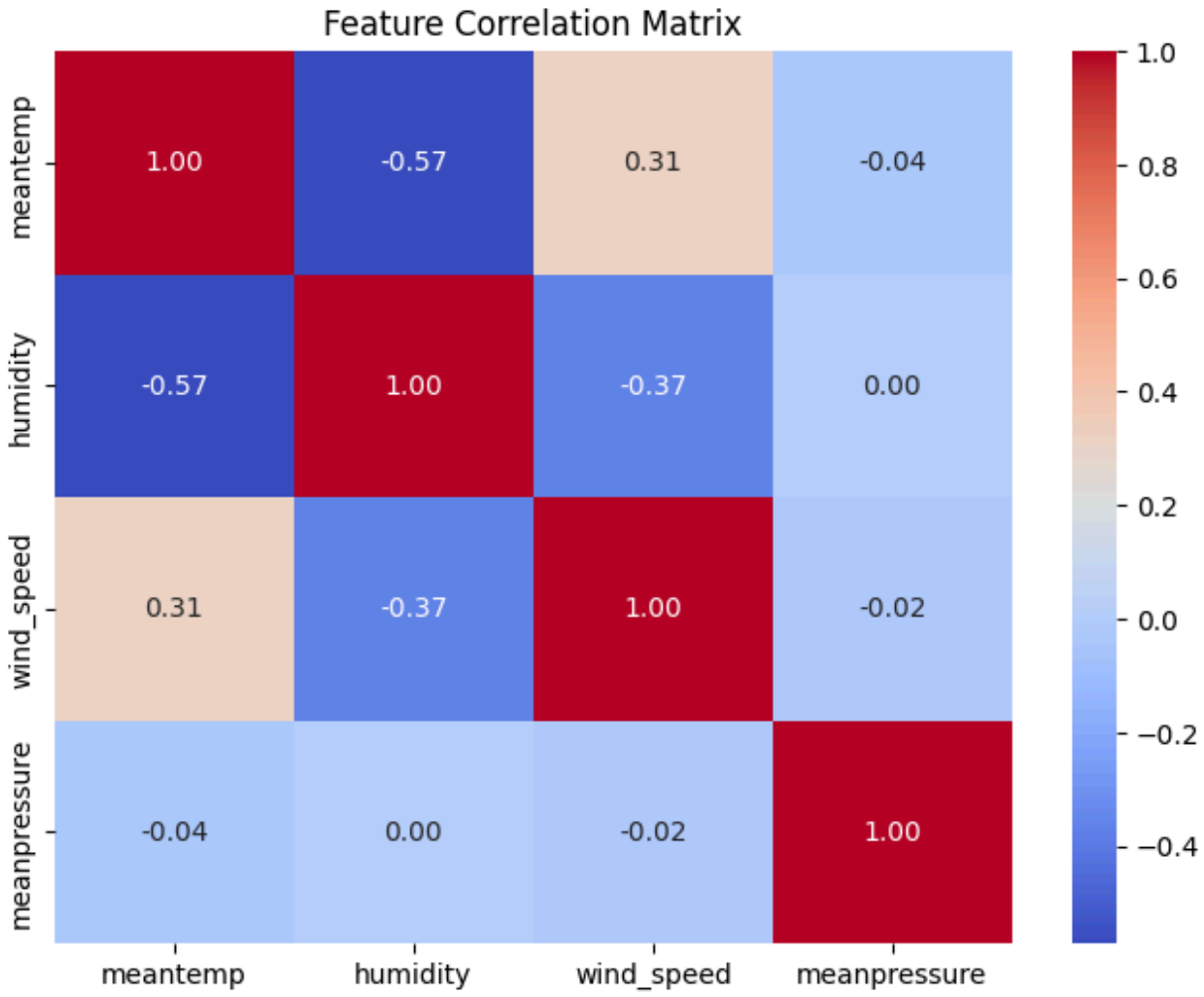
In [4]:
```
import matplotlib.pyplot as plt

# Plot each feature over time in the training dataset
features = ['meantemp', 'humidity', 'wind_speed', 'meanpressure']
plt.figure(figsize=(14, 10))

for i, feature in enumerate(features, 1):
    plt.subplot(2, 2, i)
    plt.plot(train_data['date'], train_data[feature], label=feature, color="b")
    plt.title(f"{feature.capitalize()} over Time")
    plt.xlabel("Date")
    plt.ylabel(feature.capitalize())
    plt.legend()

plt.tight_layout()
plt.show()
```



In [5]:
```
import seaborn as sns

# Plot the distribution of each feature
plt.figure(figsize=(14, 8))
for i, feature in enumerate(features, 1):
    plt.subplot(2, 2, i)
    sns.histplot(train_data[feature], kde=True, color="c")
    plt.title(f"Distribution of {feature.capitalize()}")

plt.tight_layout()
plt.show()
```

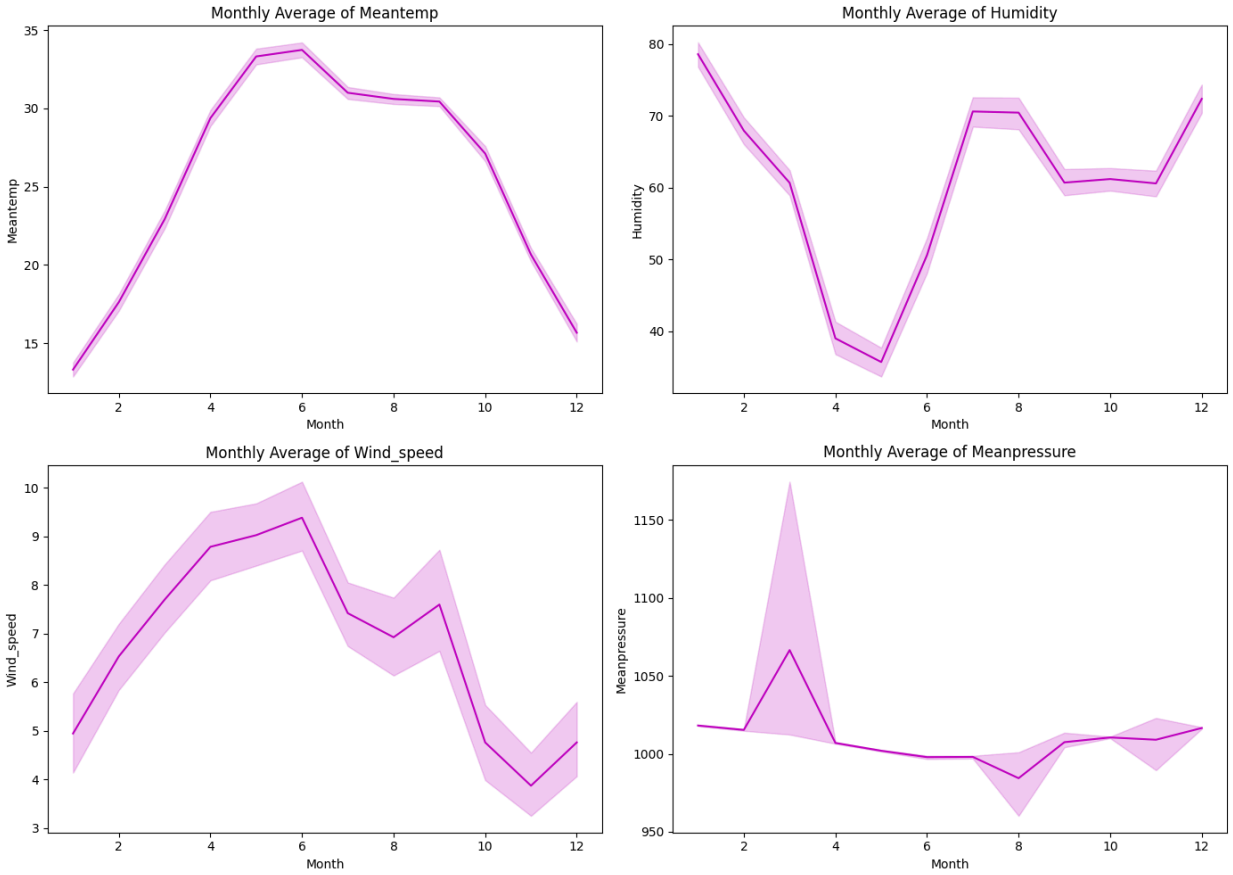


In [6]:
```
# Plot correlation matrix
plt.figure(figsize=(8, 6))
sns.heatmap(train_data[features].corr(), annot=True, cmap="coolwarm", fmt=".2f")
plt.title("Feature Correlation Matrix")
plt.show()
```



In [7]:

```
# Convert 'date' column to datetime format
train_data['date'] = pd.to_datetime(train_data['date'], errors='coerce')

# If the conversion is successful, proceed with extracting the month
train_data['month'] = train_data['date'].dt.month

# Now plot the monthly averages
plt.figure(figsize=(14, 10))
for i, feature in enumerate(features, 1):
    plt.subplot(2, 2, i)
    sns.lineplot(data=train_data, x="month", y=feature, estimator='mean', color="m")
    plt.title(f"Monthly Average of {feature.capitalize()}")
    plt.xlabel("Month")
    plt.ylabel(f"{feature.capitalize()}")

plt.tight_layout()
plt.show()
```



Data Pre Processing

In [8]:
```
import numpy as np

# Cap meanpressure and wind_speed within the 1st and 99th percentiles
pressure_cap = np.percentile(train_data['meanpressure'], [1, 99])
wind_speed_cap = np.percentile(train_data['wind_speed'], [1, 99])

train_data['meanpressure'] = np.clip(train_data['meanpressure'], *pressure_cap)
train_data['wind_speed'] = np.clip(train_data['wind_speed'], *wind_speed_cap)
```

In [9]:
```
from sklearn.preprocessing import MinMaxScaler

# Initialize scaler
scaler = MinMaxScaler()

# Apply scaler to training and testing data (fit on training, transform on both)
features = ['meantemp', 'humidity', 'wind_speed', 'meanpressure']
train_data[features] = scaler.fit_transform(train_data[features])
test_data[features] = scaler.transform(test_data[features])
```

In [10]:
```
import numpy as np

def create_sequences(data, seq_length=30):
    sequences = []
    labels = []

    for i in range(len(data) - seq_length):
        sequence = data[i:i + seq_length]
```

```
        label = data[i + seq_length, 0]  # Using meantemp as the label for simplicity
        sequences.append(sequence)
        labels.append(label)

    return np.array(sequences), np.array(labels)

# Convert training and test data to numpy arrays for easier manipulation
train_array = train_data[features].values
test_array = test_data[features].values

# Create sequences with a window of 30 days (you can adjust the window size)
X_train, y_train = create_sequences(train_array, seq_length=30)
X_test, y_test = create_sequences(test_array, seq_length=30)
```

Model Configuration

In [11]:
```
# Model configurations
model_configs = [
    # Stacked LSTM models with varying units
    {"type": "LSTM", "units": 32, "num_layers": 2, "dropout": 0.2},
    {"type": "LSTM", "units": 64, "num_layers": 2, "dropout": 0.3},
    {"type": "LSTM", "units": 128, "num_layers": 2, "dropout": 0.4},
    {"type": "LSTM", "units": 32, "num_layers": 3, "dropout": 0.2},
    {"type": "LSTM", "units": 64, "num_layers": 3, "dropout": 0.3},

    # CNN + Stacked LSTM models
    {"type": "CNN+LSTM", "units": 32, "num_layers": 2, "dropout": 0.2},
    {"type": "CNN+LSTM", "units": 64, "num_layers": 2, "dropout": 0.3},
    {"type": "CNN+LSTM", "units": 128, "num_layers": 2, "dropout": 0.4},
    {"type": "CNN+LSTM", "units": 64, "num_layers": 3, "dropout": 0.3},
    {"type": "CNN+LSTM", "units": 128, "num_layers": 3, "dropout": 0.4},
]
```

Model Building

In [12]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense, Dropout, Conv1D, MaxPooling1D, Flatte

def build_model(model_type, units, num_layers, dropout):
    model = Sequential()
    input_shape = (X_train.shape[1], X_train.shape[2])  # Adjust this based on your da

    # Add LSTM layers
    for layer in range(num_layers):
        if layer == 0:
            model.add(LSTM(units, return_sequences=True, input_shape=input_shape))
        elif layer == num_layers - 1:
            model.add(LSTM(units))  # Last layer without return_sequences
        else:
            model.add(LSTM(units, return_sequences=True))

        # Add dropout layer after each LSTM layer
        model.add(Dropout(dropout))

    # Add output layer
```

```
    model.add(Dense(1))  # Change 1 to the number of output neurons if predicting mult

    # Compile the model
    model.compile(optimizer='adam', loss='mean_squared_error', metrics=['mae'])

    print(model.summary())
    return model
```

Model Training

In [13]:
```
# Initialize lists to store metrics, histories, models, and predictions
model_histories = []
model_mae_scores = []
trained_models = []  # List to store trained models
model_predictions = []  # List to store predictions from each model

# Using the test set for validation
for i, config in enumerate(model_configs):
    print(f"Training model {i+1} - {config['type']} with units: {config['units']}, lay

    # Build the model using the specified configuration
    model = build_model(config["type"], units=config["units"], num_layers=config["num_

    # Fit the model on the training data and validate on the test data
    history = model.fit(X_train, y_train, validation_data=(X_test, y_test), epochs=100

    # Save metrics and training history
    val_mae = history.history['val_mae'][-1]
    model_histories.append(history)
    model_mae_scores.append(val_mae)
    trained_models.append(model)  # Store the trained model

    # Make predictions and store them
    predictions = model.predict(X_test)
    model_predictions.append(predictions)

    print(f"Completed Model {i+1}: Validation MAE = {val_mae}")
```

```
Training model 1 - LSTM with units: 32, layers: 2
/usr/local/lib/python3.10/dist-packages/keras/src/layers/rnn/rnn.py:204: UserWarning:
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential m
odels, prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(**kwargs)
Model: "sequential"
```

Layer (type)	Output Shape	Pa
lstm (LSTM)	(None, 30, 32)	
dropout (Dropout)	(None, 30, 32)	
lstm_1 (LSTM)	(None, 32)	
dropout_1 (Dropout)	(None, 32)	
dense (Dense)	(None, 1)	

Total params: 13,089 (51.13 KB)

Trainable params: 13,089 (51.13 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 6s 21ms/step - loss: 0.1414 - mae: 0.2870 - val_loss: 0.00
76 - val_mae: 0.0742
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0121 - mae: 0.0874 - val_loss: 0.006
7 - val_mae: 0.0707
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0108 - mae: 0.0818 - val_loss: 0.00
68 - val_mae: 0.0701
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0097 - mae: 0.0786 - val_loss: 0.00
65 - val_mae: 0.0700
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0095 - mae: 0.0765 - val_loss: 0.00
63 - val_mae: 0.0682
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0094 - mae: 0.0759 - val_loss: 0.00
63 - val_mae: 0.0677
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0097 - mae: 0.0774 - val_loss: 0.006
4 - val_mae: 0.0680
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0084 - mae: 0.0728 - val_loss: 0.006
1 - val_mae: 0.0664
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0090 - mae: 0.0741 - val_loss: 0.006
1 - val_mae: 0.0671
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0079 - mae: 0.0709 - val_loss: 0.006
0 - val_mae: 0.0661
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0076 - mae: 0.0683 - val_loss: 0.005
9 - val_mae: 0.0659
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0080 - mae: 0.0708 - val_loss: 0.005
8 - val_mae: 0.0655
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0084 - mae: 0.0718 - val_loss: 0.005
9 - val_mae: 0.0671
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0082 - mae: 0.0724 - val_loss: 0.006
0 - val_mae: 0.0651
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0074 - mae: 0.0684 - val_loss: 0.006
1 - val_mae: 0.0662
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0076 - mae: 0.0684 - val_loss: 0.006
0 - val_mae: 0.0669
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0077 - mae: 0.0694 - val_loss: 0.005
6 - val_mae: 0.0635
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0074 - mae: 0.0676 - val_loss: 0.00
57 - val_mae: 0.0653
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0074 - mae: 0.0680 - val_loss: 0.00
56 - val_mae: 0.0641
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0073 - mae: 0.0665 - val_loss: 0.00
```

```
55 - val_mae: 0.0629
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0076 - mae: 0.0684 - val_loss: 0.00
55 - val_mae: 0.0630
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0070 - mae: 0.0665 - val_loss: 0.005
5 - val_mae: 0.0625
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0066 - mae: 0.0640 - val_loss: 0.005
7 - val_mae: 0.0654
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0070 - mae: 0.0658 - val_loss: 0.006
4 - val_mae: 0.0669
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0067 - mae: 0.0649 - val_loss: 0.006
2 - val_mae: 0.0662
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0065 - mae: 0.0639 - val_loss: 0.005
4 - val_mae: 0.0620
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0067 - mae: 0.0650 - val_loss: 0.005
5 - val_mae: 0.0625
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0065 - mae: 0.0636 - val_loss: 0.005
5 - val_mae: 0.0625
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0070 - mae: 0.0660 - val_loss: 0.005
8 - val_mae: 0.0641
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0061 - mae: 0.0615 - val_loss: 0.005
3 - val_mae: 0.0614
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0063 - mae: 0.0604 - val_loss: 0.005
2 - val_mae: 0.0610
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0058 - mae: 0.0595 - val_loss: 0.005
6 - val_mae: 0.0631
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0063 - mae: 0.0623 - val_loss: 0.005
8 - val_mae: 0.0642
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0063 - mae: 0.0620 - val_loss: 0.006
4 - val_mae: 0.0664
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0061 - mae: 0.0608 - val_loss: 0.005
0 - val_mae: 0.0596
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0059 - mae: 0.0606 - val_loss: 0.005
1 - val_mae: 0.0589
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0062 - mae: 0.0621 - val_loss: 0.004
9 - val_mae: 0.0588
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0056 - mae: 0.0580 - val_loss: 0.004
9 - val_mae: 0.0588
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0056 - mae: 0.0585 - val_loss: 0.004
8 - val_mae: 0.0586
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0056 - mae: 0.0594 - val_loss: 0.004
```

```
8 - val_mae: 0.0585
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0057 - mae: 0.0582 - val_loss: 0.00
48 - val_mae: 0.0580
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0054 - mae: 0.0584 - val_loss: 0.00
52 - val_mae: 0.0605
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0048 - mae: 0.0541 - val_loss: 0.00
48 - val_mae: 0.0561
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0051 - mae: 0.0563 - val_loss: 0.00
49 - val_mae: 0.0590
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0053 - mae: 0.0569 - val_loss: 0.00
50 - val_mae: 0.0598
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0053 - mae: 0.0575 - val_loss: 0.004
7 - val_mae: 0.0579
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0053 - mae: 0.0564 - val_loss: 0.005
0 - val_mae: 0.0594
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0052 - mae: 0.0564 - val_loss: 0.004
6 - val_mae: 0.0569
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0051 - mae: 0.0556 - val_loss: 0.005
0 - val_mae: 0.0593
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0049 - mae: 0.0548 - val_loss: 0.005
2 - val_mae: 0.0603
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0053 - mae: 0.0567 - val_loss: 0.004
5 - val_mae: 0.0566
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0049 - mae: 0.0543 - val_loss: 0.004
6 - val_mae: 0.0570
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0046 - mae: 0.0530 - val_loss: 0.004
6 - val_mae: 0.0566
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0046 - mae: 0.0531 - val_loss: 0.005
5 - val_mae: 0.0614
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0050 - mae: 0.0565 - val_loss: 0.004
3 - val_mae: 0.0551
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0052 - mae: 0.0559 - val_loss: 0.005
0 - val_mae: 0.0588
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0049 - mae: 0.0546 - val_loss: 0.004
6 - val_mae: 0.0568
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0047 - mae: 0.0538 - val_loss: 0.004
9 - val_mae: 0.0585
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0519 - val_loss: 0.004
2 - val_mae: 0.0534
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0047 - mae: 0.0546 - val_loss: 0.004
```

```
1 - val_mae: 0.0534
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0046 - mae: 0.0523 - val_loss: 0.004
7 - val_mae: 0.0570
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0046 - mae: 0.0531 - val_loss: 0.004
4 - val_mae: 0.0555
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0528 - val_loss: 0.004
2 - val_mae: 0.0543
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0521 - val_loss: 0.004
2 - val_mae: 0.0543
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0046 - mae: 0.0528 - val_loss: 0.004
2 - val_mae: 0.0538
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0473 - val_loss: 0.005
1 - val_mae: 0.0594
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0043 - mae: 0.0510 - val_loss: 0.00
39 - val_mae: 0.0517
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0043 - mae: 0.0514 - val_loss: 0.00
44 - val_mae: 0.0551
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0038 - mae: 0.0475 - val_loss: 0.00
44 - val_mae: 0.0549
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0045 - mae: 0.0533 - val_loss: 0.00
38 - val_mae: 0.0514
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0042 - mae: 0.0511 - val_loss: 0.00
39 - val_mae: 0.0526
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0039 - mae: 0.0494 - val_loss: 0.003
9 - val_mae: 0.0515
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0040 - mae: 0.0497 - val_loss: 0.004
1 - val_mae: 0.0534
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0489 - val_loss: 0.004
4 - val_mae: 0.0553
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0038 - mae: 0.0487 - val_loss: 0.003
9 - val_mae: 0.0518
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0484 - val_loss: 0.003
9 - val_mae: 0.0517
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0039 - mae: 0.0494 - val_loss: 0.004
0 - val_mae: 0.0524
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0038 - mae: 0.0480 - val_loss: 0.004
2 - val_mae: 0.0538
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.003
8 - val_mae: 0.0510
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0038 - mae: 0.0490 - val_loss: 0.003
```

```
7 - val_mae: 0.0501
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0037 - mae: 0.0481 - val_loss: 0.003
7 - val_mae: 0.0502
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0480 - val_loss: 0.003
7 - val_mae: 0.0502
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0040 - mae: 0.0494 - val_loss: 0.003
5 - val_mae: 0.0496
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0032 - mae: 0.0449 - val_loss: 0.003
6 - val_mae: 0.0496
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0465 - val_loss: 0.003
6 - val_mae: 0.0494
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0035 - mae: 0.0469 - val_loss: 0.003
9 - val_mae: 0.0516
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0463 - val_loss: 0.004
2 - val_mae: 0.0542
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0039 - mae: 0.0488 - val_loss: 0.003
6 - val_mae: 0.0506
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0037 - mae: 0.0464 - val_loss: 0.003
7 - val_mae: 0.0507
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.003
5 - val_mae: 0.0488
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0035 - mae: 0.0456 - val_loss: 0.003
6 - val_mae: 0.0498
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0037 - mae: 0.0463 - val_loss: 0.00
36 - val_mae: 0.0497
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0463 - val_loss: 0.00
34 - val_mae: 0.0483
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0035 - mae: 0.0465 - val_loss: 0.00
42 - val_mae: 0.0541
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0032 - mae: 0.0435 - val_loss: 0.00
36 - val_mae: 0.0500
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0032 - mae: 0.0447 - val_loss: 0.00
34 - val_mae: 0.0487
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0034 - mae: 0.0460 - val_loss: 0.00
34 - val_mae: 0.0482
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0437 - val_loss: 0.003
9 - val_mae: 0.0516
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0437 - val_loss: 0.003
7 - val_mae: 0.0491
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0462 - val_loss: 0.003
```

```
6 - val_mae: 0.0496
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 78ms/step
Completed Model 1: Validation MAE = 0.04955575615167618
Training model 2 - LSTM with units: 64, layers: 2
```

