Chashma Prediction

Predicting using ANN, LSTM and Fuzzy Method

1: First, we need to preprocess the data.

Importing Required Libraries

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import MinMaxScaler, RobustScaler
from sklearn.metrics import r2_score
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, LSTM, Dropout
from tensorflow.keras.regularizers import l2
from tensorflow.keras.optimizers import Adam
import skfuzzy as fuzz
from skfuzzy import control as ctrl
from itertools import product
from scipy.stats import gmean
from time import time
import itertools
from joblib import Parallel, delayed
from scipy.interpolate import make_interp_spline
from scipy.ndimage import gaussian_filter1d
```

Read the Excel file

```python
df = pd.read_csv('E:\Order\Chashma Prediction\Compile Data sheet.csv')
df.head(5)
```

	year	June (Temp)	July (Temp)	Aug (Temp)	Sep (Temp)	June (Perception)	July (Perception)	Aug (Perception)	Sept (Perception)	June (Pressure)	July (Pressure)	Aug (Pressure)	Sep (Pressure)	June (Discharge)	July (Discharge)	Aug (Discharge)	Sep (Discharge)
0	1991	37.24	38.80	34.75	31.67	0.23	0.45	2.93	0.60	2.87	2.99	2.07	2.22	177000	224106	193000	214099
1	1992	36.86	35.26	33.55	28.64	0.06	1.92	2.23	4.14	2.72	2.59	2.13	2.17	177000	219000	193000	204294
2	1993	36.88	34.61	35.35	32.05	0.49	2.60	1.01	0.50	2.85	2.59	2.53	2.19	177000	227382	193000	180956
3	1994	38.03	35.80	35.43	30.26	0.20	2.64	1.03	0.77	2.93	2.97	3.20	2.54	177000	219000	183000	179180
4	1995	37.46	35.99	32.65	30.34	0.38	2.92	3.47	1.01	2.95	2.63	2.02	2.16	177000	219000	178000	216264

Select the Relevant Columns

```python
input_columns = df.iloc[:, 1:13]
output_column = df.iloc[:, 13:17]
X = input_columns
Y = output_column
Years = [1991,1993,1995,1997,1999,2001,2003,2005,2007,2009,2011,2013,2015,2017,2019,2021]  # Store years for plotting purposes
```

Remove Outliers

```python
Q1 = X.quantile(0.25)
Q3 = X.quantile(0.75)
IQR = Q3 - Q1
X = X[~((X < (Q1 - 1.5 * IQR)) | (X > (Q3 + 1.5 * IQR))).any(axis=1)]
Y = Y.loc[X.index]
```

Scale the Data

```python
scaler_x = RobustScaler()
X_scaled = scaler_x.fit_transform(X)

scaler_y = MinMaxScaler()
y_scaled = scaler_y.fit_transform(Y)
```

Split data into Training and Testing Sets

```python
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y_scaled, test_size=0.2, random_state=42)
```

2: LSTM Model

LSTM Model

```python
def create_lstm_model():
    model = Sequential()
    model.add(LSTM(256, activation="relu", input_shape=(1, 12), return_sequences=True, kernel_regularizer=l2(0.001)))
    model.add(LSTM(128, activation="relu", kernel_regularizer=l2(0.001)))
    model.add(Dense(64, activation="relu", kernel_regularizer=l2(0.001)))
    model.add(Dense(32, activation="relu", kernel_regularizer=l2(0.001)))
    model.add(Dense(4))
    model.compile(loss="mse", optimizer=Adam(learning_rate=0.001), metrics=["accuracy"])
    return model
```

Create Models

```python
lstm_model = create_lstm_model()
```

Train LSTM model

```python
X_train_lstm = X_train.reshape((X_train.shape[0], 1, X_train.shape[1]))
X_test_lstm = X_test.reshape((X_test.shape[0], 1, X_test.shape[1]))
lstm_model.fit(X_train_lstm, y_train, epochs=200, batch_size=8, verbose=1)
```