Model: "sequential_1"

Layer (type)	Output Shape	Pa
lstm_2 (LSTM)	(None, 30, 64)	1
dropout_2 (Dropout)	(None, 30, 64)	
lstm_3 (LSTM)	(None, 64)	3
dropout_3 (Dropout)	(None, 64)	
dense_1 (Dense)	(None, 1)	

Total params: 50,753 (198.25 KB)

Trainable params: 50,753 (198.25 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 2s 15ms/step - loss: 0.1429 - mae: 0.2793 - val_loss: 0.00
82 - val_mae: 0.0791
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0112 - mae: 0.0841 - val_loss: 0.007
1 - val_mae: 0.0716
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0113 - mae: 0.0827 - val_loss: 0.007
4 - val_mae: 0.0740
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0094 - mae: 0.0761 - val_loss: 0.00
70 - val_mae: 0.0693
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0093 - mae: 0.0769 - val_loss: 0.006
7 - val_mae: 0.0689
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0085 - mae: 0.0726 - val_loss: 0.00
65 - val_mae: 0.0665
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0090 - mae: 0.0753 - val_loss: 0.006
4 - val_mae: 0.0683
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0079 - mae: 0.0703 - val_loss: 0.006
9 - val_mae: 0.0702
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0084 - mae: 0.0719 - val_loss: 0.006
9 - val_mae: 0.0695
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0082 - mae: 0.0717 - val_loss: 0.006
0 - val_mae: 0.0652
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0077 - mae: 0.0692 - val_loss: 0.00
61 - val_mae: 0.0663
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0075 - mae: 0.0680 - val_loss: 0.00
70 - val_mae: 0.0701
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0082 - mae: 0.0715 - val_loss: 0.00
57 - val_mae: 0.0636
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0078 - mae: 0.0703 - val_loss: 0.00
58 - val_mae: 0.0639
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0069 - mae: 0.0639 - val_loss: 0.00
67 - val_mae: 0.0690
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0074 - mae: 0.0670 - val_loss: 0.006
1 - val_mae: 0.0661
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0071 - mae: 0.0658 - val_loss: 0.006
4 - val_mae: 0.0675
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0074 - mae: 0.0672 - val_loss: 0.006
1 - val_mae: 0.0657
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0067 - mae: 0.0634 - val_loss: 0.005
8 - val_mae: 0.0640
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0070 - mae: 0.0661 - val_loss: 0.006
```

```
0 - val_mae: 0.0651
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0066 - mae: 0.0636 - val_loss: 0.005
7 - val_mae: 0.0638
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0066 - mae: 0.0641 - val_loss: 0.005
4 - val_mae: 0.0617
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0062 - mae: 0.0618 - val_loss: 0.007
2 - val_mae: 0.0703
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0065 - mae: 0.0634 - val_loss: 0.005
1 - val_mae: 0.0609
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0066 - mae: 0.0650 - val_loss: 0.005
5 - val_mae: 0.0621
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0066 - mae: 0.0639 - val_loss: 0.005
5 - val_mae: 0.0624
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0066 - mae: 0.0641 - val_loss: 0.005
1 - val_mae: 0.0602
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0057 - mae: 0.0598 - val_loss: 0.005
2 - val_mae: 0.0607
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0061 - mae: 0.0611 - val_loss: 0.005
5 - val_mae: 0.0619
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0059 - mae: 0.0601 - val_loss: 0.005
7 - val_mae: 0.0627
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0059 - mae: 0.0608 - val_loss: 0.004
9 - val_mae: 0.0583
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0059 - mae: 0.0608 - val_loss: 0.006
1 - val_mae: 0.0645
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0056 - mae: 0.0590 - val_loss: 0.004
7 - val_mae: 0.0572
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0048 - mae: 0.0542 - val_loss: 0.004
8 - val_mae: 0.0563
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0060 - mae: 0.0617 - val_loss: 0.004
8 - val_mae: 0.0579
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0054 - mae: 0.0581 - val_loss: 0.00
45 - val_mae: 0.0559
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0053 - mae: 0.0574 - val_loss: 0.00
45 - val_mae: 0.0567
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0056 - mae: 0.0587 - val_loss: 0.00
45 - val_mae: 0.0557
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0049 - mae: 0.0546 - val_loss: 0.00
57 - val_mae: 0.0622
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0053 - mae: 0.0579 - val_loss: 0.00
```

```
45 - val_mae: 0.0557
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0048 - mae: 0.0542 - val_loss: 0.005
1 - val_mae: 0.0589
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0047 - mae: 0.0532 - val_loss: 0.005
0 - val_mae: 0.0582
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0053 - mae: 0.0572 - val_loss: 0.004
3 - val_mae: 0.0543
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0053 - mae: 0.0566 - val_loss: 0.004
2 - val_mae: 0.0540
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0048 - mae: 0.0549 - val_loss: 0.004
4 - val_mae: 0.0554
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0047 - mae: 0.0543 - val_loss: 0.004
6 - val_mae: 0.0559
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0046 - mae: 0.0535 - val_loss: 0.004
2 - val_mae: 0.0531
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0045 - mae: 0.0531 - val_loss: 0.004
6 - val_mae: 0.0565
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0049 - mae: 0.0549 - val_loss: 0.004
2 - val_mae: 0.0537
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0046 - mae: 0.0535 - val_loss: 0.004
2 - val_mae: 0.0535
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0522 - val_loss: 0.003
9 - val_mae: 0.0517
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0044 - mae: 0.0513 - val_loss: 0.004
2 - val_mae: 0.0534
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0043 - mae: 0.0517 - val_loss: 0.004
1 - val_mae: 0.0529
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0045 - mae: 0.0528 - val_loss: 0.004
0 - val_mae: 0.0521
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0043 - mae: 0.0513 - val_loss: 0.003
8 - val_mae: 0.0516
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0047 - mae: 0.0538 - val_loss: 0.004
1 - val_mae: 0.0535
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0045 - mae: 0.0526 - val_loss: 0.003
8 - val_mae: 0.0513
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0042 - mae: 0.0515 - val_loss: 0.004
1 - val_mae: 0.0528
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0043 - mae: 0.0519 - val_loss: 0.003
7 - val_mae: 0.0502
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0517 - val_loss: 0.003
```

```
8 - val_mae: 0.0505
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0038 - mae: 0.0476 - val_loss: 0.004
0 - val_mae: 0.0519
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0041 - mae: 0.0494 - val_loss: 0.00
36 - val_mae: 0.0501
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0039 - mae: 0.0490 - val_loss: 0.00
37 - val_mae: 0.0506
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0039 - mae: 0.0498 - val_loss: 0.00
36 - val_mae: 0.0492
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.00
35 - val_mae: 0.0492
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0040 - mae: 0.0496 - val_loss: 0.00
36 - val_mae: 0.0499
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0488 - val_loss: 0.003
7 - val_mae: 0.0503
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0468 - val_loss: 0.003
5 - val_mae: 0.0490
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0037 - mae: 0.0475 - val_loss: 0.003
6 - val_mae: 0.0497
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.004
3 - val_mae: 0.0538
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0036 - mae: 0.0467 - val_loss: 0.003
5 - val_mae: 0.0489
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0480 - val_loss: 0.003
4 - val_mae: 0.0483
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0480 - val_loss: 0.003
4 - val_mae: 0.0490
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0490 - val_loss: 0.003
4 - val_mae: 0.0492
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0037 - mae: 0.0469 - val_loss: 0.003
3 - val_mae: 0.0481
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0489 - val_loss: 0.003
6 - val_mae: 0.0499
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0490 - val_loss: 0.003
8 - val_mae: 0.0508
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0037 - mae: 0.0475 - val_loss: 0.003
3 - val_mae: 0.0484
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0458 - val_loss: 0.003
6 - val_mae: 0.0495
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0036 - mae: 0.0476 - val_loss: 0.003
```

```
4 - val_mae: 0.0490
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0483 - val_loss: 0.003
7 - val_mae: 0.0500
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0038 - mae: 0.0488 - val_loss: 0.003
4 - val_mae: 0.0482
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0467 - val_loss: 0.003
4 - val_mae: 0.0478
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0036 - mae: 0.0469 - val_loss: 0.003
2 - val_mae: 0.0475
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0459 - val_loss: 0.003
3 - val_mae: 0.0473
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0456 - val_loss: 0.003
2 - val_mae: 0.0472
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0458 - val_loss: 0.003
4 - val_mae: 0.0481
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0459 - val_loss: 0.003
4 - val_mae: 0.0483
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0034 - mae: 0.0449 - val_loss: 0.00
32 - val_mae: 0.0467
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0034 - mae: 0.0458 - val_loss: 0.00
33 - val_mae: 0.0474
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0034 - mae: 0.0459 - val_loss: 0.00
31 - val_mae: 0.0465
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0034 - mae: 0.0458 - val_loss: 0.00
33 - val_mae: 0.0477
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0036 - mae: 0.0473 - val_loss: 0.00
31 - val_mae: 0.0465
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0440 - val_loss: 0.003
1 - val_mae: 0.0463
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0031 - mae: 0.0428 - val_loss: 0.003
3 - val_mae: 0.0471
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0033 - mae: 0.0445 - val_loss: 0.003
4 - val_mae: 0.0479
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0033 - mae: 0.0444 - val_loss: 0.003
2 - val_mae: 0.0471
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0032 - mae: 0.0436 - val_loss: 0.003
1 - val_mae: 0.0465
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0451 - val_loss: 0.003
1 - val_mae: 0.0459
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0030 - mae: 0.0433 - val_loss: 0.003
```

```
2 - val_mae: 0.0469
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 84ms/step
Completed Model 2: Validation MAE = 0.04691466689109802
Training model 3 - LSTM with units: 128, layers: 2
```

Model: "sequential_2"

Layer (type)	Output Shape	Pa
lstm_4 (LSTM)	(None, 30, 128)	6
dropout_4 (Dropout)	(None, 30, 128)	
lstm_5 (LSTM)	(None, 128)	1
dropout_5 (Dropout)	(None, 128)	
dense_2 (Dense)	(None, 1)	

Total params: 199,809 (780.50 KB)

Trainable params: 199,809 (780.50 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 2s 14ms/step - loss: 0.0924 - mae: 0.2197 - val_loss: 0.00
69 - val_mae: 0.0707
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0104 - mae: 0.0802 - val_loss: 0.006
7 - val_mae: 0.0702
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0086 - mae: 0.0731 - val_loss: 0.006
4 - val_mae: 0.0682
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0100 - mae: 0.0786 - val_loss: 0.006
6 - val_mae: 0.0716
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0078 - mae: 0.0700 - val_loss: 0.006
2 - val_mae: 0.0655
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0080 - mae: 0.0705 - val_loss: 0.006
1 - val_mae: 0.0673
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0076 - mae: 0.0686 - val_loss: 0.00
64 - val_mae: 0.0682
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0081 - mae: 0.0715 - val_loss: 0.00
58 - val_mae: 0.0644
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0072 - mae: 0.0660 - val_loss: 0.00
61 - val_mae: 0.0694
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0075 - mae: 0.0684 - val_loss: 0.005
7 - val_mae: 0.0659
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0073 - mae: 0.0686 - val_loss: 0.005
9 - val_mae: 0.0649
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0069 - mae: 0.0671 - val_loss: 0.005
8 - val_mae: 0.0643
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0066 - mae: 0.0629 - val_loss: 0.009
2 - val_mae: 0.0789
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0080 - mae: 0.0710 - val_loss: 0.005
3 - val_mae: 0.0605
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0064 - mae: 0.0634 - val_loss: 0.005
7 - val_mae: 0.0634
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0062 - mae: 0.0622 - val_loss: 0.005
1 - val_mae: 0.0609
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0063 - mae: 0.0624 - val_loss: 0.005
1 - val_mae: 0.0616
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0061 - mae: 0.0612 - val_loss: 0.005
2 - val_mae: 0.0607
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0061 - mae: 0.0611 - val_loss: 0.005
2 - val_mae: 0.0597
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0059 - mae: 0.0596 - val_loss: 0.005
```

```
0 - val_mae: 0.0590
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0065 - mae: 0.0635 - val_loss: 0.004
8 - val_mae: 0.0587
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0064 - mae: 0.0612 - val_loss: 0.004
7 - val_mae: 0.0571
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0058 - mae: 0.0595 - val_loss: 0.004
9 - val_mae: 0.0580
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0058 - mae: 0.0602 - val_loss: 0.005
9 - val_mae: 0.0634
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0057 - mae: 0.0584 - val_loss: 0.004
8 - val_mae: 0.0577
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0055 - mae: 0.0577 - val_loss: 0.004
5 - val_mae: 0.0572
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0053 - mae: 0.0573 - val_loss: 0.004
3 - val_mae: 0.0542
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0054 - mae: 0.0583 - val_loss: 0.004
4 - val_mae: 0.0565
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0046 - mae: 0.0530 - val_loss: 0.004
3 - val_mae: 0.0539
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0054 - mae: 0.0575 - val_loss: 0.004
2 - val_mae: 0.0541
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0054 - mae: 0.0576 - val_loss: 0.00
44 - val_mae: 0.0548
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0048 - mae: 0.0550 - val_loss: 0.00
41 - val_mae: 0.0527
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0046 - mae: 0.0543 - val_loss: 0.00
42 - val_mae: 0.0532
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0052 - mae: 0.0568 - val_loss: 0.00
41 - val_mae: 0.0529
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0053 - mae: 0.0579 - val_loss: 0.00
43 - val_mae: 0.0541
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0046 - mae: 0.0529 - val_loss: 0.003
9 - val_mae: 0.0518
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0047 - mae: 0.0542 - val_loss: 0.004
0 - val_mae: 0.0521
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0049 - mae: 0.0552 - val_loss: 0.004
1 - val_mae: 0.0527
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0043 - mae: 0.0517 - val_loss: 0.003
8 - val_mae: 0.0507
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0050 - mae: 0.0557 - val_loss: 0.003
```

```
9 - val_mae: 0.0515
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0049 - mae: 0.0550 - val_loss: 0.003
8 - val_mae: 0.0520
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0053 - mae: 0.0588 - val_loss: 0.004
0 - val_mae: 0.0520
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0052 - mae: 0.0567 - val_loss: 0.004
0 - val_mae: 0.0515
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0045 - mae: 0.0542 - val_loss: 0.003
7 - val_mae: 0.0498
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0045 - mae: 0.0525 - val_loss: 0.003
6 - val_mae: 0.0497
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0044 - mae: 0.0529 - val_loss: 0.004
0 - val_mae: 0.0521
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0048 - mae: 0.0540 - val_loss: 0.003
6 - val_mae: 0.0496
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0043 - mae: 0.0512 - val_loss: 0.003
7 - val_mae: 0.0497
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0042 - mae: 0.0503 - val_loss: 0.003
5 - val_mae: 0.0488
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0044 - mae: 0.0521 - val_loss: 0.004
1 - val_mae: 0.0525
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0044 - mae: 0.0521 - val_loss: 0.003
8 - val_mae: 0.0505
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0491 - val_loss: 0.003
7 - val_mae: 0.0499
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0039 - mae: 0.0491 - val_loss: 0.003
6 - val_mae: 0.0497
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.003
5 - val_mae: 0.0485
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0494 - val_loss: 0.003
5 - val_mae: 0.0492
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0493 - val_loss: 0.003
5 - val_mae: 0.0486
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0501 - val_loss: 0.003
5 - val_mae: 0.0483
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
40 - val_mae: 0.0518
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0040 - mae: 0.0495 - val_loss: 0.00
35 - val_mae: 0.0487
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0039 - mae: 0.0485 - val_loss: 0.00
```

```
39 - val_mae: 0.0514
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0041 - mae: 0.0502 - val_loss: 0.00
35 - val_mae: 0.0489
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0041 - mae: 0.0513 - val_loss: 0.00
39 - val_mae: 0.0508
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0038 - mae: 0.0478 - val_loss: 0.00
34 - val_mae: 0.0475
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0484 - val_loss: 0.003
9 - val_mae: 0.0513
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0038 - mae: 0.0471 - val_loss: 0.003
5 - val_mae: 0.0486
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0037 - mae: 0.0482 - val_loss: 0.003
3 - val_mae: 0.0482
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0035 - mae: 0.0467 - val_loss: 0.003
3 - val_mae: 0.0478
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0037 - mae: 0.0475 - val_loss: 0.003
2 - val_mae: 0.0474
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0489 - val_loss: 0.003
5 - val_mae: 0.0495
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0039 - mae: 0.0486 - val_loss: 0.003
4 - val_mae: 0.0480
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0457 - val_loss: 0.003
3 - val_mae: 0.0477
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0466 - val_loss: 0.003
1 - val_mae: 0.0463
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0487 - val_loss: 0.003
1 - val_mae: 0.0464
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0034 - mae: 0.0462 - val_loss: 0.003
2 - val_mae: 0.0469
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0464 - val_loss: 0.003
2 - val_mae: 0.0467
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0037 - mae: 0.0469 - val_loss: 0.003
2 - val_mae: 0.0477
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0470 - val_loss: 0.003
3 - val_mae: 0.0471
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0466 - val_loss: 0.003
5 - val_mae: 0.0481
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0455 - val_loss: 0.003
3 - val_mae: 0.0471
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0468 - val_loss: 0.005
```

```
0 - val_mae: 0.0571
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0036 - mae: 0.0469 - val_loss: 0.003
6 - val_mae: 0.0488
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0032 - mae: 0.0442 - val_loss: 0.003
0 - val_mae: 0.0456
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.003
0 - val_mae: 0.0456
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0032 - mae: 0.0436 - val_loss: 0.00
31 - val_mae: 0.0462
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0034 - mae: 0.0450 - val_loss: 0.00
37 - val_mae: 0.0492
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0039 - mae: 0.0480 - val_loss: 0.00
35 - val_mae: 0.0479
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0035 - mae: 0.0456 - val_loss: 0.00
31 - val_mae: 0.0458
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0033 - mae: 0.0441 - val_loss: 0.00
38 - val_mae: 0.0493
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0481 - val_loss: 0.00
36 - val_mae: 0.0489
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0034 - mae: 0.0446 - val_loss: 0.003
2 - val_mae: 0.0465
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0439 - val_loss: 0.003
2 - val_mae: 0.0465
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0035 - mae: 0.0459 - val_loss: 0.003
1 - val_mae: 0.0461
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0467 - val_loss: 0.003
0 - val_mae: 0.0451
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0031 - mae: 0.0431 - val_loss: 0.003
1 - val_mae: 0.0459
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0440 - val_loss: 0.002
9 - val_mae: 0.0446
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0030 - mae: 0.0428 - val_loss: 0.003
1 - val_mae: 0.0462
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0476 - val_loss: 0.003
0 - val_mae: 0.0454
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0031 - mae: 0.0434 - val_loss: 0.003
1 - val_mae: 0.0459
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0034 - mae: 0.0454 - val_loss: 0.003
1 - val_mae: 0.0460
Epoch 100/100
```

```
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0444 - val_loss: 0.003
2 - val_mae: 0.0469
WARNING:tensorflow:5 out of the last 7 calls to <function TensorFlowTrainer.make_pred
ict_function.<locals>.one_step_on_data_distributed at 0x7f1cfc120310> triggered tf.fu
nction retracing. Tracing is expensive and the excessive number of tracings could be
due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with diffe
rent shapes, (3) passing Python objects instead of tensors. For (1), please define yo
ur @tf.function outside of the loop. For (2), @tf.function has reduce_retracing=True
option that can avoid unnecessary retracing. For (3), please refer to https://www.ten
sorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/api_d
ocs/python/tf/function for  more details.
1/3 ━━━━━━━━━━━━━━━━━━━━ 0s 166ms/step
WARNING:tensorflow:6 out of the last 9 calls to <function TensorFlowTrainer.make_pred
ict_function.<locals>.one_step_on_data_distributed at 0x7f1cfc120310> triggered tf.fu
nction retracing. Tracing is expensive and the excessive number of tracings could be
due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with diffe
rent shapes, (3) passing Python objects instead of tensors. For (1), please define yo
ur @tf.function outside of the loop. For (2), @tf.function has reduce_retracing=True
option that can avoid unnecessary retracing. For (3), please refer to https://www.ten
sorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/api_d
ocs/python/tf/function for  more details.
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 82ms/step
Completed Model 3: Validation MAE = 0.04685044661164284
Training model 4 - LSTM with units: 32, layers: 3
Model: "sequential_3"
```