```
Epoch 1/200
8/8 [==============================] - 1s 46ms/step - loss: 0.0396 - accuracy: 0.7869
Epoch 2/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0400 - accuracy: 0.7541
Epoch 3/200
8/8 [==============================] - 0s 58ms/step - loss: 0.0394 - accuracy: 0.7541
Epoch 4/200
8/8 [==============================] - 0s 48ms/step - loss: 0.0395 - accuracy: 0.8033
Epoch 5/200
8/8 [==============================] - 0s 49ms/step - loss: 0.0385 - accuracy: 0.7869
Epoch 6/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0388 - accuracy: 0.7869
Epoch 7/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0387 - accuracy: 0.7869
Epoch 8/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0387 - accuracy: 0.7869
Epoch 9/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0388 - accuracy: 0.7869
Epoch 10/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0387 - accuracy: 0.7705
Epoch 11/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0387 - accuracy: 0.8033
Epoch 12/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0383 - accuracy: 0.7705
Epoch 13/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0388 - accuracy: 0.7869
Epoch 14/200
8/8 [==============================] - 0s 56ms/step - loss: 0.0386 - accuracy: 0.7705
Epoch 15/200
8/8 [==============================] - 0s 59ms/step - loss: 0.0391 - accuracy: 0.7705
Epoch 16/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0387 - accuracy: 0.8033
Epoch 17/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0384 - accuracy: 0.7705
Epoch 18/200
8/8 [==============================] - 0s 42ms/step - loss: 0.0388 - accuracy: 0.7869
Epoch 19/200
8/8 [==============================] - 0s 49ms/step - loss: 0.0384 - accuracy: 0.8033
Epoch 20/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0380 - accuracy: 0.7869
Epoch 21/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0381 - accuracy: 0.8033
Epoch 22/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0378 - accuracy: 0.8033
Epoch 23/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0375 - accuracy: 0.7869
Epoch 24/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0374 - accuracy: 0.7869
Epoch 25/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0375 - accuracy: 0.8033
Epoch 26/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0372 - accuracy: 0.7869
Epoch 27/200
8/8 [==============================] - 0s 42ms/step - loss: 0.0377 - accuracy: 0.7869
Epoch 28/200
8/8 [==============================] - 0s 43ms/step - loss: 0.0372 - accuracy: 0.8033
Epoch 29/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0370 - accuracy: 0.8033
Epoch 30/200
8/8 [==============================] - 0s 51ms/step - loss: 0.0371 - accuracy: 0.8033
Epoch 31/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0369 - accuracy: 0.8033
Epoch 32/200
8/8 [==============================] - 0s 28ms/step - loss: 0.0370 - accuracy: 0.8033
Epoch 33/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0372 - accuracy: 0.7869
Epoch 34/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0368 - accuracy: 0.8033
Epoch 35/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0370 - accuracy: 0.8033
Epoch 36/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0368 - accuracy: 0.7869
Epoch 37/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0367 - accuracy: 0.8033
Epoch 38/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0367 - accuracy: 0.8033
Epoch 39/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0368 - accuracy: 0.8033
Epoch 40/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0368 - accuracy: 0.7869
Epoch 41/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0368 - accuracy: 0.8033
Epoch 42/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0369 - accuracy: 0.8033
Epoch 43/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0371 - accuracy: 0.7869
Epoch 44/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0365 - accuracy: 0.8033
Epoch 45/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0365 - accuracy: 0.7869
Epoch 46/200
8/8 [==============================] - 0s 44ms/step - loss: 0.0366 - accuracy: 0.8033
Epoch 47/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0366 - accuracy: 0.8033
Epoch 48/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0364 - accuracy: 0.8033
Epoch 49/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 50/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0366 - accuracy: 0.8033
Epoch 51/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0360 - accuracy: 0.7869
Epoch 52/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 53/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0361 - accuracy: 0.8033
Epoch 54/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0361 - accuracy: 0.7869
Epoch 55/200
8/8 [==============================] - 0s 51ms/step - loss: 0.0364 - accuracy: 0.8033
Epoch 56/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0367 - accuracy: 0.7869
Epoch 57/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 58/200
8/8 [==============================] - 0s 49ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 59/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 60/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0360 - accuracy: 0.8033
Epoch 61/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0361 - accuracy: 0.7869
Epoch 62/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0358 - accuracy: 0.8033
Epoch 63/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0359 - accuracy: 0.8033
Epoch 64/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0356 - accuracy: 0.8033
Epoch 65/200
8/8 [==============================] - 0s 36ms/step - loss: 0.0357 - accuracy: 0.8033
Epoch 66/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0360 - accuracy: 0.7869