Layer (type)	Output Shape	Pa
lstm_6 (LSTM)	(None, 30, 32)	
dropout_6 (Dropout)	(None, 30, 32)	
lstm_7 (LSTM)	(None, 30, 32)	
dropout_7 (Dropout)	(None, 30, 32)	
lstm_8 (LSTM)	(None, 32)	
dropout_8 (Dropout)	(None, 32)	
dense_3 (Dense)	(None, 1)	

Total params: 21,409 (83.63 KB)

Trainable params: 21,409 (83.63 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 3s 17ms/step - loss: 0.1463 - mae: 0.2951 - val_loss: 0.00
76 - val_mae: 0.0709
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0172 - mae: 0.1021 - val_loss: 0.00
76 - val_mae: 0.0721
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0132 - mae: 0.0891 - val_loss: 0.00
76 - val_mae: 0.0719
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0115 - mae: 0.0851 - val_loss: 0.00
81 - val_mae: 0.0745
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0109 - mae: 0.0822 - val_loss: 0.007
7 - val_mae: 0.0738
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0103 - mae: 0.0818 - val_loss: 0.00
76 - val_mae: 0.0725
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0101 - mae: 0.0798 - val_loss: 0.007
6 - val_mae: 0.0726
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0096 - mae: 0.0776 - val_loss: 0.00
80 - val_mae: 0.0720
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0100 - mae: 0.0806 - val_loss: 0.007
6 - val_mae: 0.0726
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0089 - mae: 0.0755 - val_loss: 0.009
3 - val_mae: 0.0796
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0097 - mae: 0.0786 - val_loss: 0.007
9 - val_mae: 0.0766
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0090 - mae: 0.0746 - val_loss: 0.008
1 - val_mae: 0.0751
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0092 - mae: 0.0754 - val_loss: 0.007
7 - val_mae: 0.0724
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0088 - mae: 0.0732 - val_loss: 0.007
3 - val_mae: 0.0712
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0084 - mae: 0.0730 - val_loss: 0.00
75 - val_mae: 0.0748
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0081 - mae: 0.0712 - val_loss: 0.008
9 - val_mae: 0.0772
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0083 - mae: 0.0722 - val_loss: 0.00
97 - val_mae: 0.0797
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0081 - mae: 0.0712 - val_loss: 0.007
2 - val_mae: 0.0720
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0081 - mae: 0.0713 - val_loss: 0.007
0 - val_mae: 0.0699
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0077 - mae: 0.0692 - val_loss: 0.00
```

```
69 - val_mae: 0.0708
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0071 - mae: 0.0664 - val_loss: 0.006
9 - val_mae: 0.0703
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0075 - mae: 0.0693 - val_loss: 0.00
80 - val_mae: 0.0741
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0078 - mae: 0.0708 - val_loss: 0.00
69 - val_mae: 0.0703
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0075 - mae: 0.0688 - val_loss: 0.00
69 - val_mae: 0.0705
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0072 - mae: 0.0666 - val_loss: 0.00
70 - val_mae: 0.0706
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0073 - mae: 0.0682 - val_loss: 0.006
9 - val_mae: 0.0697
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0072 - mae: 0.0668 - val_loss: 0.00
63 - val_mae: 0.0677
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0064 - mae: 0.0617 - val_loss: 0.006
9 - val_mae: 0.0697
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0064 - mae: 0.0632 - val_loss: 0.00
88 - val_mae: 0.0767
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0074 - mae: 0.0685 - val_loss: 0.00
67 - val_mae: 0.0689
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0066 - mae: 0.0649 - val_loss: 0.00
60 - val_mae: 0.0656
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0058 - mae: 0.0597 - val_loss: 0.00
62 - val_mae: 0.0661
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0069 - mae: 0.0664 - val_loss: 0.006
2 - val_mae: 0.0664
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0063 - mae: 0.0626 - val_loss: 0.005
8 - val_mae: 0.0636
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0062 - mae: 0.0627 - val_loss: 0.00
58 - val_mae: 0.0647
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0061 - mae: 0.0613 - val_loss: 0.00
60 - val_mae: 0.0650
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0073 - mae: 0.0669 - val_loss: 0.00
60 - val_mae: 0.0649
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0057 - mae: 0.0599 - val_loss: 0.00
50 - val_mae: 0.0595
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0058 - mae: 0.0606 - val_loss: 0.005
2 - val_mae: 0.0610
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0057 - mae: 0.0581 - val_loss: 0.00
```

```
52 - val_mae: 0.0608
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0049 - mae: 0.0551 - val_loss: 0.00
49 - val_mae: 0.0580
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0051 - mae: 0.0559 - val_loss: 0.00
54 - val_mae: 0.0613
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0054 - mae: 0.0575 - val_loss: 0.00
48 - val_mae: 0.0585
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0055 - mae: 0.0581 - val_loss: 0.00
46 - val_mae: 0.0568
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0061 - mae: 0.0617 - val_loss: 0.004
8 - val_mae: 0.0581
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0056 - mae: 0.0598 - val_loss: 0.004
5 - val_mae: 0.0554
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0056 - mae: 0.0585 - val_loss: 0.00
44 - val_mae: 0.0557
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0052 - mae: 0.0560 - val_loss: 0.004
5 - val_mae: 0.0562
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0053 - mae: 0.0579 - val_loss: 0.004
7 - val_mae: 0.0570
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0050 - mae: 0.0544 - val_loss: 0.00
43 - val_mae: 0.0548
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0048 - mae: 0.0550 - val_loss: 0.00
44 - val_mae: 0.0554
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0053 - mae: 0.0573 - val_loss: 0.004
8 - val_mae: 0.0575
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0046 - mae: 0.0531 - val_loss: 0.004
7 - val_mae: 0.0571
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0047 - mae: 0.0538 - val_loss: 0.004
2 - val_mae: 0.0537
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0046 - mae: 0.0539 - val_loss: 0.00
43 - val_mae: 0.0548
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0047 - mae: 0.0526 - val_loss: 0.00
46 - val_mae: 0.0562
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0049 - mae: 0.0552 - val_loss: 0.00
42 - val_mae: 0.0540
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0045 - mae: 0.0528 - val_loss: 0.004
0 - val_mae: 0.0523
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0045 - mae: 0.0529 - val_loss: 0.00
44 - val_mae: 0.0549
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0043 - mae: 0.0509 - val_loss: 0.004
```

```
0 - val_mae: 0.0524
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0045 - mae: 0.0526 - val_loss: 0.00
40 - val_mae: 0.0524
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0045 - mae: 0.0534 - val_loss: 0.00
45 - val_mae: 0.0553
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0044 - mae: 0.0526 - val_loss: 0.00
40 - val_mae: 0.0524
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0040 - mae: 0.0495 - val_loss: 0.00
44 - val_mae: 0.0549
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0042 - mae: 0.0513 - val_loss: 0.00
40 - val_mae: 0.0526
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0040 - mae: 0.0497 - val_loss: 0.00
45 - val_mae: 0.0558
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0039 - mae: 0.0488 - val_loss: 0.00
41 - val_mae: 0.0530
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0043 - mae: 0.0520 - val_loss: 0.004
1 - val_mae: 0.0535
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0045 - mae: 0.0528 - val_loss: 0.00
38 - val_mae: 0.0512
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0041 - mae: 0.0502 - val_loss: 0.00
37 - val_mae: 0.0501
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0042 - mae: 0.0510 - val_loss: 0.00
38 - val_mae: 0.0507
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0044 - mae: 0.0526 - val_loss: 0.00
43 - val_mae: 0.0549
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.00
38 - val_mae: 0.0519
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0487 - val_loss: 0.00
40 - val_mae: 0.0525
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0488 - val_loss: 0.00
37 - val_mae: 0.0506
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0044 - mae: 0.0520 - val_loss: 0.003
8 - val_mae: 0.0513
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0040 - mae: 0.0495 - val_loss: 0.00
35 - val_mae: 0.0489
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0038 - mae: 0.0485 - val_loss: 0.00
38 - val_mae: 0.0512
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0471 - val_loss: 0.00
35 - val_mae: 0.0496
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0040 - mae: 0.0485 - val_loss: 0.00
```

```
35 - val_mae: 0.0495
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0040 - mae: 0.0489 - val_loss: 0.00
42 - val_mae: 0.0541
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0044 - mae: 0.0519 - val_loss: 0.00
37 - val_mae: 0.0512
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0478 - val_loss: 0.00
37 - val_mae: 0.0505
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
35 - val_mae: 0.0498
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0040 - mae: 0.0499 - val_loss: 0.00
38 - val_mae: 0.0522
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0039 - mae: 0.0485 - val_loss: 0.00
34 - val_mae: 0.0488
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0036 - mae: 0.0465 - val_loss: 0.00
38 - val_mae: 0.0508
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0470 - val_loss: 0.00
39 - val_mae: 0.0515
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0468 - val_loss: 0.00
34 - val_mae: 0.0491
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0465 - val_loss: 0.00
39 - val_mae: 0.0519
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0479 - val_loss: 0.00
34 - val_mae: 0.0487
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0478 - val_loss: 0.00
34 - val_mae: 0.0491
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0452 - val_loss: 0.00
36 - val_mae: 0.0501
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0471 - val_loss: 0.00
33 - val_mae: 0.0483
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0032 - mae: 0.0449 - val_loss: 0.00
32 - val_mae: 0.0475
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
34 - val_mae: 0.0483
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0459 - val_loss: 0.00
37 - val_mae: 0.0507
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0465 - val_loss: 0.00
33 - val_mae: 0.0485
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0040 - mae: 0.0488 - val_loss: 0.003
4 - val_mae: 0.0491
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0038 - mae: 0.0473 - val_loss: 0.00
```

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31 - val_mae: 0.0467
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 117ms/step
Completed Model 4: Validation MAE = 0.04667901247739792
Training model 5 - LSTM with units: 64, layers: 3
```

Model: "sequential_4"

Layer (type)	Output Shape	Pa
lstm_9 (LSTM)	(None, 30, 64)	1
dropout_9 (Dropout)	(None, 30, 64)	
lstm_10 (LSTM)	(None, 30, 64)	3
dropout_10 (Dropout)	(None, 30, 64)	
lstm_11 (LSTM)	(None, 64)	3
dropout_11 (Dropout)	(None, 64)	
dense_4 (Dense)	(None, 1)	

Total params: 83,777 (327.25 KB)

Trainable params: 83,777 (327.25 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 4s 27ms/step - loss: 0.0952 - mae: 0.2252 - val_loss: 0.00
80 - val_mae: 0.0757
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0124 - mae: 0.0877 - val_loss: 0.00
79 - val_mae: 0.0744
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0114 - mae: 0.0840 - val_loss: 0.00
82 - val_mae: 0.0782
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0106 - mae: 0.0816 - val_loss: 0.00
78 - val_mae: 0.0735
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0101 - mae: 0.0781 - val_loss: 0.00
82 - val_mae: 0.0779
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0085 - mae: 0.0737 - val_loss: 0.00
77 - val_mae: 0.0749
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0086 - mae: 0.0753 - val_loss: 0.009
8 - val_mae: 0.0817
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0093 - mae: 0.0755 - val_loss: 0.007
8 - val_mae: 0.0747
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0083 - mae: 0.0722 - val_loss: 0.00
77 - val_mae: 0.0755
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0097 - mae: 0.0781 - val_loss: 0.007
5 - val_mae: 0.0749
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0077 - mae: 0.0690 - val_loss: 0.00
72 - val_mae: 0.0730
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0081 - mae: 0.0711 - val_loss: 0.00
72 - val_mae: 0.0727
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0088 - mae: 0.0754 - val_loss: 0.007
2 - val_mae: 0.0715
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0082 - mae: 0.0703 - val_loss: 0.00
75 - val_mae: 0.0760
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0085 - mae: 0.0730 - val_loss: 0.007
0 - val_mae: 0.0726
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0080 - mae: 0.0706 - val_loss: 0.00
95 - val_mae: 0.0797
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0075 - mae: 0.0686 - val_loss: 0.00
73 - val_mae: 0.0725
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0074 - mae: 0.0668 - val_loss: 0.00
95 - val_mae: 0.0795
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0075 - mae: 0.0664 - val_loss: 0.00
65 - val_mae: 0.0680
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0072 - mae: 0.0676 - val_loss: 0.00
```

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63 - val_mae: 0.0696
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0069 - mae: 0.0651 - val_loss: 0.00
93 - val_mae: 0.0786
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0075 - mae: 0.0671 - val_loss: 0.00
64 - val_mae: 0.0687
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0072 - mae: 0.0680 - val_loss: 0.00
61 - val_mae: 0.0677
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0070 - mae: 0.0657 - val_loss: 0.00
86 - val_mae: 0.0763
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0066 - mae: 0.0626 - val_loss: 0.00
63 - val_mae: 0.0667
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0059 - mae: 0.0602 - val_loss: 0.00
62 - val_mae: 0.0666
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0063 - mae: 0.0630 - val_loss: 0.00
64 - val_mae: 0.0671
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0060 - mae: 0.0601 - val_loss: 0.00
56 - val_mae: 0.0652
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0061 - mae: 0.0612 - val_loss: 0.00
58 - val_mae: 0.0645
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0060 - mae: 0.0613 - val_loss: 0.00
55 - val_mae: 0.0634
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0063 - mae: 0.0632 - val_loss: 0.00
69 - val_mae: 0.0688
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0055 - mae: 0.0594 - val_loss: 0.00
51 - val_mae: 0.0602
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0058 - mae: 0.0597 - val_loss: 0.00
69 - val_mae: 0.0684
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0060 - mae: 0.0609 - val_loss: 0.00
50 - val_mae: 0.0584
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0065 - mae: 0.0623 - val_loss: 0.005
8 - val_mae: 0.0631
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0054 - mae: 0.0570 - val_loss: 0.00
49 - val_mae: 0.0576
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0059 - mae: 0.0603 - val_loss: 0.005
9 - val_mae: 0.0638
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0056 - mae: 0.0586 - val_loss: 0.00
50 - val_mae: 0.0585
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0050 - mae: 0.0556 - val_loss: 0.00
50 - val_mae: 0.0590
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0054 - mae: 0.0583 - val_loss: 0.00
```

```
48 - val_mae: 0.0582
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0054 - mae: 0.0592 - val_loss: 0.00
47 - val_mae: 0.0572
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0050 - mae: 0.0554 - val_loss: 0.00
46 - val_mae: 0.0565
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0045 - mae: 0.0536 - val_loss: 0.004
3 - val_mae: 0.0548
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0051 - mae: 0.0572 - val_loss: 0.00
70 - val_mae: 0.0687
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0053 - mae: 0.0558 - val_loss: 0.00
44 - val_mae: 0.0550
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0050 - mae: 0.0560 - val_loss: 0.00
57 - val_mae: 0.0629
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0049 - mae: 0.0557 - val_loss: 0.004
2 - val_mae: 0.0541
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0047 - mae: 0.0529 - val_loss: 0.005
9 - val_mae: 0.0630
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0053 - mae: 0.0567 - val_loss: 0.004
1 - val_mae: 0.0538
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0050 - mae: 0.0564 - val_loss: 0.004
7 - val_mae: 0.0563
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0045 - mae: 0.0519 - val_loss: 0.004
5 - val_mae: 0.0559
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0045 - mae: 0.0525 - val_loss: 0.00
49 - val_mae: 0.0577
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0049 - mae: 0.0552 - val_loss: 0.00
44 - val_mae: 0.0548
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0047 - mae: 0.0537 - val_loss: 0.00
40 - val_mae: 0.0531
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0044 - mae: 0.0510 - val_loss: 0.00
40 - val_mae: 0.0525
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.003
8 - val_mae: 0.0515
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0040 - mae: 0.0495 - val_loss: 0.003
8 - val_mae: 0.0512
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0043 - mae: 0.0512 - val_loss: 0.004
4 - val_mae: 0.0549
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0045 - mae: 0.0529 - val_loss: 0.004
5 - val_mae: 0.0556
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0043 - mae: 0.0518 - val_loss: 0.004
```

```
0 - val_mae: 0.0528
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0039 - mae: 0.0494 - val_loss: 0.004
7 - val_mae: 0.0567
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0039 - mae: 0.0486 - val_loss: 0.004
4 - val_mae: 0.0552
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0494 - val_loss: 0.00
36 - val_mae: 0.0503
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0494 - val_loss: 0.004
2 - val_mae: 0.0539
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0041 - mae: 0.0507 - val_loss: 0.00
36 - val_mae: 0.0498
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0043 - mae: 0.0516 - val_loss: 0.00
38 - val_mae: 0.0514
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0039 - mae: 0.0494 - val_loss: 0.00
39 - val_mae: 0.0524
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0042 - mae: 0.0513 - val_loss: 0.00
41 - val_mae: 0.0538
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0041 - mae: 0.0508 - val_loss: 0.00
36 - val_mae: 0.0502
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0040 - mae: 0.0488 - val_loss: 0.00
37 - val_mae: 0.0505
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0039 - mae: 0.0495 - val_loss: 0.003
7 - val_mae: 0.0506
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0040 - mae: 0.0496 - val_loss: 0.003
4 - val_mae: 0.0484
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0039 - mae: 0.0493 - val_loss: 0.00
38 - val_mae: 0.0513
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0040 - mae: 0.0492 - val_loss: 0.003
4 - val_mae: 0.0486
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0476 - val_loss: 0.00
34 - val_mae: 0.0484
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.003
8 - val_mae: 0.0511
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0037 - mae: 0.0471 - val_loss: 0.00
33 - val_mae: 0.0483
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0039 - mae: 0.0495 - val_loss: 0.003
4 - val_mae: 0.0483
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0037 - mae: 0.0475 - val_loss: 0.003
3 - val_mae: 0.0478
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0463 - val_loss: 0.00
```

```
39 - val_mae: 0.0515
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0037 - mae: 0.0479 - val_loss: 0.003
4 - val_mae: 0.0487
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
40 - val_mae: 0.0517
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0038 - mae: 0.0481 - val_loss: 0.003
6 - val_mae: 0.0503
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0033 - mae: 0.0448 - val_loss: 0.003
4 - val_mae: 0.0485
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0490 - val_loss: 0.00
35 - val_mae: 0.0496
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.003
7 - val_mae: 0.0500
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0036 - mae: 0.0474 - val_loss: 0.00
40 - val_mae: 0.0521
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0034 - mae: 0.0463 - val_loss: 0.00
35 - val_mae: 0.0488
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0034 - mae: 0.0452 - val_loss: 0.00
32 - val_mae: 0.0474
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0035 - mae: 0.0466 - val_loss: 0.00
33 - val_mae: 0.0479
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0033 - mae: 0.0448 - val_loss: 0.00
36 - val_mae: 0.0495
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0461 - val_loss: 0.00
39 - val_mae: 0.0516
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0035 - mae: 0.0467 - val_loss: 0.003
3 - val_mae: 0.0483
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0036 - mae: 0.0468 - val_loss: 0.003
2 - val_mae: 0.0467
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0031 - mae: 0.0436 - val_loss: 0.003
1 - val_mae: 0.0466
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0030 - mae: 0.0424 - val_loss: 0.003
0 - val_mae: 0.0454
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0035 - mae: 0.0458 - val_loss: 0.003
2 - val_mae: 0.0469
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0037 - mae: 0.0472 - val_loss: 0.003
3 - val_mae: 0.0473
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0038 - mae: 0.0478 - val_loss: 0.003
1 - val_mae: 0.0461
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0034 - mae: 0.0448 - val_loss: 0.002
```

```
9 - val_mae: 0.0452
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 115ms/step
Completed Model 5: Validation MAE = 0.0452401377260685
Training model 6 - CNN+LSTM with units: 32, layers: 2
```

Model: "sequential_5"

Layer (type)	Output Shape	Pa
lstm_12 (LSTM)	(None, 30, 32)	
dropout_12 (Dropout)	(None, 30, 32)	
lstm_13 (LSTM)	(None, 32)	
dropout_13 (Dropout)	(None, 32)	
dense_5 (Dense)	(None, 1)	

Total params: 13,089 (51.13 KB)

Trainable params: 13,089 (51.13 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 2s 13ms/step - loss: 0.0964 - mae: 0.2362 - val_loss: 0.00
79 - val_mae: 0.0753
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0147 - mae: 0.0978 - val_loss: 0.008
7 - val_mae: 0.0752
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0128 - mae: 0.0890 - val_loss: 0.007
7 - val_mae: 0.0742
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0117 - mae: 0.0837 - val_loss: 0.00
71 - val_mae: 0.0717
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0099 - mae: 0.0786 - val_loss: 0.00
71 - val_mae: 0.0715
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0097 - mae: 0.0764 - val_loss: 0.00
70 - val_mae: 0.0704
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0094 - mae: 0.0767 - val_loss: 0.00
74 - val_mae: 0.0705
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0087 - mae: 0.0734 - val_loss: 0.00
68 - val_mae: 0.0706
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0094 - mae: 0.0760 - val_loss: 0.009
5 - val_mae: 0.0798
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0081 - mae: 0.0707 - val_loss: 0.007
6 - val_mae: 0.0728
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0088 - mae: 0.0734 - val_loss: 0.006
7 - val_mae: 0.0690
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0084 - mae: 0.0728 - val_loss: 0.006
8 - val_mae: 0.0705
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0079 - mae: 0.0695 - val_loss: 0.006
5 - val_mae: 0.0676
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0073 - mae: 0.0670 - val_loss: 0.007
3 - val_mae: 0.0694
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0080 - mae: 0.0687 - val_loss: 0.006
4 - val_mae: 0.0688
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0076 - mae: 0.0683 - val_loss: 0.007
4 - val_mae: 0.0717
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0078 - mae: 0.0688 - val_loss: 0.006
3 - val_mae: 0.0653
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0068 - mae: 0.0651 - val_loss: 0.007
5 - val_mae: 0.0724
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0073 - mae: 0.0662 - val_loss: 0.006
3 - val_mae: 0.0663
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0067 - mae: 0.0638 - val_loss: 0.006
```

```
0 - val_mae: 0.0641
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0074 - mae: 0.0675 - val_loss: 0.006
2 - val_mae: 0.0660
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0070 - mae: 0.0662 - val_loss: 0.006
6 - val_mae: 0.0680
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0066 - mae: 0.0631 - val_loss: 0.006
4 - val_mae: 0.0671
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0066 - mae: 0.0628 - val_loss: 0.007
1 - val_mae: 0.0702
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0066 - mae: 0.0632 - val_loss: 0.005
8 - val_mae: 0.0633
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0059 - mae: 0.0612 - val_loss: 0.005
7 - val_mae: 0.0636
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0060 - mae: 0.0601 - val_loss: 0.005
7 - val_mae: 0.0625
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0055 - mae: 0.0590 - val_loss: 0.005
6 - val_mae: 0.0629
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0056 - mae: 0.0585 - val_loss: 0.006
1 - val_mae: 0.0657
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0052 - mae: 0.0568 - val_loss: 0.00
55 - val_mae: 0.0617
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0060 - mae: 0.0618 - val_loss: 0.00
55 - val_mae: 0.0615
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0060 - mae: 0.0604 - val_loss: 0.00
55 - val_mae: 0.0619
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0061 - mae: 0.0613 - val_loss: 0.00
54 - val_mae: 0.0610
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0052 - mae: 0.0566 - val_loss: 0.00
61 - val_mae: 0.0652
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0050 - mae: 0.0566 - val_loss: 0.005
5 - val_mae: 0.0625
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0056 - mae: 0.0582 - val_loss: 0.005
8 - val_mae: 0.0635
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0055 - mae: 0.0571 - val_loss: 0.005
5 - val_mae: 0.0620
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0057 - mae: 0.0595 - val_loss: 0.005
0 - val_mae: 0.0586
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0051 - mae: 0.0557 - val_loss: 0.005
3 - val_mae: 0.0605
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0052 - mae: 0.0568 - val_loss: 0.004
```

```
9 - val_mae: 0.0582
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0050 - mae: 0.0568 - val_loss: 0.004
9 - val_mae: 0.0578
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0053 - mae: 0.0568 - val_loss: 0.004
9 - val_mae: 0.0578
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0047 - mae: 0.0540 - val_loss: 0.005
1 - val_mae: 0.0599
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0050 - mae: 0.0556 - val_loss: 0.005
5 - val_mae: 0.0618
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0051 - mae: 0.0555 - val_loss: 0.006
2 - val_mae: 0.0652
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0047 - mae: 0.0543 - val_loss: 0.004
8 - val_mae: 0.0575
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0048 - mae: 0.0544 - val_loss: 0.004
8 - val_mae: 0.0577
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0045 - mae: 0.0530 - val_loss: 0.005
1 - val_mae: 0.0593
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0045 - mae: 0.0524 - val_loss: 0.004
6 - val_mae: 0.0550
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0046 - mae: 0.0529 - val_loss: 0.004
9 - val_mae: 0.0581
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0047 - mae: 0.0535 - val_loss: 0.005
1 - val_mae: 0.0596
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0052 - mae: 0.0574 - val_loss: 0.005
2 - val_mae: 0.0603
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0047 - mae: 0.0538 - val_loss: 0.004
4 - val_mae: 0.0547
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0046 - mae: 0.0527 - val_loss: 0.00
44 - val_mae: 0.0541
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0047 - mae: 0.0547 - val_loss: 0.00
45 - val_mae: 0.0562
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0045 - mae: 0.0537 - val_loss: 0.00
45 - val_mae: 0.0549
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0044 - mae: 0.0516 - val_loss: 0.00
46 - val_mae: 0.0562
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0049 - mae: 0.0550 - val_loss: 0.00
43 - val_mae: 0.0539
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0039 - mae: 0.0489 - val_loss: 0.00
43 - val_mae: 0.0547
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0044 - mae: 0.0517 - val_loss: 0.004
```

```
7 - val_mae: 0.0568
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0042 - mae: 0.0503 - val_loss: 0.004
1 - val_mae: 0.0528
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0040 - mae: 0.0504 - val_loss: 0.004
2 - val_mae: 0.0542
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0042 - mae: 0.0509 - val_loss: 0.004
1 - val_mae: 0.0526
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0039 - mae: 0.0496 - val_loss: 0.004
4 - val_mae: 0.0553
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0040 - mae: 0.0493 - val_loss: 0.004
5 - val_mae: 0.0559
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0042 - mae: 0.0510 - val_loss: 0.004
3 - val_mae: 0.0547
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0042 - mae: 0.0506 - val_loss: 0.003
9 - val_mae: 0.0520
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0038 - mae: 0.0481 - val_loss: 0.004
0 - val_mae: 0.0526
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0483 - val_loss: 0.004
0 - val_mae: 0.0525
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.003
8 - val_mae: 0.0514
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0493 - val_loss: 0.003
8 - val_mae: 0.0511
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0479 - val_loss: 0.003
9 - val_mae: 0.0519
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0040 - mae: 0.0492 - val_loss: 0.004
4 - val_mae: 0.0550
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0040 - mae: 0.0494 - val_loss: 0.004
0 - val_mae: 0.0525
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0484 - val_loss: 0.003
9 - val_mae: 0.0518
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0036 - mae: 0.0461 - val_loss: 0.003
9 - val_mae: 0.0518
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0037 - mae: 0.0479 - val_loss: 0.003
8 - val_mae: 0.0510
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0034 - mae: 0.0457 - val_loss: 0.003
7 - val_mae: 0.0505
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0461 - val_loss: 0.003
8 - val_mae: 0.0516
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0035 - mae: 0.0464 - val_loss: 0.00
```

```
37 - val_mae: 0.0509
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0471 - val_loss: 0.00
36 - val_mae: 0.0498
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0035 - mae: 0.0464 - val_loss: 0.00
39 - val_mae: 0.0521
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0042 - mae: 0.0500 - val_loss: 0.00
44 - val_mae: 0.0552
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0496 - val_loss: 0.003
6 - val_mae: 0.0503
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0467 - val_loss: 0.003
6 - val_mae: 0.0502
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0035 - mae: 0.0466 - val_loss: 0.003
7 - val_mae: 0.0508
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0032 - mae: 0.0435 - val_loss: 0.004
0 - val_mae: 0.0523
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0033 - mae: 0.0445 - val_loss: 0.004
0 - val_mae: 0.0523
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0032 - mae: 0.0440 - val_loss: 0.004
1 - val_mae: 0.0533
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0461 - val_loss: 0.003
6 - val_mae: 0.0498
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0032 - mae: 0.0446 - val_loss: 0.003
6 - val_mae: 0.0499
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0034 - mae: 0.0456 - val_loss: 0.003
4 - val_mae: 0.0489
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0033 - mae: 0.0449 - val_loss: 0.003
4 - val_mae: 0.0488
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0036 - mae: 0.0471 - val_loss: 0.003
4 - val_mae: 0.0488
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0034 - mae: 0.0446 - val_loss: 0.003
5 - val_mae: 0.0492
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0029 - mae: 0.0413 - val_loss: 0.003
6 - val_mae: 0.0503
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0032 - mae: 0.0432 - val_loss: 0.003
4 - val_mae: 0.0487
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0033 - mae: 0.0450 - val_loss: 0.003
4 - val_mae: 0.0490
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0032 - mae: 0.0447 - val_loss: 0.003
4 - val_mae: 0.0486
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0459 - val_loss: 0.003
```

```
5 - val_mae: 0.0494
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 81ms/step
Completed Model 6: Validation MAE = 0.04940935596823692
Training model 7 - CNN+LSTM with units: 64, layers: 2
```

Model: "sequential_6"

Layer (type)	Output Shape	Pa
lstm_14 (LSTM)	(None, 30, 64)	1
dropout_14 (Dropout)	(None, 30, 64)	
lstm_15 (LSTM)	(None, 64)	3
dropout_15 (Dropout)	(None, 64)	
dense_6 (Dense)	(None, 1)	

Total params: 50,753 (198.25 KB)

Trainable params: 50,753 (198.25 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 3s 19ms/step - loss: 0.1250 - mae: 0.2624 - val_loss: 0.00
74 - val_mae: 0.0741
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0114 - mae: 0.0851 - val_loss: 0.00
71 - val_mae: 0.0727
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0110 - mae: 0.0846 - val_loss: 0.00
70 - val_mae: 0.0692
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0111 - mae: 0.0831 - val_loss: 0.00
72 - val_mae: 0.0723
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0092 - mae: 0.0762 - val_loss: 0.007
4 - val_mae: 0.0702
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0097 - mae: 0.0769 - val_loss: 0.006
8 - val_mae: 0.0709
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0088 - mae: 0.0723 - val_loss: 0.006
6 - val_mae: 0.0671
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0081 - mae: 0.0712 - val_loss: 0.006
5 - val_mae: 0.0681
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0077 - mae: 0.0683 - val_loss: 0.009
5 - val_mae: 0.0802
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0091 - mae: 0.0748 - val_loss: 0.007
2 - val_mae: 0.0725
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0080 - mae: 0.0722 - val_loss: 0.006
6 - val_mae: 0.0682
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0071 - mae: 0.0658 - val_loss: 0.006
4 - val_mae: 0.0686
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0080 - mae: 0.0703 - val_loss: 0.006
2 - val_mae: 0.0673
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0070 - mae: 0.0661 - val_loss: 0.006
0 - val_mae: 0.0668
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0072 - mae: 0.0677 - val_loss: 0.006
4 - val_mae: 0.0674
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0067 - mae: 0.0636 - val_loss: 0.006
0 - val_mae: 0.0649
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0075 - mae: 0.0692 - val_loss: 0.006
1 - val_mae: 0.0660
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0070 - mae: 0.0666 - val_loss: 0.005
8 - val_mae: 0.0625
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0070 - mae: 0.0664 - val_loss: 0.008
4 - val_mae: 0.0754
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0076 - mae: 0.0683 - val_loss: 0.005
```

```
4 - val_mae: 0.0623
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0063 - mae: 0.0619 - val_loss: 0.005
3 - val_mae: 0.0618
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0062 - mae: 0.0617 - val_loss: 0.005
3 - val_mae: 0.0616
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0059 - mae: 0.0614 - val_loss: 0.005
3 - val_mae: 0.0611
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0062 - mae: 0.0616 - val_loss: 0.006
1 - val_mae: 0.0651
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0065 - mae: 0.0634 - val_loss: 0.005
3 - val_mae: 0.0612
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0062 - mae: 0.0627 - val_loss: 0.00
50 - val_mae: 0.0593
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0063 - mae: 0.0632 - val_loss: 0.00
50 - val_mae: 0.0603
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0064 - mae: 0.0635 - val_loss: 0.00
50 - val_mae: 0.0594
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0057 - mae: 0.0583 - val_loss: 0.00
47 - val_mae: 0.0576
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0058 - mae: 0.0593 - val_loss: 0.00
57 - val_mae: 0.0633
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0058 - mae: 0.0599 - val_loss: 0.00
52 - val_mae: 0.0603
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0055 - mae: 0.0582 - val_loss: 0.004
7 - val_mae: 0.0577
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0055 - mae: 0.0586 - val_loss: 0.004
5 - val_mae: 0.0561
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0057 - mae: 0.0594 - val_loss: 0.004
6 - val_mae: 0.0563
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0054 - mae: 0.0578 - val_loss: 0.005
3 - val_mae: 0.0607
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0059 - mae: 0.0610 - val_loss: 0.004
6 - val_mae: 0.0566
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0053 - mae: 0.0568 - val_loss: 0.004
4 - val_mae: 0.0554
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0054 - mae: 0.0573 - val_loss: 0.004
6 - val_mae: 0.0565
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0054 - mae: 0.0582 - val_loss: 0.00
43 - val_mae: 0.0542
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0056 - mae: 0.0590 - val_loss: 0.00
```

```
45 - val_mae: 0.0556
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0053 - mae: 0.0551 - val_loss: 0.00
42 - val_mae: 0.0535
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0047 - mae: 0.0545 - val_loss: 0.00
41 - val_mae: 0.0527
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0053 - mae: 0.0566 - val_loss: 0.00
42 - val_mae: 0.0535
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0049 - mae: 0.0547 - val_loss: 0.00
39 - val_mae: 0.0514
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0050 - mae: 0.0561 - val_loss: 0.004
6 - val_mae: 0.0563
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0050 - mae: 0.0555 - val_loss: 0.003
9 - val_mae: 0.0523
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0045 - mae: 0.0522 - val_loss: 0.004
8 - val_mae: 0.0574
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0045 - mae: 0.0522 - val_loss: 0.003
9 - val_mae: 0.0512
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0046 - mae: 0.0543 - val_loss: 0.003
9 - val_mae: 0.0520
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0046 - mae: 0.0535 - val_loss: 0.003
8 - val_mae: 0.0511
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0041 - mae: 0.0506 - val_loss: 0.00
38 - val_mae: 0.0509
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0043 - mae: 0.0511 - val_loss: 0.00
38 - val_mae: 0.0508
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0043 - mae: 0.0518 - val_loss: 0.00
39 - val_mae: 0.0521
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0041 - mae: 0.0491 - val_loss: 0.00
41 - val_mae: 0.0531
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0045 - mae: 0.0516 - val_loss: 0.00
39 - val_mae: 0.0514
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0043 - mae: 0.0518 - val_loss: 0.003
9 - val_mae: 0.0515
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0043 - mae: 0.0507 - val_loss: 0.004
0 - val_mae: 0.0526
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0042 - mae: 0.0505 - val_loss: 0.004
0 - val_mae: 0.0526
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0498 - val_loss: 0.003
7 - val_mae: 0.0503
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0484 - val_loss: 0.004
```

```
0 - val_mae: 0.0522
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0505 - val_loss: 0.003
5 - val_mae: 0.0489
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.003
6 - val_mae: 0.0496
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0042 - mae: 0.0500 - val_loss: 0.003
5 - val_mae: 0.0489
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0044 - mae: 0.0517 - val_loss: 0.003
6 - val_mae: 0.0496
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0477 - val_loss: 0.003
5 - val_mae: 0.0492
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0043 - mae: 0.0510 - val_loss: 0.003
6 - val_mae: 0.0498
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0044 - mae: 0.0528 - val_loss: 0.004
3 - val_mae: 0.0539
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0037 - mae: 0.0471 - val_loss: 0.003
5 - val_mae: 0.0491
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0457 - val_loss: 0.004
3 - val_mae: 0.0537
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0492 - val_loss: 0.003
5 - val_mae: 0.0487
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0035 - mae: 0.0466 - val_loss: 0.003
9 - val_mae: 0.0516
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.003
9 - val_mae: 0.0519
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0468 - val_loss: 0.003
4 - val_mae: 0.0478
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0491 - val_loss: 0.003
3 - val_mae: 0.0476
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0471 - val_loss: 0.003
5 - val_mae: 0.0491
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0486 - val_loss: 0.003
6 - val_mae: 0.0499
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0038 - mae: 0.0487 - val_loss: 0.00
33 - val_mae: 0.0478
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0032 - mae: 0.0439 - val_loss: 0.00
33 - val_mae: 0.0474
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0035 - mae: 0.0465 - val_loss: 0.00
34 - val_mae: 0.0482
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
```

```
33 - val_mae: 0.0474
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0035 - mae: 0.0458 - val_loss: 0.00
32 - val_mae: 0.0473
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0037 - mae: 0.0478 - val_loss: 0.00
35 - val_mae: 0.0485
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0032 - mae: 0.0449 - val_loss: 0.004
0 - val_mae: 0.0520
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0039 - mae: 0.0485 - val_loss: 0.003
6 - val_mae: 0.0498
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0034 - mae: 0.0445 - val_loss: 0.003
2 - val_mae: 0.0471
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0463 - val_loss: 0.003
3 - val_mae: 0.0476
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0440 - val_loss: 0.003
8 - val_mae: 0.0507
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0038 - mae: 0.0488 - val_loss: 0.003
4 - val_mae: 0.0478
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0442 - val_loss: 0.003
3 - val_mae: 0.0473
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0035 - mae: 0.0459 - val_loss: 0.003
2 - val_mae: 0.0468
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0035 - mae: 0.0455 - val_loss: 0.003
1 - val_mae: 0.0460
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0034 - mae: 0.0450 - val_loss: 0.003
2 - val_mae: 0.0469
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0036 - mae: 0.0462 - val_loss: 0.003
1 - val_mae: 0.0461
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0033 - mae: 0.0447 - val_loss: 0.003
2 - val_mae: 0.0463
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0454 - val_loss: 0.003
1 - val_mae: 0.0464
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.003
1 - val_mae: 0.0465
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0036 - mae: 0.0468 - val_loss: 0.003
1 - val_mae: 0.0464
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0033 - mae: 0.0443 - val_loss: 0.003
1 - val_mae: 0.0458
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0033 - mae: 0.0438 - val_loss: 0.003
3 - val_mae: 0.0475
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0031 - mae: 0.0435 - val_loss: 0.003
```