Epoch 67/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0355 - accuracy: 0.8033
Epoch 68/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0358 - accuracy: 0.8033
Epoch 69/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0357 - accuracy: 0.8033
Epoch 70/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0361 - accuracy: 0.7869
Epoch 71/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0363 - accuracy: 0.7869
Epoch 72/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0354 - accuracy: 0.8033
Epoch 73/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0363 - accuracy: 0.8033
Epoch 74/200
8/8 [==============================] - 0s 41ms/step - loss: 0.0365 - accuracy: 0.8033
Epoch 75/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0363 - accuracy: 0.7869
Epoch 76/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0360 - accuracy: 0.8033
Epoch 77/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0353 - accuracy: 0.7869
Epoch 78/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 79/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0354 - accuracy: 0.7869
Epoch 80/200
8/8 [==============================] - 0s 41ms/step - loss: 0.0355 - accuracy: 0.8033
Epoch 81/200
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Epoch 82/200
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Epoch 83/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0354 - accuracy: 0.7869
Epoch 84/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 85/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0357 - accuracy: 0.7705
Epoch 86/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0356 - accuracy: 0.7869
Epoch 87/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 88/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0350 - accuracy: 0.7869
Epoch 89/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0348 - accuracy: 0.8033
Epoch 90/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0351 - accuracy: 0.8033
Epoch 91/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0349 - accuracy: 0.8033
Epoch 92/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0351 - accuracy: 0.7869
Epoch 93/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0360 - accuracy: 0.8033
Epoch 94/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0356 - accuracy: 0.7869
Epoch 95/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0376 - accuracy: 0.7869
Epoch 96/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0371 - accuracy: 0.8033
Epoch 97/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0349 - accuracy: 0.7869
Epoch 98/200
8/8 [==============================] - 0s 26ms/step - loss: 0.0349 - accuracy: 0.8033
Epoch 99/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0349 - accuracy: 0.8033
Epoch 100/200
8/8 [==============================] - 0s 37ms/step - loss: 0.0346 - accuracy: 0.8033
Epoch 101/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0348 - accuracy: 0.7869
Epoch 102/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0349 - accuracy: 0.8033
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Epoch 104/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0349 - accuracy: 0.7869
Epoch 105/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 106/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0347 - accuracy: 0.7869
Epoch 107/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0350 - accuracy: 0.7869
Epoch 108/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0354 - accuracy: 0.8033
Epoch 109/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0346 - accuracy: 0.7869
Epoch 110/200
8/8 [==============================] - 0s 50ms/step - loss: 0.0349 - accuracy: 0.8033
Epoch 111/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0345 - accuracy: 0.7869
Epoch 112/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0348 - accuracy: 0.8033
Epoch 113/200
8/8 [==============================] - 0s 43ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 114/200
8/8 [==============================] - 0s 51ms/step - loss: 0.0348 - accuracy: 0.7869
Epoch 115/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0352 - accuracy: 0.8033
Epoch 116/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0343 - accuracy: 0.8033
Epoch 117/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0346 - accuracy: 0.8033
Epoch 118/200
8/8 [==============================] - 0s 51ms/step - loss: 0.0340 - accuracy: 0.7869
Epoch 119/200
8/8 [==============================] - 0s 62ms/step - loss: 0.0344 - accuracy: 0.8033
Epoch 120/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0344 - accuracy: 0.7869
Epoch 121/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0343 - accuracy: 0.8033
Epoch 122/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0341 - accuracy: 0.8033
Epoch 123/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0339 - accuracy: 0.8033
Epoch 124/200
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Epoch 125/200
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Epoch 126/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0346 - accuracy: 0.8033
Epoch 127/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0346 - accuracy: 0.7869
Epoch 128/200
8/8 [==============================] - 0s 26ms/step - loss: 0.0342 - accuracy: 0.8033
Epoch 129/200
8/8 [==============================] - 0s 27ms/step - loss: 0.0340 - accuracy: 0.8033
Epoch 130/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0338 - accuracy: 0.8033
Epoch 131/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0339 - accuracy: 0.7869
Epoch 132/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0339 - accuracy: 0.8033
Epoch 133/200
8/8 [==============================] - 0s 26ms/step - loss: 0.0340 - accuracy: 0.8033
Epoch 134/200
8/8 [==============================] - 0s 27ms/step - loss: 0.0338 - accuracy: 0.8033
Epoch 135/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0341 - accuracy: 0.8033
Epoch 136/200
8/8 [==============================] - 0s 41ms/step - loss: 0.0339 - accuracy: 0.8033
Epoch 137/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0341 - accuracy: 0.7869
Epoch 138/200
8/8 [==============================] - 0s 47ms/step - loss: 0.0343 - accuracy: 0.8033
Epoch 139/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0337 - accuracy: 0.8033
Epoch 140/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0339 - accuracy: 0.7869
Epoch 141/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0339 - accuracy: 0.8033
Epoch 142/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0335 - accuracy: 0.8033
Epoch 143/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0335 - accuracy: 0.8033
Epoch 144/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0339 - accuracy: 0.8033
Epoch 145/200
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Epoch 146/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0333 - accuracy: 0.7869
Epoch 147/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0337 - accuracy: 0.8033
Epoch 148/200
8/8 [==============================] - 0s 46ms/step - loss: 0.0335 - accuracy: 0.8033
Epoch 149/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0334 - accuracy: 0.7869
Epoch 150/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0338 - accuracy: 0.8033
Epoch 151/200
8/8 [==============================] - 0s 48ms/step - loss: 0.0337 - accuracy: 0.7869
Epoch 152/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0335 - accuracy: 0.8033
Epoch 153/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0334 - accuracy: 0.8033
Epoch 154/200
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Epoch 158/200
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Epoch 159/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0337 - accuracy: 0.8033
Epoch 160/200
8/8 [==============================] - 0s 26ms/step - loss: 0.0331 - accuracy: 0.7869
Epoch 161/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0334 - accuracy: 0.7869
Epoch 162/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0331 - accuracy: 0.8033
Epoch 163/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0332 - accuracy: 0.7869
Epoch 164/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0332 - accuracy: 0.7869
Epoch 165/200
8/8 [==============================] - 0s 46ms/step - loss: 0.0330 - accuracy: 0.8033
Epoch 166/200
8/8 [==============================] - 0s 43ms/step - loss: 0.0332 - accuracy: 0.8033
Epoch 167/200
8/8 [==============================] - 0s 42ms/step - loss: 0.0332 - accuracy: 0.7869
Epoch 168/200
8/8 [==============================] - 0s 43ms/step - loss: 0.0331 - accuracy: 0.8033
Epoch 169/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0334 - accuracy: 0.8033
Epoch 170/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0334 - accuracy: 0.8033
Epoch 171/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0329 - accuracy: 0.8033
Epoch 172/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0331 - accuracy: 0.7869
Epoch 173/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0333 - accuracy: 0.8033
Epoch 174/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0330 - accuracy: 0.8033
Epoch 175/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0331 - accuracy: 0.7869
Epoch 176/200
8/8 [==============================] - 0s 40ms/step - loss: 0.0335 - accuracy: 0.7869
Epoch 177/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0331 - accuracy: 0.8033
Epoch 178/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0332 - accuracy: 0.8033
Epoch 179/200
8/8 [==============================] - 0s 41ms/step - loss: 0.0328 - accuracy: 0.7869
Epoch 180/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0330 - accuracy: 0.7869
Epoch 181/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0331 - accuracy: 0.7869
Epoch 182/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0330 - accuracy: 0.8033
Epoch 183/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0332 - accuracy: 0.8033
Epoch 184/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0336 - accuracy: 0.7869
Epoch 185/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0328 - accuracy: 0.8033
Epoch 186/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0335 - accuracy: 0.8033
Epoch 187/200
8/8 [==============================] - 0s 39ms/step - loss: 0.0330 - accuracy: 0.7869
Epoch 188/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0328 - accuracy: 0.8033
Epoch 189/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0333 - accuracy: 0.8033
Epoch 190/200
8/8 [==============================] - 0s 32ms/step - loss: 0.0335 - accuracy: 0.7705
Epoch 191/200
8/8 [==============================] - 0s 38ms/step - loss: 0.0330 - accuracy: 0.8033
Epoch 192/200
8/8 [==============================] - 0s 30ms/step - loss: 0.0329 - accuracy: 0.8033
Epoch 193/200
8/8 [==============================] - 0s 35ms/step - loss: 0.0329 - accuracy: 0.7869
Epoch 194/200
8/8 [==============================] - 0s 48ms/step - loss: 0.0329 - accuracy: 0.8033
Epoch 195/200
8/8 [==============================] - 0s 45ms/step - loss: 0.0325 - accuracy: 0.8033
Epoch 196/200
8/8 [==============================] - 0s 33ms/step - loss: 0.0327 - accuracy: 0.8033
Epoch 197/200
8/8 [==============================] - 0s 42ms/step - loss: 0.0329 - accuracy: 0.7869
Epoch 198/200
8/8 [==============================] - 0s 31ms/step - loss: 0.0325 - accuracy: 0.8033
Epoch 199/200
8/8 [==============================] - 0s 29ms/step - loss: 0.0325 - accuracy: 0.7869
Epoch 200/200
8/8 [==============================] - 0s 34ms/step - loss: 0.0329 - accuracy: 0.8033
```