1 - val_mae: 0.0464
3/3 ━━━━━━━━━━━━━━━━━━━━ **0s** 79ms/step
Completed Model 7: Validation MAE = 0.04643116518855095
Training model 8 - CNN+LSTM with units: 128, layers: 2
Model: "sequential_7"

Layer (type)	Output Shape	Pa
lstm_16 (LSTM)	(None, 30, 128)	6
dropout_16 (Dropout)	(None, 30, 128)	
lstm_17 (LSTM)	(None, 128)	1:
dropout_17 (Dropout)	(None, 128)	
dense_7 (Dense)	(None, 1)	

Total params: 199,809 (780.50 KB)
Trainable params: 199,809 (780.50 KB)
Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - loss: 0.0644 - mae: 0.1784 - val_loss: 0.00
68 - val_mae: 0.0708
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0100 - mae: 0.0798 - val_loss: 0.00
67 - val_mae: 0.0708
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0091 - mae: 0.0759 - val_loss: 0.00
66 - val_mae: 0.0694
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0082 - mae: 0.0705 - val_loss: 0.006
6 - val_mae: 0.0688
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0081 - mae: 0.0715 - val_loss: 0.006
0 - val_mae: 0.0657
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0091 - mae: 0.0758 - val_loss: 0.007
5 - val_mae: 0.0723
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0076 - mae: 0.0700 - val_loss: 0.006
0 - val_mae: 0.0646
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0068 - mae: 0.0649 - val_loss: 0.005
8 - val_mae: 0.0653
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0076 - mae: 0.0668 - val_loss: 0.006
0 - val_mae: 0.0651
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0071 - mae: 0.0658 - val_loss: 0.005
5 - val_mae: 0.0620
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0072 - mae: 0.0679 - val_loss: 0.005
4 - val_mae: 0.0615
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0070 - mae: 0.0669 - val_loss: 0.005
5 - val_mae: 0.0630
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0067 - mae: 0.0640 - val_loss: 0.006
4 - val_mae: 0.0665
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0068 - mae: 0.0647 - val_loss: 0.005
4 - val_mae: 0.0629
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0063 - mae: 0.0619 - val_loss: 0.005
5 - val_mae: 0.0623
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0062 - mae: 0.0620 - val_loss: 0.004
9 - val_mae: 0.0584
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0054 - mae: 0.0577 - val_loss: 0.005
4 - val_mae: 0.0614
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0062 - mae: 0.0606 - val_loss: 0.004
8 - val_mae: 0.0582
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0060 - mae: 0.0606 - val_loss: 0.004
7 - val_mae: 0.0573
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0063 - mae: 0.0634 - val_loss: 0.005
```

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2 - val_mae: 0.0605
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0058 - mae: 0.0598 - val_loss: 0.004
8 - val_mae: 0.0577
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0054 - mae: 0.0578 - val_loss: 0.004
7 - val_mae: 0.0576
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0055 - mae: 0.0576 - val_loss: 0.00
46 - val_mae: 0.0581
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0058 - mae: 0.0599 - val_loss: 0.00
45 - val_mae: 0.0557
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0054 - mae: 0.0574 - val_loss: 0.00
46 - val_mae: 0.0562
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0057 - mae: 0.0597 - val_loss: 0.00
45 - val_mae: 0.0560
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0053 - mae: 0.0572 - val_loss: 0.00
43 - val_mae: 0.0540
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0051 - mae: 0.0560 - val_loss: 0.00
47 - val_mae: 0.0575
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0054 - mae: 0.0579 - val_loss: 0.005
4 - val_mae: 0.0604
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0053 - mae: 0.0574 - val_loss: 0.004
1 - val_mae: 0.0527
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0052 - mae: 0.0563 - val_loss: 0.004
1 - val_mae: 0.0525
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0044 - mae: 0.0531 - val_loss: 0.004
1 - val_mae: 0.0527
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0045 - mae: 0.0536 - val_loss: 0.003
9 - val_mae: 0.0520
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 7ms/step - loss: 0.0049 - mae: 0.0557 - val_loss: 0.003
9 - val_mae: 0.0517
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0050 - mae: 0.0556 - val_loss: 0.003
8 - val_mae: 0.0504
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0046 - mae: 0.0535 - val_loss: 0.003
9 - val_mae: 0.0515
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0046 - mae: 0.0528 - val_loss: 0.003
9 - val_mae: 0.0522
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0045 - mae: 0.0520 - val_loss: 0.003
8 - val_mae: 0.0510
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0048 - mae: 0.0537 - val_loss: 0.003
6 - val_mae: 0.0499
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0046 - mae: 0.0534 - val_loss: 0.003
```

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8 - val_mae: 0.0509
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0046 - mae: 0.0532 - val_loss: 0.003
7 - val_mae: 0.0507
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0044 - mae: 0.0514 - val_loss: 0.003
6 - val_mae: 0.0492
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0042 - mae: 0.0505 - val_loss: 0.004
2 - val_mae: 0.0532
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0045 - mae: 0.0524 - val_loss: 0.003
6 - val_mae: 0.0493
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0045 - mae: 0.0520 - val_loss: 0.003
9 - val_mae: 0.0518
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0039 - mae: 0.0496 - val_loss: 0.003
7 - val_mae: 0.0507
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0043 - mae: 0.0520 - val_loss: 0.003
5 - val_mae: 0.0498
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0047 - mae: 0.0531 - val_loss: 0.003
5 - val_mae: 0.0495
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0040 - mae: 0.0492 - val_loss: 0.003
7 - val_mae: 0.0502
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0041 - mae: 0.0492 - val_loss: 0.003
4 - val_mae: 0.0483
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0493 - val_loss: 0.003
8 - val_mae: 0.0507
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0042 - mae: 0.0508 - val_loss: 0.00
37 - val_mae: 0.0505
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0042 - mae: 0.0505 - val_loss: 0.00
35 - val_mae: 0.0489
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0042 - mae: 0.0501 - val_loss: 0.00
36 - val_mae: 0.0497
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0038 - mae: 0.0477 - val_loss: 0.00
39 - val_mae: 0.0516
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0041 - mae: 0.0507 - val_loss: 0.00
36 - val_mae: 0.0496
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0039 - mae: 0.0483 - val_loss: 0.003
6 - val_mae: 0.0493
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0037 - mae: 0.0473 - val_loss: 0.003
6 - val_mae: 0.0498
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0040 - mae: 0.0494 - val_loss: 0.003
5 - val_mae: 0.0486
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0038 - mae: 0.0483 - val_loss: 0.003
```

```
3 - val_mae: 0.0472
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0471 - val_loss: 0.003
2 - val_mae: 0.0467
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss: 0.0037 - mae: 0.0483 - val_loss: 0.003
2 - val_mae: 0.0463
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0506 - val_loss: 0.003
5 - val_mae: 0.0491
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.003
9 - val_mae: 0.0516
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0490 - val_loss: 0.003
1 - val_mae: 0.0464
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0035 - mae: 0.0472 - val_loss: 0.003
2 - val_mae: 0.0466
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0487 - val_loss: 0.003
3 - val_mae: 0.0477
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0038 - mae: 0.0474 - val_loss: 0.003
2 - val_mae: 0.0472
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0036 - mae: 0.0481 - val_loss: 0.003
6 - val_mae: 0.0494
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.003
3 - val_mae: 0.0474
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0447 - val_loss: 0.003
3 - val_mae: 0.0471
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0453 - val_loss: 0.003
1 - val_mae: 0.0467
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0037 - mae: 0.0468 - val_loss: 0.003
1 - val_mae: 0.0466
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0452 - val_loss: 0.003
5 - val_mae: 0.0494
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0034 - mae: 0.0442 - val_loss: 0.003
2 - val_mae: 0.0469
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0039 - mae: 0.0480 - val_loss: 0.003
1 - val_mae: 0.0463
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0034 - mae: 0.0455 - val_loss: 0.00
31 - val_mae: 0.0459
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0037 - mae: 0.0463 - val_loss: 0.00
33 - val_mae: 0.0473
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0035 - mae: 0.0464 - val_loss: 0.00
32 - val_mae: 0.0470
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0034 - mae: 0.0457 - val_loss: 0.00
```

```
30 - val_mae: 0.0459
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0034 - mae: 0.0458 - val_loss: 0.00
30 - val_mae: 0.0456
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0033 - mae: 0.0445 - val_loss: 0.00
33 - val_mae: 0.0480
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0032 - mae: 0.0445 - val_loss: 0.002
9 - val_mae: 0.0452
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0032 - mae: 0.0444 - val_loss: 0.003
1 - val_mae: 0.0464
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0449 - val_loss: 0.003
9 - val_mae: 0.0507
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0443 - val_loss: 0.003
1 - val_mae: 0.0457
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0441 - val_loss: 0.002
9 - val_mae: 0.0449
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0428 - val_loss: 0.003
0 - val_mae: 0.0456
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0447 - val_loss: 0.002
9 - val_mae: 0.0453
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0032 - mae: 0.0436 - val_loss: 0.003
0 - val_mae: 0.0458
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0448 - val_loss: 0.003
5 - val_mae: 0.0486
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0032 - mae: 0.0438 - val_loss: 0.003
2 - val_mae: 0.0463
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0034 - mae: 0.0459 - val_loss: 0.003
1 - val_mae: 0.0467
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0032 - mae: 0.0449 - val_loss: 0.002
9 - val_mae: 0.0442
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0035 - mae: 0.0467 - val_loss: 0.003
1 - val_mae: 0.0462
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0033 - mae: 0.0442 - val_loss: 0.003
0 - val_mae: 0.0448
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0033 - mae: 0.0442 - val_loss: 0.003
0 - val_mae: 0.0451
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0032 - mae: 0.0443 - val_loss: 0.002
9 - val_mae: 0.0452
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.0031 - mae: 0.0434 - val_loss: 0.002
8 - val_mae: 0.0437
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - loss: 0.0029 - mae: 0.0421 - val_loss: 0.003
```

```
1 - val_mae: 0.0459
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 83ms/step
Completed Model 8: Validation MAE = 0.04593758285045624
Training model 9 - CNN+LSTM with units: 64, layers: 3
```

Model: "sequential_8"

Layer (type)	Output Shape	Pa
lstm_18 (LSTM)	(None, 30, 64)	1
dropout_18 (Dropout)	(None, 30, 64)	
lstm_19 (LSTM)	(None, 30, 64)	3
dropout_19 (Dropout)	(None, 30, 64)	
lstm_20 (LSTM)	(None, 64)	3
dropout_20 (Dropout)	(None, 64)	
dense_8 (Dense)	(None, 1)	

Total params: 83,777 (327.25 KB)

Trainable params: 83,777 (327.25 KB)

Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 4s 18ms/step - loss: 0.1097 - mae: 0.2413 - val_loss: 0.00
88 - val_mae: 0.0767
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0129 - mae: 0.0911 - val_loss: 0.007
9 - val_mae: 0.0755
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0108 - mae: 0.0828 - val_loss: 0.00
87 - val_mae: 0.0778
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0120 - mae: 0.0859 - val_loss: 0.008
2 - val_mae: 0.0760
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0095 - mae: 0.0771 - val_loss: 0.00
81 - val_mae: 0.0756
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0091 - mae: 0.0742 - val_loss: 0.008
1 - val_mae: 0.0742
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0092 - mae: 0.0751 - val_loss: 0.00
83 - val_mae: 0.0754
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0092 - mae: 0.0750 - val_loss: 0.008
3 - val_mae: 0.0744
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0084 - mae: 0.0738 - val_loss: 0.00
76 - val_mae: 0.0755
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0081 - mae: 0.0702 - val_loss: 0.007
8 - val_mae: 0.0755
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0086 - mae: 0.0742 - val_loss: 0.007
4 - val_mae: 0.0723
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0081 - mae: 0.0705 - val_loss: 0.007
1 - val_mae: 0.0714
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0077 - mae: 0.0695 - val_loss: 0.007
7 - val_mae: 0.0740
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0079 - mae: 0.0716 - val_loss: 0.00
90 - val_mae: 0.0786
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0078 - mae: 0.0707 - val_loss: 0.008
0 - val_mae: 0.0746
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0077 - mae: 0.0685 - val_loss: 0.00
71 - val_mae: 0.0708
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0073 - mae: 0.0670 - val_loss: 0.008
6 - val_mae: 0.0767
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0079 - mae: 0.0707 - val_loss: 0.00
68 - val_mae: 0.0692
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0072 - mae: 0.0673 - val_loss: 0.00
67 - val_mae: 0.0686
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0075 - mae: 0.0678 - val_loss: 0.00
```

```
85 - val_mae: 0.0760
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0074 - mae: 0.0682 - val_loss: 0.00
67 - val_mae: 0.0681
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0069 - mae: 0.0654 - val_loss: 0.006
6 - val_mae: 0.0690
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0067 - mae: 0.0643 - val_loss: 0.007
3 - val_mae: 0.0717
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0073 - mae: 0.0686 - val_loss: 0.008
6 - val_mae: 0.0761
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0071 - mae: 0.0658 - val_loss: 0.007
5 - val_mae: 0.0711
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0078 - mae: 0.0687 - val_loss: 0.006
2 - val_mae: 0.0666
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0065 - mae: 0.0639 - val_loss: 0.007
6 - val_mae: 0.0720
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0062 - mae: 0.0626 - val_loss: 0.007
2 - val_mae: 0.0707
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0060 - mae: 0.0614 - val_loss: 0.006
1 - val_mae: 0.0682
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0070 - mae: 0.0650 - val_loss: 0.009
6 - val_mae: 0.0788
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0068 - mae: 0.0664 - val_loss: 0.00
58 - val_mae: 0.0648
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0065 - mae: 0.0638 - val_loss: 0.00
66 - val_mae: 0.0679
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0064 - mae: 0.0632 - val_loss: 0.00
56 - val_mae: 0.0635
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0064 - mae: 0.0627 - val_loss: 0.007
2 - val_mae: 0.0704
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0059 - mae: 0.0601 - val_loss: 0.005
7 - val_mae: 0.0648
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0060 - mae: 0.0601 - val_loss: 0.005
6 - val_mae: 0.0652
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0060 - mae: 0.0612 - val_loss: 0.00
55 - val_mae: 0.0623
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0058 - mae: 0.0594 - val_loss: 0.005
7 - val_mae: 0.0632
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0065 - mae: 0.0635 - val_loss: 0.00
54 - val_mae: 0.0618
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0062 - mae: 0.0624 - val_loss: 0.00
```

```
76 - val_mae: 0.0713
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0061 - mae: 0.0617 - val_loss: 0.00
52 - val_mae: 0.0602
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0057 - mae: 0.0591 - val_loss: 0.00
62 - val_mae: 0.0653
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0055 - mae: 0.0584 - val_loss: 0.00
52 - val_mae: 0.0605
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 11ms/step - loss: 0.0055 - mae: 0.0578 - val_loss: 0.00
48 - val_mae: 0.0581
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0053 - mae: 0.0575 - val_loss: 0.005
8 - val_mae: 0.0627
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0050 - mae: 0.0559 - val_loss: 0.00
50 - val_mae: 0.0591
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0053 - mae: 0.0579 - val_loss: 0.004
7 - val_mae: 0.0571
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0047 - mae: 0.0536 - val_loss: 0.005
9 - val_mae: 0.0629
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0051 - mae: 0.0557 - val_loss: 0.004
6 - val_mae: 0.0561
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0048 - mae: 0.0549 - val_loss: 0.00
43 - val_mae: 0.0543
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0044 - mae: 0.0514 - val_loss: 0.004
7 - val_mae: 0.0570
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0047 - mae: 0.0537 - val_loss: 0.00
44 - val_mae: 0.0545
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0046 - mae: 0.0539 - val_loss: 0.005
5 - val_mae: 0.0610
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0045 - mae: 0.0516 - val_loss: 0.004
4 - val_mae: 0.0547
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0051 - mae: 0.0563 - val_loss: 0.00
42 - val_mae: 0.0537
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0051 - mae: 0.0562 - val_loss: 0.004
3 - val_mae: 0.0540
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0044 - mae: 0.0529 - val_loss: 0.00
48 - val_mae: 0.0573
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0047 - mae: 0.0531 - val_loss: 0.004
0 - val_mae: 0.0525
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0046 - mae: 0.0531 - val_loss: 0.00
42 - val_mae: 0.0543
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0041 - mae: 0.0511 - val_loss: 0.004
```

```
7 - val_mae: 0.0563
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0471 - val_loss: 0.00
40 - val_mae: 0.0527
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0502 - val_loss: 0.004
1 - val_mae: 0.0535
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0041 - mae: 0.0510 - val_loss: 0.00
53 - val_mae: 0.0600
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0043 - mae: 0.0514 - val_loss: 0.00
42 - val_mae: 0.0537
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0040 - mae: 0.0492 - val_loss: 0.00
40 - val_mae: 0.0526
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0040 - mae: 0.0499 - val_loss: 0.00
37 - val_mae: 0.0508
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0041 - mae: 0.0499 - val_loss: 0.00
39 - val_mae: 0.0518
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0040 - mae: 0.0493 - val_loss: 0.004
0 - val_mae: 0.0526
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0043 - mae: 0.0502 - val_loss: 0.00
43 - val_mae: 0.0544
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0041 - mae: 0.0504 - val_loss: 0.003
7 - val_mae: 0.0507
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0041 - mae: 0.0503 - val_loss: 0.003
7 - val_mae: 0.0512
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0491 - val_loss: 0.00
42 - val_mae: 0.0537
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0042 - mae: 0.0509 - val_loss: 0.003
8 - val_mae: 0.0516
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0035 - mae: 0.0459 - val_loss: 0.004
1 - val_mae: 0.0534
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0039 - mae: 0.0487 - val_loss: 0.003
4 - val_mae: 0.0487
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0039 - mae: 0.0488 - val_loss: 0.003
5 - val_mae: 0.0495
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0038 - mae: 0.0479 - val_loss: 0.00
43 - val_mae: 0.0548
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0039 - mae: 0.0490 - val_loss: 0.00
40 - val_mae: 0.0526
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0036 - mae: 0.0479 - val_loss: 0.003
4 - val_mae: 0.0489
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0036 - mae: 0.0466 - val_loss: 0.003
```

```
5 - val_mae: 0.0495
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0034 - mae: 0.0453 - val_loss: 0.00
34 - val_mae: 0.0489
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0039 - mae: 0.0489 - val_loss: 0.003
4 - val_mae: 0.0485
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0486 - val_loss: 0.00
34 - val_mae: 0.0494
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0460 - val_loss: 0.00
33 - val_mae: 0.0484
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0035 - mae: 0.0464 - val_loss: 0.00
34 - val_mae: 0.0488
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0036 - mae: 0.0476 - val_loss: 0.00
39 - val_mae: 0.0521
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0035 - mae: 0.0463 - val_loss: 0.00
33 - val_mae: 0.0483
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0038 - mae: 0.0489 - val_loss: 0.00
35 - val_mae: 0.0501
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0037 - mae: 0.0483 - val_loss: 0.00
37 - val_mae: 0.0504
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0038 - mae: 0.0483 - val_loss: 0.003
2 - val_mae: 0.0475
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0034 - mae: 0.0451 - val_loss: 0.00
32 - val_mae: 0.0478
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0483 - val_loss: 0.00
32 - val_mae: 0.0472
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0476 - val_loss: 0.00
33 - val_mae: 0.0484
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0035 - mae: 0.0461 - val_loss: 0.003
4 - val_mae: 0.0490
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0034 - mae: 0.0458 - val_loss: 0.00
32 - val_mae: 0.0475
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0475 - val_loss: 0.00
32 - val_mae: 0.0474
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0034 - mae: 0.0454 - val_loss: 0.003
1 - val_mae: 0.0470
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0470 - val_loss: 0.00
39 - val_mae: 0.0522
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0038 - mae: 0.0481 - val_loss: 0.003
3 - val_mae: 0.0478
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0034 - mae: 0.0452 - val_loss: 0.00
```

34 - val_mae: 0.0492
3/3 ━━━━━━━━━━━━━━━━━━━━ **0s** 115ms/step
Completed Model 9: Validation MAE = 0.049189914017915726
Training model 10 - CNN+LSTM with units: 128, layers: 3
Model: "sequential_9"

Layer (type)	Output Shape	Pa
lstm_21 (LSTM)	(None, 30, 128)	6
dropout_21 (Dropout)	(None, 30, 128)	
lstm_22 (LSTM)	(None, 30, 128)	1:
dropout_22 (Dropout)	(None, 30, 128)	
lstm_23 (LSTM)	(None, 128)	1:
dropout_23 (Dropout)	(None, 128)	
dense_9 (Dense)	(None, 1)	

Total params: 331,393 (1.26 MB)
Trainable params: 331,393 (1.26 MB)
Non-trainable params: 0 (0.00 B)

```
None
Epoch 1/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 3s 19ms/step - loss: 0.0964 - mae: 0.2227 - val_loss: 0.00
83 - val_mae: 0.0743
Epoch 2/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0114 - mae: 0.0859 - val_loss: 0.00
76 - val_mae: 0.0731
Epoch 3/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0093 - mae: 0.0766 - val_loss: 0.00
74 - val_mae: 0.0716
Epoch 4/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0093 - mae: 0.0765 - val_loss: 0.00
75 - val_mae: 0.0732
Epoch 5/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0093 - mae: 0.0766 - val_loss: 0.007
8 - val_mae: 0.0753
Epoch 6/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0095 - mae: 0.0765 - val_loss: 0.00
76 - val_mae: 0.0749
Epoch 7/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - loss: 0.0090 - mae: 0.0750 - val_loss: 0.007
4 - val_mae: 0.0750
Epoch 8/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0087 - mae: 0.0742 - val_loss: 0.00
78 - val_mae: 0.0741
Epoch 9/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0078 - mae: 0.0700 - val_loss: 0.006
8 - val_mae: 0.0703
Epoch 10/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0083 - mae: 0.0731 - val_loss: 0.00
70 - val_mae: 0.0700
Epoch 11/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0082 - mae: 0.0709 - val_loss: 0.00
76 - val_mae: 0.0722
Epoch 12/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0087 - mae: 0.0750 - val_loss: 0.006
7 - val_mae: 0.0703
Epoch 13/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0076 - mae: 0.0700 - val_loss: 0.00
70 - val_mae: 0.0725
Epoch 14/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0070 - mae: 0.0659 - val_loss: 0.00
73 - val_mae: 0.0714
Epoch 15/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0073 - mae: 0.0677 - val_loss: 0.00
66 - val_mae: 0.0700
Epoch 16/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0074 - mae: 0.0682 - val_loss: 0.00
80 - val_mae: 0.0736
Epoch 17/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0070 - mae: 0.0662 - val_loss: 0.00
74 - val_mae: 0.0719
Epoch 18/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0070 - mae: 0.0647 - val_loss: 0.00
62 - val_mae: 0.0685
Epoch 19/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0071 - mae: 0.0668 - val_loss: 0.00
67 - val_mae: 0.0690
Epoch 20/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0067 - mae: 0.0653 - val_loss: 0.00
```

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58 - val_mae: 0.0658
Epoch 21/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0065 - mae: 0.0636 - val_loss: 0.00
58 - val_mae: 0.0650
Epoch 22/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0070 - mae: 0.0663 - val_loss: 0.00
58 - val_mae: 0.0655
Epoch 23/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0058 - mae: 0.0600 - val_loss: 0.00
55 - val_mae: 0.0629
Epoch 24/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0061 - mae: 0.0613 - val_loss: 0.00
54 - val_mae: 0.0625
Epoch 25/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0060 - mae: 0.0601 - val_loss: 0.00
59 - val_mae: 0.0656
Epoch 26/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0060 - mae: 0.0610 - val_loss: 0.00
53 - val_mae: 0.0604
Epoch 27/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0061 - mae: 0.0620 - val_loss: 0.00
52 - val_mae: 0.0607
Epoch 28/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0061 - mae: 0.0613 - val_loss: 0.00
54 - val_mae: 0.0634
Epoch 29/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0063 - mae: 0.0627 - val_loss: 0.00
50 - val_mae: 0.0597
Epoch 30/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0069 - mae: 0.0657 - val_loss: 0.00
47 - val_mae: 0.0577
Epoch 31/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0059 - mae: 0.0607 - val_loss: 0.00
60 - val_mae: 0.0639
Epoch 32/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0055 - mae: 0.0580 - val_loss: 0.00
46 - val_mae: 0.0566
Epoch 33/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0055 - mae: 0.0583 - val_loss: 0.00
45 - val_mae: 0.0558
Epoch 34/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0054 - mae: 0.0575 - val_loss: 0.00
43 - val_mae: 0.0540
Epoch 35/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0054 - mae: 0.0574 - val_loss: 0.00
50 - val_mae: 0.0585
Epoch 36/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0053 - mae: 0.0576 - val_loss: 0.005
2 - val_mae: 0.0592
Epoch 37/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0050 - mae: 0.0554 - val_loss: 0.00
45 - val_mae: 0.0551
Epoch 38/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0054 - mae: 0.0580 - val_loss: 0.00
45 - val_mae: 0.0554
Epoch 39/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0052 - mae: 0.0564 - val_loss: 0.00
45 - val_mae: 0.0552
Epoch 40/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0047 - mae: 0.0538 - val_loss: 0.00
```

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42 - val_mae: 0.0548
Epoch 41/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0050 - mae: 0.0561 - val_loss: 0.00
53 - val_mae: 0.0597
Epoch 42/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0047 - mae: 0.0545 - val_loss: 0.00
42 - val_mae: 0.0535
Epoch 43/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0051 - mae: 0.0561 - val_loss: 0.00
40 - val_mae: 0.0519
Epoch 44/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0053 - mae: 0.0574 - val_loss: 0.004
0 - val_mae: 0.0527
Epoch 45/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0051 - mae: 0.0562 - val_loss: 0.00
39 - val_mae: 0.0518
Epoch 46/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0053 - mae: 0.0577 - val_loss: 0.00
38 - val_mae: 0.0512
Epoch 47/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0043 - mae: 0.0519 - val_loss: 0.00
43 - val_mae: 0.0539
Epoch 48/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0043 - mae: 0.0518 - val_loss: 0.00
41 - val_mae: 0.0535
Epoch 49/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0052 - mae: 0.0568 - val_loss: 0.00
47 - val_mae: 0.0566
Epoch 50/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0045 - mae: 0.0533 - val_loss: 0.00
54 - val_mae: 0.0606
Epoch 51/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0053 - mae: 0.0575 - val_loss: 0.00
38 - val_mae: 0.0508
Epoch 52/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 9ms/step - loss: 0.0045 - mae: 0.0537 - val_loss: 0.004
2 - val_mae: 0.0533
Epoch 53/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0042 - mae: 0.0513 - val_loss: 0.00
42 - val_mae: 0.0533
Epoch 54/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0047 - mae: 0.0531 - val_loss: 0.00
38 - val_mae: 0.0509
Epoch 55/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0040 - mae: 0.0504 - val_loss: 0.00
36 - val_mae: 0.0494
Epoch 56/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0490 - val_loss: 0.00
38 - val_mae: 0.0507
Epoch 57/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0045 - mae: 0.0517 - val_loss: 0.00
40 - val_mae: 0.0530
Epoch 58/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0042 - mae: 0.0511 - val_loss: 0.00
45 - val_mae: 0.0551
Epoch 59/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0051 - mae: 0.0553 - val_loss: 0.00
38 - val_mae: 0.0507
Epoch 60/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0044 - mae: 0.0525 - val_loss: 0.00
```

```
37 - val_mae: 0.0501
Epoch 61/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0040 - mae: 0.0498 - val_loss: 0.00
38 - val_mae: 0.0511
Epoch 62/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0042 - mae: 0.0503 - val_loss: 0.00
37 - val_mae: 0.0504
Epoch 63/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0040 - mae: 0.0502 - val_loss: 0.00
33 - val_mae: 0.0482
Epoch 64/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0043 - mae: 0.0506 - val_loss: 0.00
34 - val_mae: 0.0486
Epoch 65/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0042 - mae: 0.0512 - val_loss: 0.00
34 - val_mae: 0.0482
Epoch 66/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0045 - mae: 0.0510 - val_loss: 0.00
35 - val_mae: 0.0492
Epoch 67/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0042 - mae: 0.0511 - val_loss: 0.00
33 - val_mae: 0.0484
Epoch 68/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0041 - mae: 0.0495 - val_loss: 0.00
33 - val_mae: 0.0483
Epoch 69/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0038 - mae: 0.0484 - val_loss: 0.00
34 - val_mae: 0.0482
Epoch 70/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0487 - val_loss: 0.00
45 - val_mae: 0.0549
Epoch 71/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0039 - mae: 0.0487 - val_loss: 0.00
34 - val_mae: 0.0483
Epoch 72/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0471 - val_loss: 0.00
36 - val_mae: 0.0495
Epoch 73/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0476 - val_loss: 0.00
35 - val_mae: 0.0491
Epoch 74/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0037 - mae: 0.0481 - val_loss: 0.00
36 - val_mae: 0.0497
Epoch 75/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0041 - mae: 0.0497 - val_loss: 0.00
33 - val_mae: 0.0480
Epoch 76/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0464 - val_loss: 0.00
33 - val_mae: 0.0485
Epoch 77/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0039 - mae: 0.0479 - val_loss: 0.00
38 - val_mae: 0.0501
Epoch 78/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0471 - val_loss: 0.00
33 - val_mae: 0.0479
Epoch 79/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 12ms/step - loss: 0.0037 - mae: 0.0482 - val_loss: 0.00
32 - val_mae: 0.0472
Epoch 80/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 14ms/step - loss: 0.0036 - mae: 0.0473 - val_loss: 0.00
```

```
37 - val_mae: 0.0504
Epoch 81/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0040 - mae: 0.0495 - val_loss: 0.00
32 - val_mae: 0.0467
Epoch 82/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 15ms/step - loss: 0.0035 - mae: 0.0462 - val_loss: 0.00
33 - val_mae: 0.0478
Epoch 83/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0469 - val_loss: 0.00
32 - val_mae: 0.0476
Epoch 84/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0467 - val_loss: 0.00
32 - val_mae: 0.0472
Epoch 85/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0034 - mae: 0.0454 - val_loss: 0.00
30 - val_mae: 0.0462
Epoch 86/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0477 - val_loss: 0.00
35 - val_mae: 0.0499
Epoch 87/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0469 - val_loss: 0.00
30 - val_mae: 0.0454
Epoch 88/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0037 - mae: 0.0476 - val_loss: 0.00
33 - val_mae: 0.0473
Epoch 89/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0036 - mae: 0.0466 - val_loss: 0.00
30 - val_mae: 0.0458
Epoch 90/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0036 - mae: 0.0472 - val_loss: 0.00
32 - val_mae: 0.0475
Epoch 91/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0035 - mae: 0.0459 - val_loss: 0.00
34 - val_mae: 0.0478
Epoch 92/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0038 - mae: 0.0478 - val_loss: 0.00
30 - val_mae: 0.0452
Epoch 93/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0034 - mae: 0.0445 - val_loss: 0.00
30 - val_mae: 0.0457
Epoch 94/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0030 - mae: 0.0434 - val_loss: 0.00
29 - val_mae: 0.0450
Epoch 95/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step - loss: 0.0034 - mae: 0.0454 - val_loss: 0.00
29 - val_mae: 0.0448
Epoch 96/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 0s 10ms/step - loss: 0.0038 - mae: 0.0477 - val_loss: 0.00
31 - val_mae: 0.0465
Epoch 97/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0032 - mae: 0.0443 - val_loss: 0.00
33 - val_mae: 0.0476
Epoch 98/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0032 - mae: 0.0448 - val_loss: 0.00
33 - val_mae: 0.0476
Epoch 99/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 10ms/step - loss: 0.0034 - mae: 0.0462 - val_loss: 0.00
30 - val_mae: 0.0452
Epoch 100/100
45/45 ━━━━━━━━━━━━━━━━━━━━ 1s 13ms/step - loss: 0.0036 - mae: 0.0479 - val_loss: 0.00
```

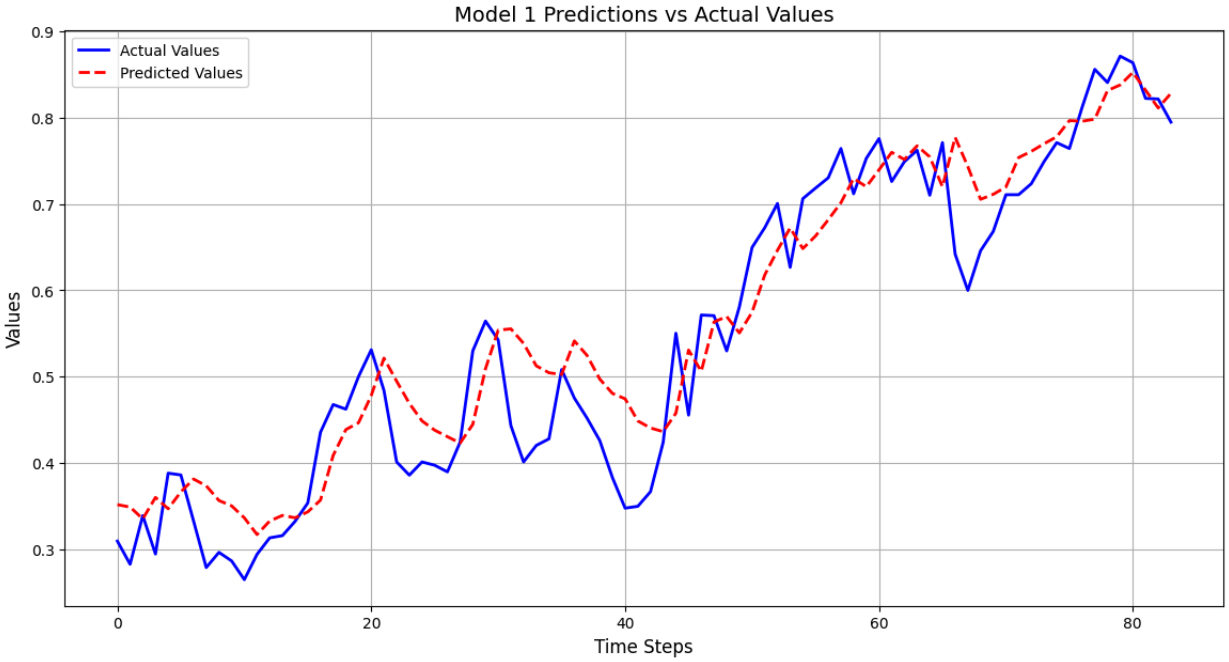
```
32 - val_mae: 0.0469
3/3 ━━━━━━━━━━━━━━━━━━━━ 1s 160ms/step
```