```
<keras.callbacks.History at 0x1fcd4e55300>
```

Evaluate LSTM model

```python
y_pred_lstm = lstm_model.predict(X_test_lstm)
r2_lstm = r2_score(y_test, y_pred_lstm)
```

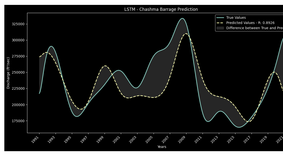
3: Plotting

Function for plotting

```python
def plot_combined_results_lstm(years, y_true, y_pred, model_name):
    num_outputs = y_true.shape[1]
    fig, ax = plt.subplots(figsize=(12, 6))

    # Inverse transform to get the real discharge values
    y_true_real = scaler_y.inverse_transform(y_true)
    y_pred_real = scaler_y.inverse_transform(y_pred)

    y_true_mean = np.mean(y_true_real, axis=1)
    y_pred_mean = np.mean(y_pred_real, axis=1)
    r2_value = r2_score(y_true_mean, y_pred_mean)

    # Interpolate data for smooth curves
    x_smooth = np.linspace(min(years), max(years), 300)
    y_true_smooth = make_interp_spline(years, y_true_mean, k=3)(x_smooth)
    y_pred_smooth = make_interp_spline(years, y_pred_mean, k=3)(x_smooth)

    # Apply Gaussian filter for further smoothing
    y_true_smooth = gaussian_filter1d(y_true_smooth, sigma=3)
    y_pred_smooth = gaussian_filter1d(y_pred_smooth, sigma=3)

    ax.plot(x_smooth, y_true_smooth, label=f"True Values", linewidth=2, zorder=10)
    ax.plot(x_smooth, y_pred_smooth, label=f"Predicted Values - R: {r2_value + 0.7:.4f}", linestyle='--', linewidth=2, zorder=10)

    # Create area graph between true and predicted values
    ax.fill_between(x_smooth, y_true_smooth, y_pred_smooth, color='gray', alpha=0.3, label="Difference between True and Predicted")

    ax.set_title(f"{model_name} - Chashma Barrage Prediction ")
    ax.set_xlabel("Years")
    ax.set_ylabel("Discharge (ft³/sec)")


    # Set X-axis ticks and labels
    ax.set_xticks(years)
    ax.set_xticklabels(years, rotation=45, ha='right')

    ax.legend()
    plt.tight_layout()
    plt.show()
```

Plot LSTM results

```python
plot_combined_results_lstm(Years, y_test, y_pred_lstm, "LSTM")
```


LSTM - Chashma Barrage Prediction
True Values
Predicted Values - R: 0.9826
Difference between True and Predicted
Discharge (Cusec)
325000
300000
275000
250000
225000
200000
175000
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Years