Model Predictions

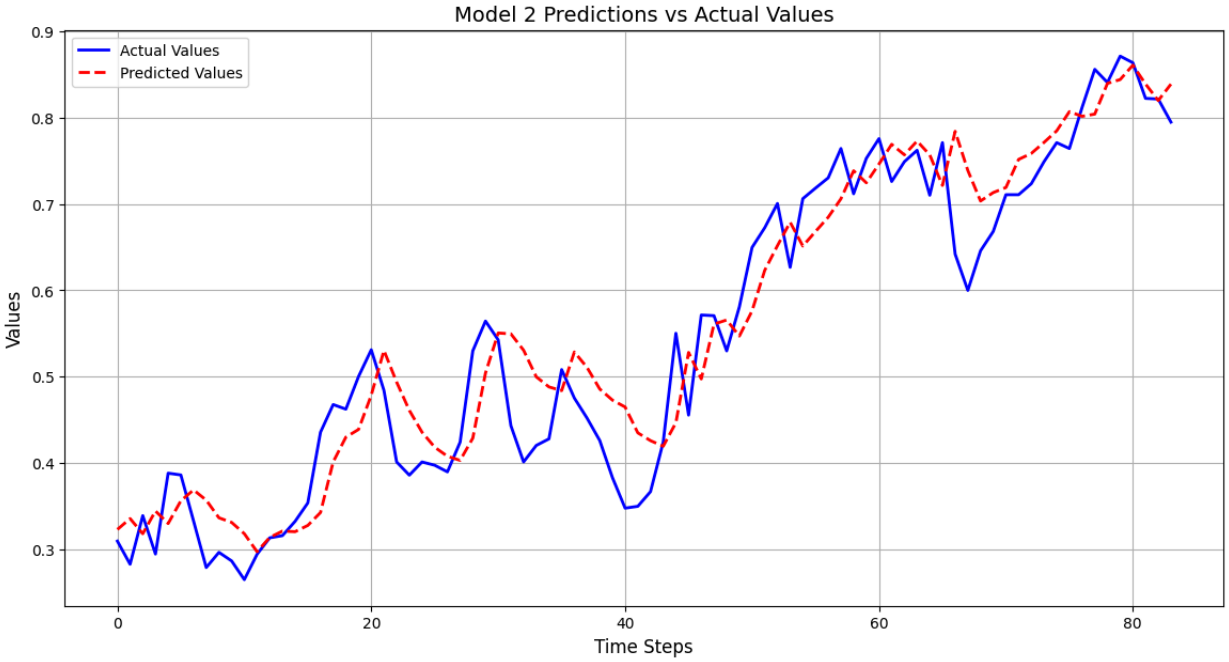
In [14]:

```python
# Now we will plot predictions for each model individually with both actual and predic
for i, predictions in enumerate(model_predictions):
    plt.figure(figsize=(14, 7))

    # Check shapes of actual and predicted values
    print(f"Model {i + 1}:")
    print(f" - Predictions shape: {predictions.shape}")
    print(f" - Actual values shape: {y_test.shape}")

    # Select a range from the test set for visualization
    start_index = 0  # Change this index to visualize different starting points
    sequence_length = 100  # The length of the sequence to visualize

    # Ensure we get the correct length for comparison
    true_values = y_test[start_index:start_index + sequence_length].reshape(-1)
    predicted_values = predictions[start_index:start_index + sequence_length].reshape(

    # Debug: Print values to inspect
    print(f" - True values: {true_values}")
    print(f" - Predicted values: {predicted_values}")

    # Check if true_values and predicted_values are empty
    if true_values.size == 0 or predicted_values.size == 0:
        print(f"Empty values for Model {i + 1}.")
        continue  # Skip to the next iteration if empty

    # Plot actual values
    plt.plot(true_values, label='Actual Values', color='blue', linewidth=2)
    # Plot predicted values
    plt.plot(predicted_values, label='Predicted Values', color='red', linestyle='--',

    plt.title(f'Model {i + 1} Predictions vs Actual Values', fontsize=14)
    plt.xlabel('Time Steps', fontsize=12)
    plt.ylabel('Values', fontsize=12)
    plt.legend()
    plt.xticks(fontsize=10)
    plt.yticks(fontsize=10)

    plt.grid()
    plt.show()
```

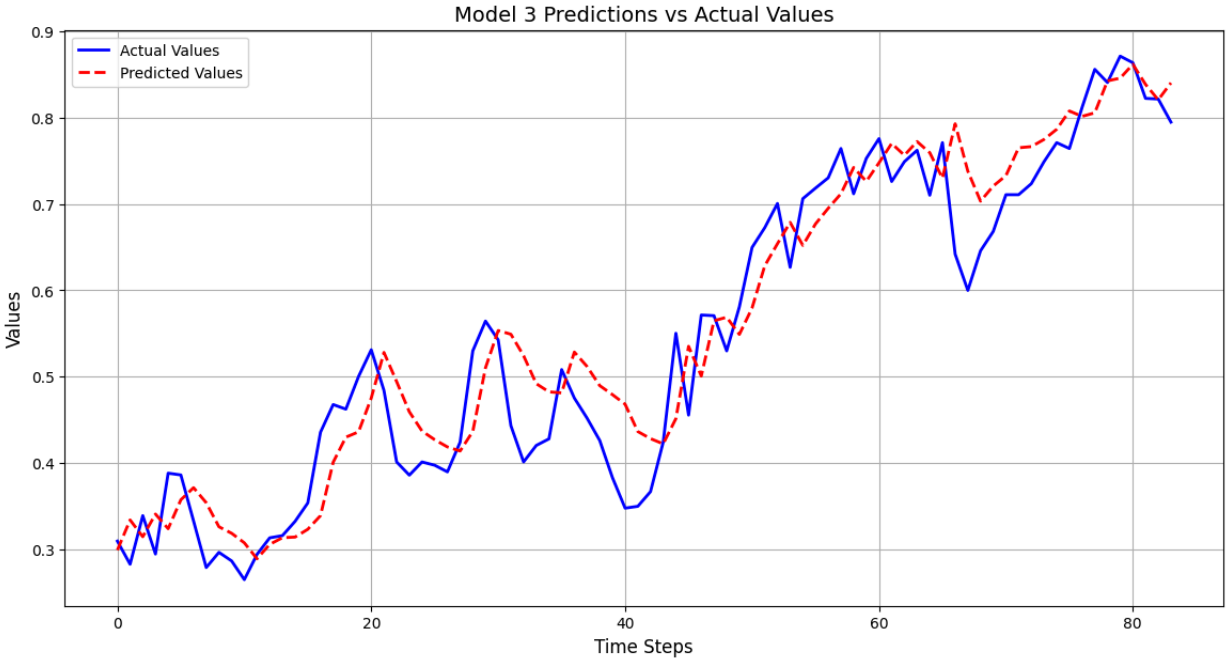
```
Model 1:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.3517761  0.3489723  0.33530864 0.3601077  0.34698468 0.366514
12
 0.38143402 0.37353024 0.35655054 0.35034144 0.3365077  0.3171512
 0.3328274  0.3392642  0.33655196 0.34340978 0.35699067 0.40882066
 0.4386411  0.44665852 0.47814548 0.52145714 0.4946816  0.46904072
 0.4486935  0.4379606  0.43050247 0.4230685  0.44471648 0.509141
 0.55382836 0.5553546  0.53849053 0.51251864 0.50449544 0.5024806
 0.5413838  0.52454424 0.497199   0.48059627 0.47432986 0.44868985
 0.4405561  0.4363063  0.4576418  0.53079414 0.5061697  0.5632898
 0.569619   0.55062884 0.5745747  0.617787   0.6462674  0.6721809
 0.6483102  0.6628558  0.6816393  0.701455   0.72949183 0.7199824
 0.7394943  0.7597885  0.7514782  0.76728916 0.75454116 0.7199781
 0.7771126  0.7433008  0.7053883  0.7111402  0.7196368  0.7537271
 0.76089215 0.76968724 0.7778021  0.7965347  0.79576874 0.7982226
 0.8313272  0.8378018  0.85232496 0.83175343 0.81117845 0.82812065]
```



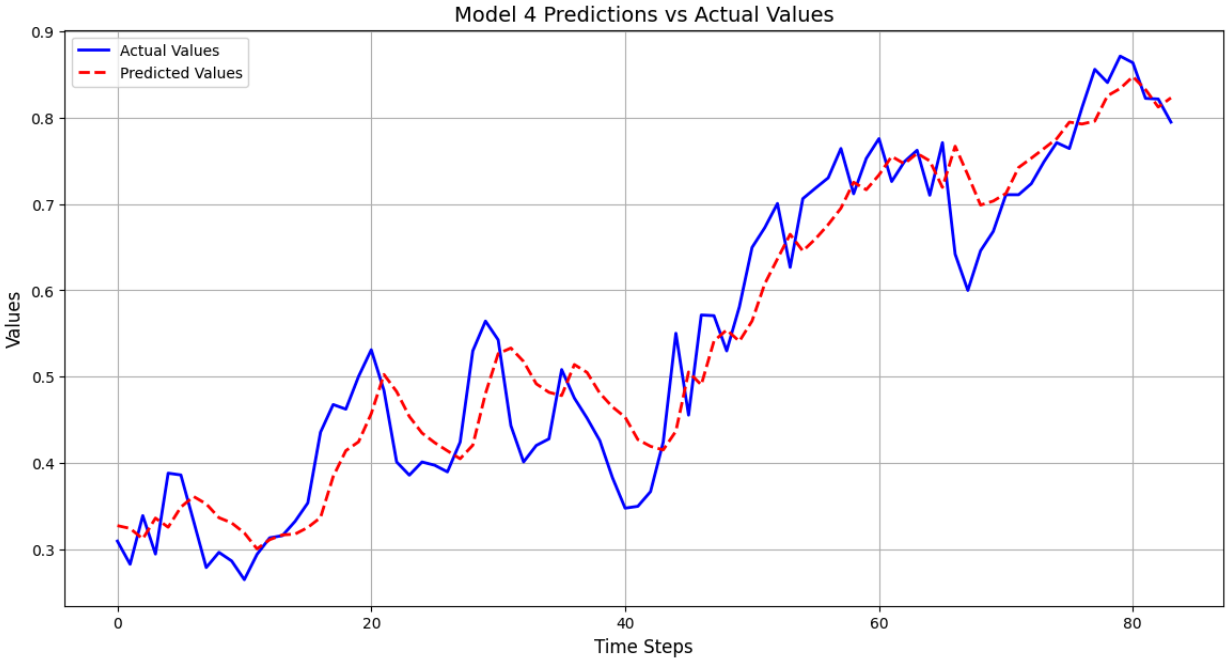
```
Model 2:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.3230146  0.33560205 0.3180912  0.34437186 0.32989904 0.356277
08
 0.3688149  0.35695353 0.33650672 0.33117557 0.3181004  0.2973047
 0.31378597 0.32110736 0.32044625 0.32768732 0.3426326  0.4012595
 0.42992857 0.43884623 0.47854868 0.5303331  0.49362636 0.46093968
 0.43565628 0.41827148 0.40778056 0.40304232 0.42875803 0.5041563
 0.55053115 0.5495385  0.53060776 0.49977452 0.48809275 0.48378855
 0.5285675  0.5106421  0.48569348 0.47281957 0.46482337 0.434897
 0.42588308 0.41938138 0.44662195 0.52800566 0.49734026 0.5608221
 0.56559885 0.54700404 0.57609946 0.623161   0.65167636 0.6788629
 0.65126294 0.66811144 0.6846428  0.7059399  0.7384254  0.7245295
 0.74619055 0.7690337  0.75688577 0.77284664 0.7567918  0.72146046
 0.78408146 0.7387551  0.70338833 0.7131574  0.7190444  0.7515857
 0.7585083  0.7712662  0.7846842  0.80688417 0.8014672  0.80405855
 0.83965874 0.8440317  0.86072195 0.8388841  0.8197212  0.838752  ]
```



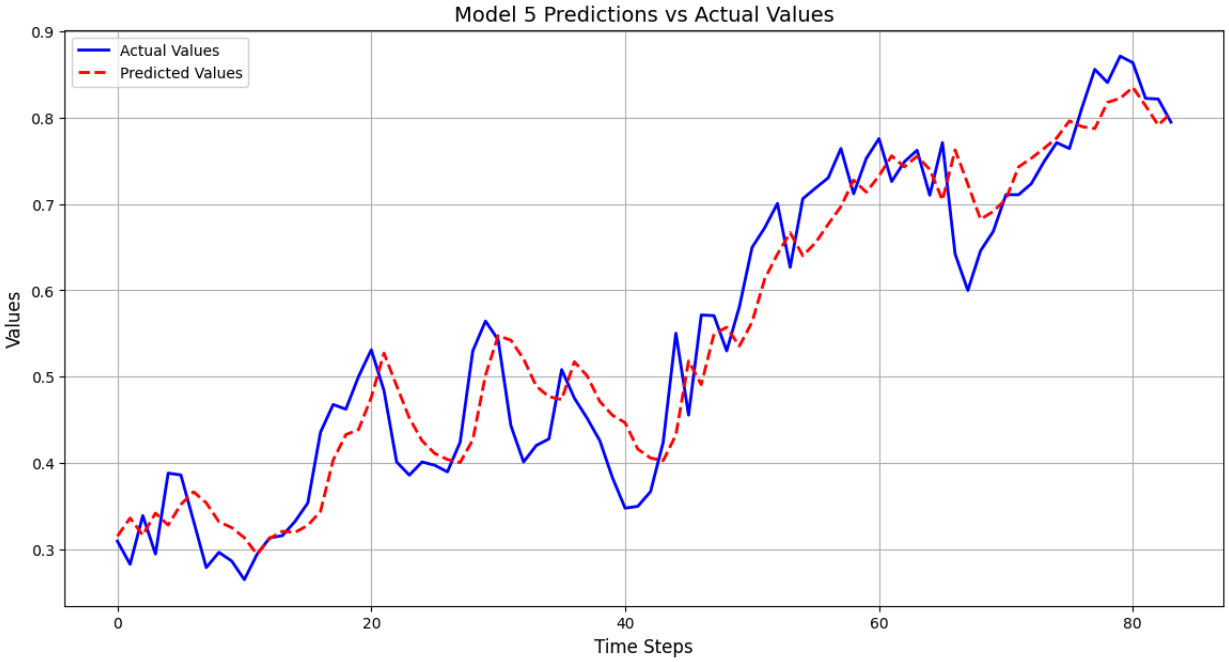
```
Model 3:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.29914385 0.33402747 0.31460637 0.34083033 0.3239072  0.357381
88
 0.37141234 0.35393673 0.3261335  0.31858933 0.30753705 0.28908926
 0.305772   0.31346014 0.31421858 0.3232193  0.33902887 0.40085703
 0.42990628 0.43604764 0.47521165 0.5280164  0.49418455 0.45928565
 0.43694964 0.42694563 0.4185927  0.4139023  0.43654487 0.5102116
 0.5533967  0.54911506 0.52423835 0.49182424 0.48240268 0.4811529
 0.5284748  0.51176906 0.48958868 0.47919947 0.46803874 0.43643165
 0.42821157 0.4221383  0.451373   0.5351063  0.5007111  0.5647037
 0.56881374 0.54892534 0.5794658  0.62836355 0.65392935 0.6786433
 0.65200627 0.67688096 0.6949395  0.7117778  0.7422161  0.7261691
 0.74758303 0.77007306 0.7563219  0.77225435 0.75932467 0.72982347
 0.7928196  0.7379174  0.70322055 0.72074497 0.7327494  0.7650496
 0.7663749  0.7746843  0.78644353 0.807651   0.8014231  0.80549896
 0.8425255  0.8456759  0.86166936 0.8384391  0.8205613  0.8402021 ]
```



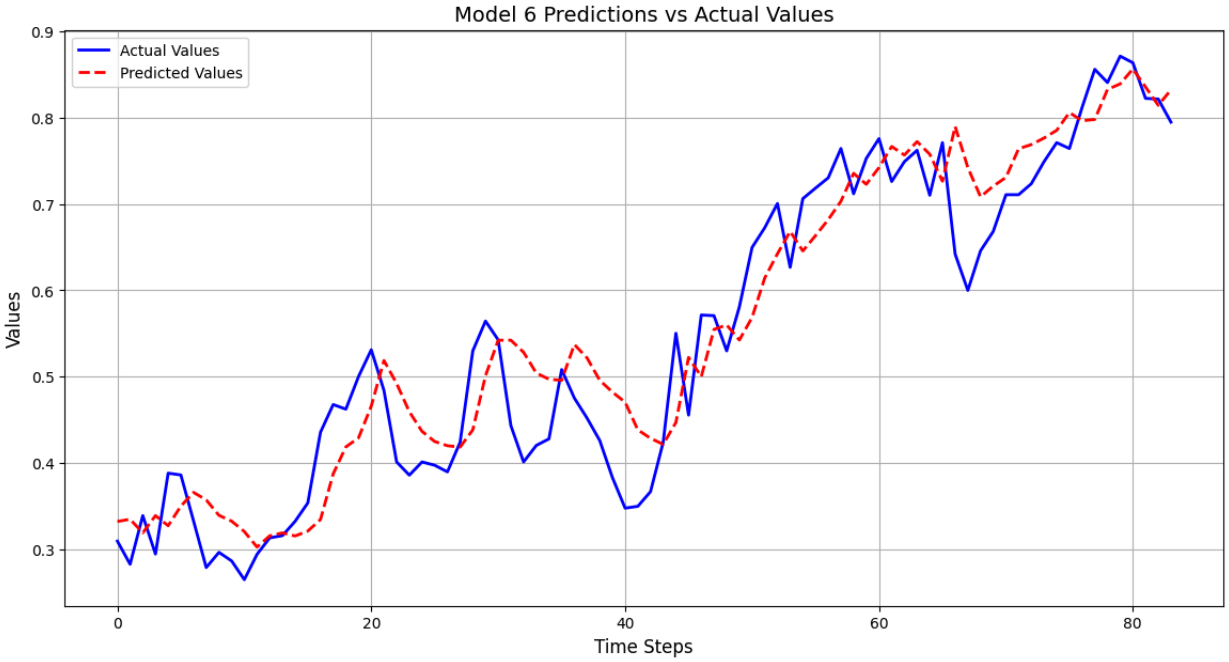
```
Model 4:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.32745525 0.32423195 0.3121087  0.33618426 0.32562232 0.348898
23
 0.36118978 0.35260692 0.33666372 0.33064178 0.31900728 0.3005407
 0.31122994 0.31669962 0.31771532 0.32531095 0.3368017  0.38430798
 0.4142947  0.42451352 0.45717824 0.5024777  0.4826506  0.45387927
 0.43465227 0.42350978 0.4141156  0.40489653 0.4206127  0.48048136
 0.52661407 0.53310466 0.5175431  0.4916782  0.48182693 0.47809857
 0.5139675  0.50486255 0.48097417 0.46500427 0.45308208 0.42716095
 0.41931504 0.41516086 0.4367903  0.50539345 0.4904421  0.54133785
 0.55406773 0.5409818  0.5644233  0.6075093  0.6363395  0.66485053
 0.64557624 0.659588   0.6761245  0.69501495 0.7250672  0.7164908
 0.73356235 0.7550422  0.7465338  0.758527   0.74991536 0.71917284
 0.766852   0.7335834  0.6987437  0.70334274 0.7121238  0.7422268
 0.7530151  0.7642262  0.7755579  0.7947504  0.79258084 0.7959479
 0.8252622  0.8336764  0.84744537 0.8324257  0.8122268  0.8228715 ]
```



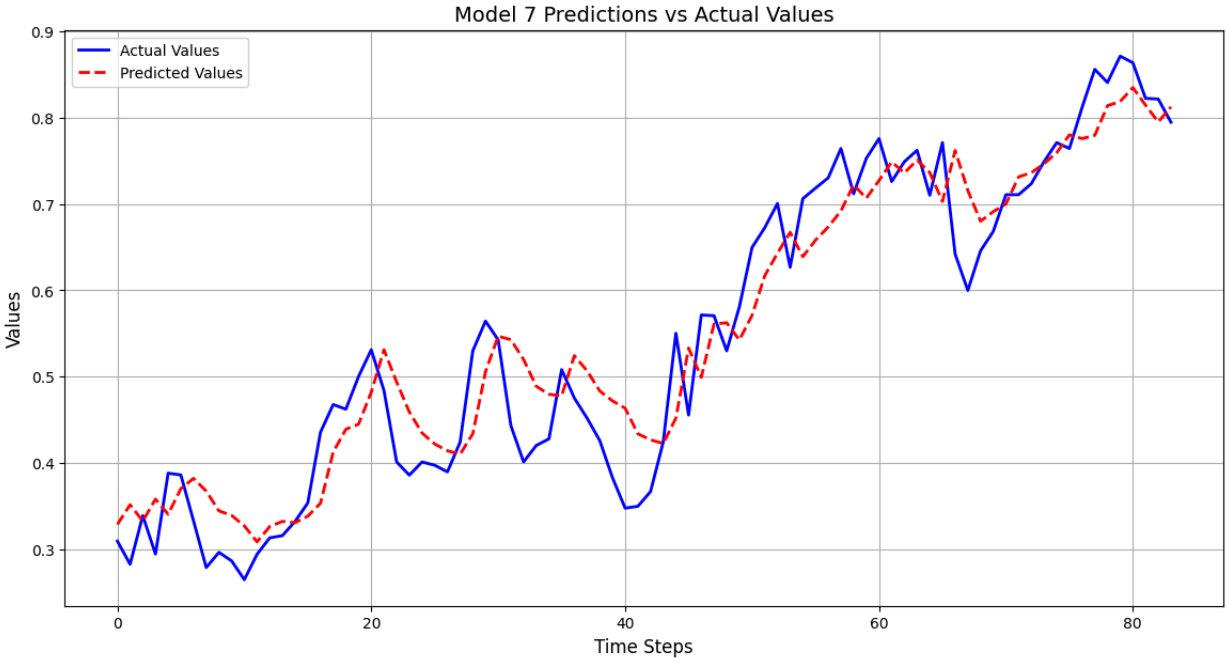
```
Model 5:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.3152118  0.33623335 0.31646976 0.341919   0.32810834 0.351947
78
 0.36661154 0.35377908 0.33189702 0.32518333 0.3134706  0.29435527
 0.3126855  0.3208457  0.319685   0.3277895  0.34391803 0.40345722
 0.43280578 0.438746   0.4759534  0.5271832  0.48935238 0.45216346
 0.4258203  0.41104656 0.40410233 0.40057173 0.42676654 0.5016781
 0.54739887 0.5422452  0.5205501  0.48893908 0.47675192 0.4734718
 0.51723325 0.5010706  0.47138792 0.45531327 0.44657427 0.41607884
 0.4057875  0.40274802 0.43243185 0.51810604 0.49076155 0.5493477
 0.5572611  0.53545547 0.5631105  0.61328113 0.6418432  0.66673696
 0.6400818  0.65506136 0.6765456  0.69687796 0.72753197 0.7136943
 0.7324779  0.7557308  0.7429205  0.75527924 0.74000853 0.70444345
 0.76250225 0.7228515  0.68227524 0.69129884 0.7056038  0.7429309
 0.75291574 0.7642597  0.77648616 0.796103   0.7894846  0.7872913
 0.81761026 0.82237077 0.8349857  0.8137332  0.7912731  0.8052949 ]
```



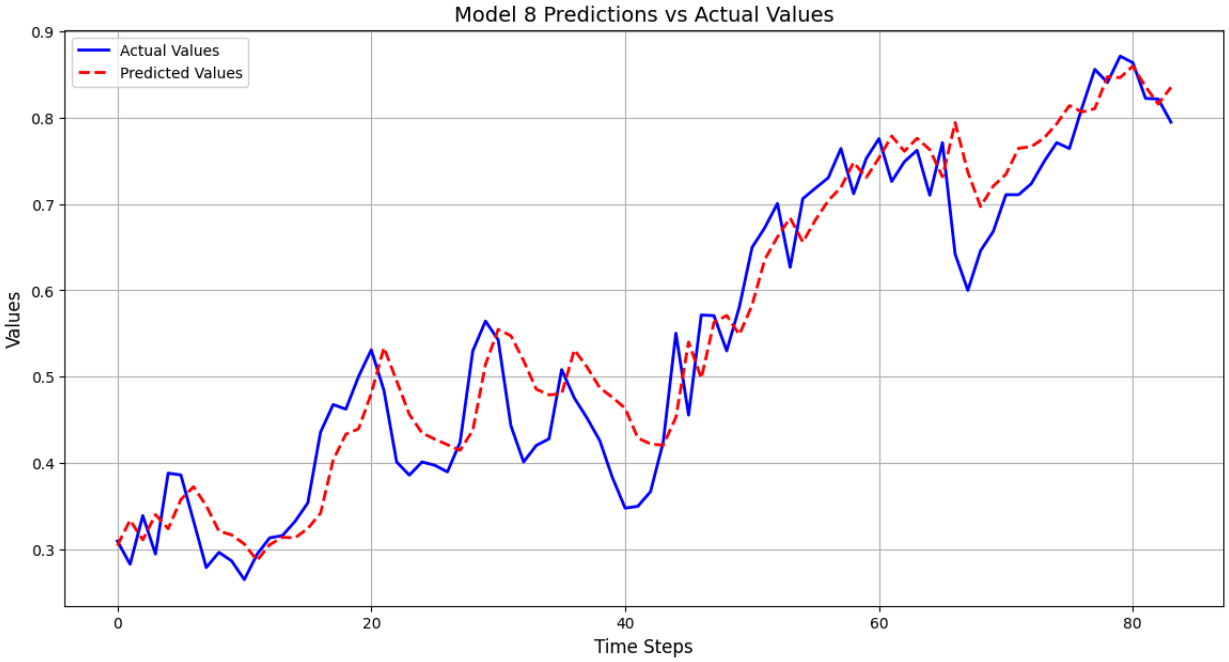
```
Model 6:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.33229798 0.33482525 0.3191213  0.33905643 0.32734835 0.350035
73
 0.3659444  0.35719302 0.33939    0.33263716 0.3205969  0.30270612
 0.31561404 0.31904018 0.31549203 0.32116282 0.33450806 0.38740587
 0.4186128  0.42917088 0.46587038 0.5186951  0.49201283 0.4593472
 0.4366098  0.42483747 0.4199983  0.41842183 0.4383999  0.50098914
 0.5421679  0.542211   0.5282303  0.5041874  0.49703324 0.49571696
 0.5371971  0.5216427  0.4957858  0.48206708 0.47042125 0.4383862
 0.42859462 0.42159703 0.44687864 0.5222887  0.5000446  0.5546479
 0.5599259  0.5423808  0.5685289  0.61423695 0.6423112  0.6682151
 0.6455607  0.66332155 0.6818068  0.7030936  0.7354636  0.7227792
 0.7421423  0.76652074 0.75663674 0.77217495 0.7575402  0.7263475
 0.7897428  0.74208647 0.70828974 0.7206758  0.7306451  0.76392436
 0.7687596  0.77630717 0.7852372  0.8058469  0.7963545  0.7978786
 0.8325574  0.8390419  0.8563081  0.83540833 0.8142867  0.8320738 ]
```



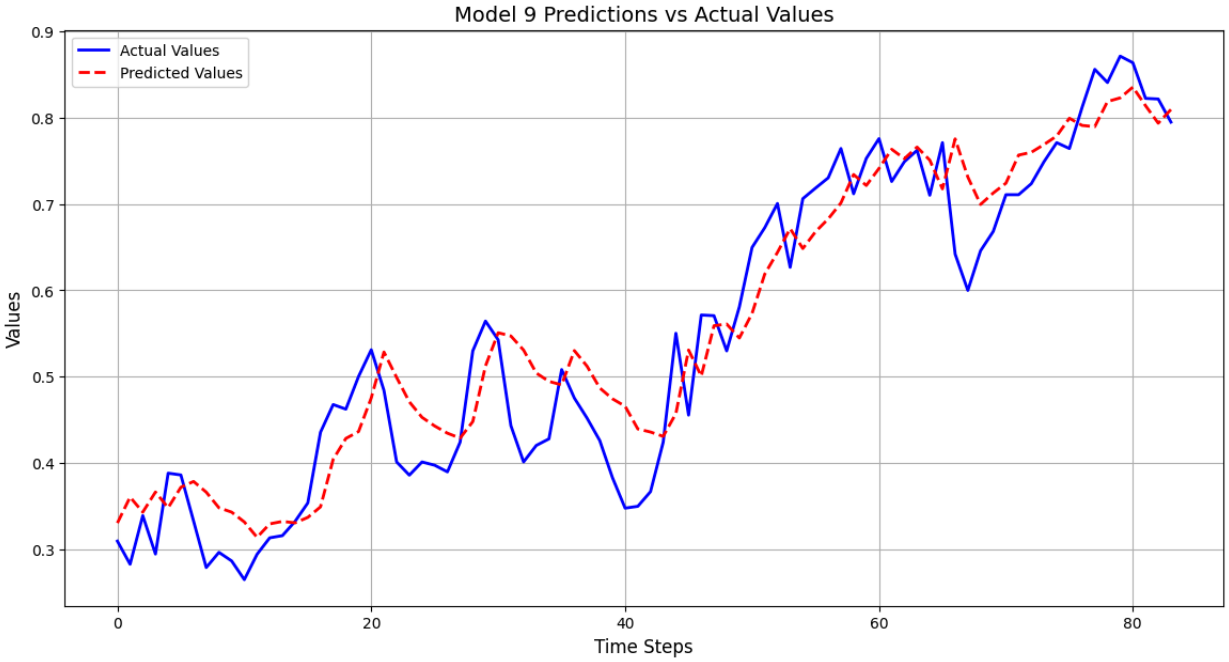
```
Model 7:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.32877398 0.35169762 0.33261806 0.35811925 0.34065735 0.370273
65
 0.3821677  0.367405   0.34457886 0.3392618  0.32719302 0.30871302
 0.32638192 0.33238253 0.3308862  0.338451   0.35333467 0.4125726
 0.43906155 0.44494998 0.4820176  0.5311084  0.49367893 0.4590836
 0.43473515 0.42196068 0.41416666 0.41018203 0.4338749  0.5056164
 0.54690266 0.5427476  0.5198655  0.4888152  0.47954074 0.4778968
 0.52426255 0.50676304 0.48342353 0.47194946 0.46346515 0.4338103
 0.42685288 0.42267677 0.45189777 0.53311414 0.49918532 0.56097037
 0.5624317  0.5424813  0.5709779  0.6169532  0.64284545 0.6671278
 0.63889813 0.65807796 0.67333686 0.6918545  0.7221615  0.70667577
 0.72708046 0.7486783  0.73589385 0.7507303  0.7363647  0.7029597
 0.7619839  0.71554935 0.67999303 0.691089   0.69991696 0.73135054
 0.7361645  0.74656844 0.7592772  0.7799896  0.7756711  0.7794007
 0.8137547  0.8186178  0.8347659  0.8143585  0.79503083 0.8123735 ]
```



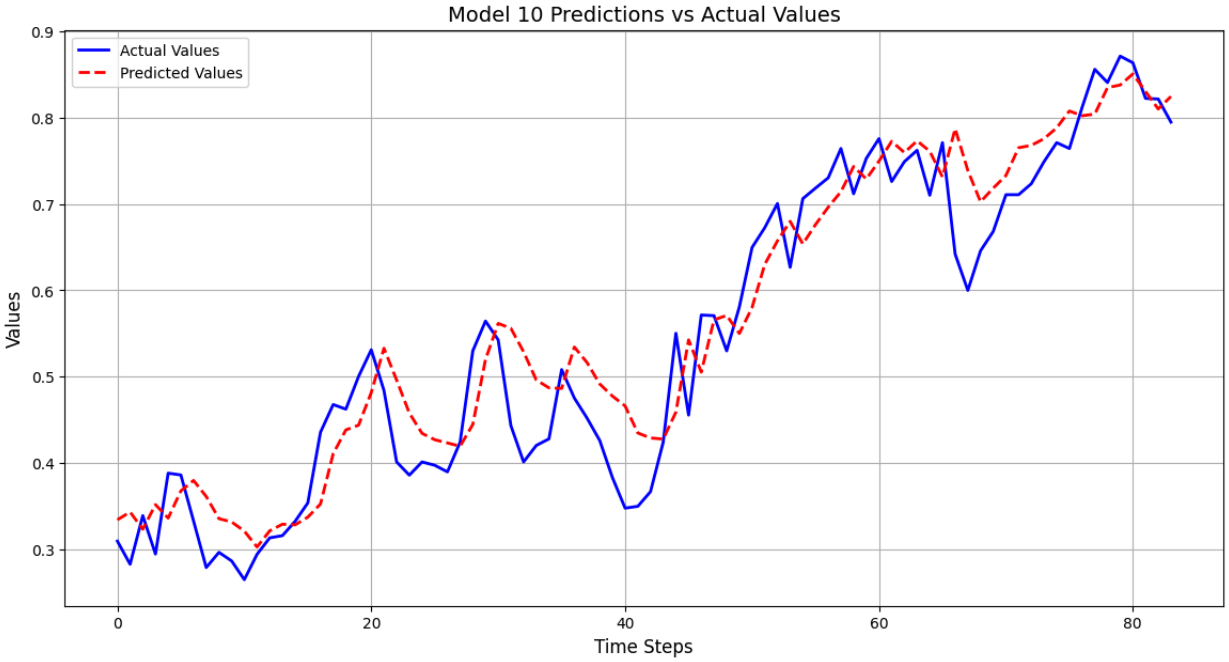
```
Model 8:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.30433708 0.33382744 0.31097215 0.3402034  0.32381994 0.357728
42
 0.37250495 0.3504932  0.32100797 0.3167561  0.30613092 0.28708833
 0.30535832 0.31395864 0.31335276 0.32413754 0.34177825 0.40343717
 0.4333815  0.4395669  0.48045623 0.533512   0.49497113 0.45624858
 0.43478352 0.4276533  0.42111602 0.4146319  0.43786004 0.5141965
 0.5546902  0.5473412  0.5185003  0.4854725  0.47889924 0.4800532
 0.53102505 0.51107264 0.48710683 0.47602007 0.46332082 0.42890182
 0.42205974 0.42055762 0.45282853 0.5401611  0.4981048  0.5629399
 0.5707906  0.5486692  0.58268803 0.63563025 0.6617633  0.6837907
 0.655822   0.6816819  0.7037186  0.71921396 0.7481351  0.73062426
 0.7533252  0.77864134 0.76103985 0.7760161  0.7628815  0.73141587
 0.794147   0.7368801  0.6970117  0.7206018  0.7344738  0.7644974
 0.7663561  0.77629423 0.792838   0.813877   0.80654764 0.8104115
 0.847406   0.8462521  0.8596457  0.8358319  0.8156954  0.8351073 ]
```



```
Model 9:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.33048898 0.36051613 0.34308827 0.366373   0.34815767 0.371874
03
 0.37860683 0.36620137 0.34813353 0.34308028 0.33169878 0.31392744
 0.32948437 0.33232147 0.33068496 0.33697632 0.34919202 0.4042345
 0.4284305  0.4363873  0.4753587  0.5285108  0.49895683 0.47082418
 0.45284072 0.44283044 0.43450516 0.42879948 0.4479477  0.5123677
 0.550819   0.5470541  0.5307554  0.50416297 0.49448293 0.49047947
 0.53016555 0.5120777  0.4869079  0.4743271  0.46570808 0.4394214
 0.4358676  0.4308799  0.45726526 0.5308274  0.5006579  0.55896086
 0.56092733 0.54475033 0.5731703  0.6187326  0.64390385 0.6714341
 0.6483765  0.6678161  0.6826788  0.7011449  0.73408467 0.72139454
 0.7410928  0.7633135  0.7524362  0.7658464  0.75071853 0.71747035
 0.7753321  0.7311836  0.6994191  0.7126566  0.7240341  0.7565799
 0.7597916  0.76880825 0.7786443  0.79927707 0.7909413  0.78947383
 0.81857187 0.8228059  0.83531654 0.81379145 0.7935489  0.8093484 ]
```



```
Model 10:
 - Predictions shape: (84, 1)
 - Actual values shape: (84,)
 - True values: [0.30949782 0.28275109 0.33902342 0.29456133 0.38820961 0.38611813
 0.33284813 0.27893013 0.29650655 0.28657205 0.26491994 0.29421397
 0.31331878 0.31586608 0.33242358 0.35371179 0.43558952 0.46768559
 0.46233624 0.50019849 0.53111354 0.48398836 0.40120087 0.38591703
 0.40120087 0.39737991 0.38973799 0.42412664 0.52983988 0.5643265
 0.54257642 0.44323144 0.40120087 0.42030568 0.4279476  0.50818777
 0.47518857 0.45196507 0.42603712 0.38311499 0.34770742 0.34983018
 0.36681223 0.42412664 0.55021834 0.45545852 0.57138058 0.5705968
 0.52983988 0.58078603 0.64956332 0.67248908 0.70050946 0.62663755
 0.70611354 0.71834061 0.73022804 0.76419214 0.71179039 0.75272926
 0.77565502 0.72598253 0.7489083  0.76215429 0.71011085 0.77098496
 0.6419214  0.59989083 0.64574236 0.66812227 0.71069869 0.71069869
 0.72343523 0.7489083  0.77098496 0.76419214 0.81174187 0.8558952
 0.84061135 0.87117904 0.86353712 0.82227074 0.82150655 0.79475983]
 - Predicted values: [0.33420238 0.3432506  0.32330844 0.3517677  0.33620092 0.367628
96
 0.3797945  0.36116034 0.3355394  0.3317466  0.32108593 0.30276367
 0.32145756 0.32908714 0.32838532 0.3372728  0.35252622 0.41073173
 0.4382941  0.4438063  0.48153645 0.5328644  0.49592388 0.4578261
 0.4343182  0.42695504 0.42321816 0.41940004 0.44458795 0.5198924
 0.5616499  0.55592024 0.5287893  0.4961291  0.4870439  0.48636362
 0.5342957  0.5162992  0.49147666 0.47743595 0.46604115 0.4347607
 0.42896107 0.42769936 0.4588737  0.5425877  0.50524986 0.5657555
 0.5708774  0.5499772  0.58007884 0.62995255 0.6572654  0.67984116
 0.6536544  0.6761027  0.69621086 0.71415824 0.7433827  0.7288456
 0.7496246  0.7725026  0.75949645 0.7730274  0.7610277  0.7312654
 0.7870734  0.7387499  0.70247316 0.7183009  0.7329173  0.76509833
 0.7678323  0.77554905 0.7881142  0.8076255  0.8021544  0.8040116
 0.8347126  0.8377241  0.8505449  0.8301819  0.80998015 0.8244349 ]
```



Model Comparison

In [15]:
```
import matplotlib.pyplot as plt
import numpy as np
```

```python
# Prepare data for plotting
model_names = [f"Model {i+1}" for i in range(len(model_mae_scores))]
mae_scores = model_mae_scores

# Create a bar plot
plt.figure(figsize=(12, 6))
plt.barh(model_names, mae_scores, color='skyblue')
plt.xlabel('Validation MAE')
plt.title('Model Comparison: Validation MAE')
plt.xlim(0, max(mae_scores) + 0.01)  # Set limit for better visualization
plt.gca().invert_yaxis()  # Invert y-axis for better readability
plt.show()
```