Friedrich-Alexander-Universität
Technische Fakultät

Pattern Recognition Lab

FAU

Time Series Challenge (Summer 2024)

Heat and water Demand forecasting

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Agenda

Time Series Challenge

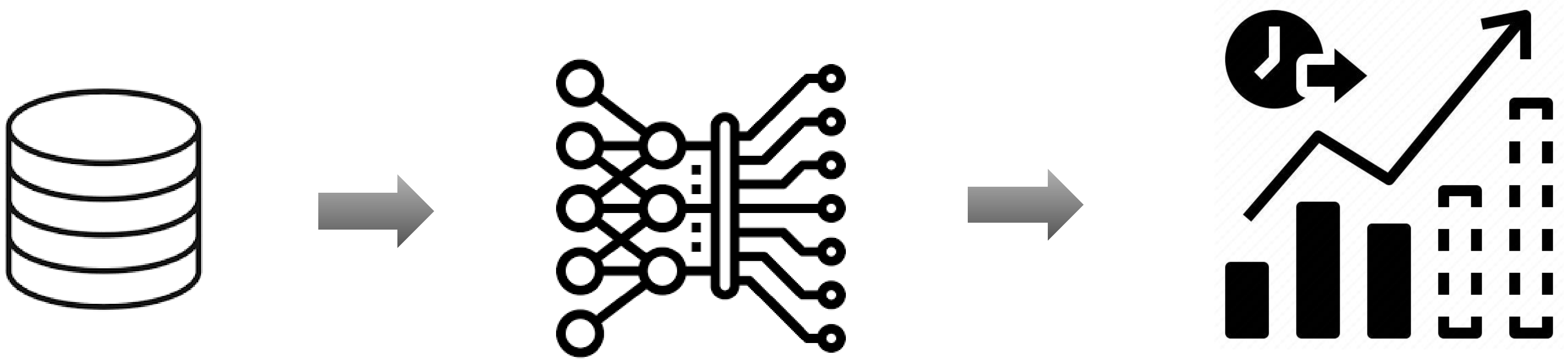
Motivation

Time Series Challenge

Introduction

Time Series Challenge

Downstream Task:



Historical Heat and Water data

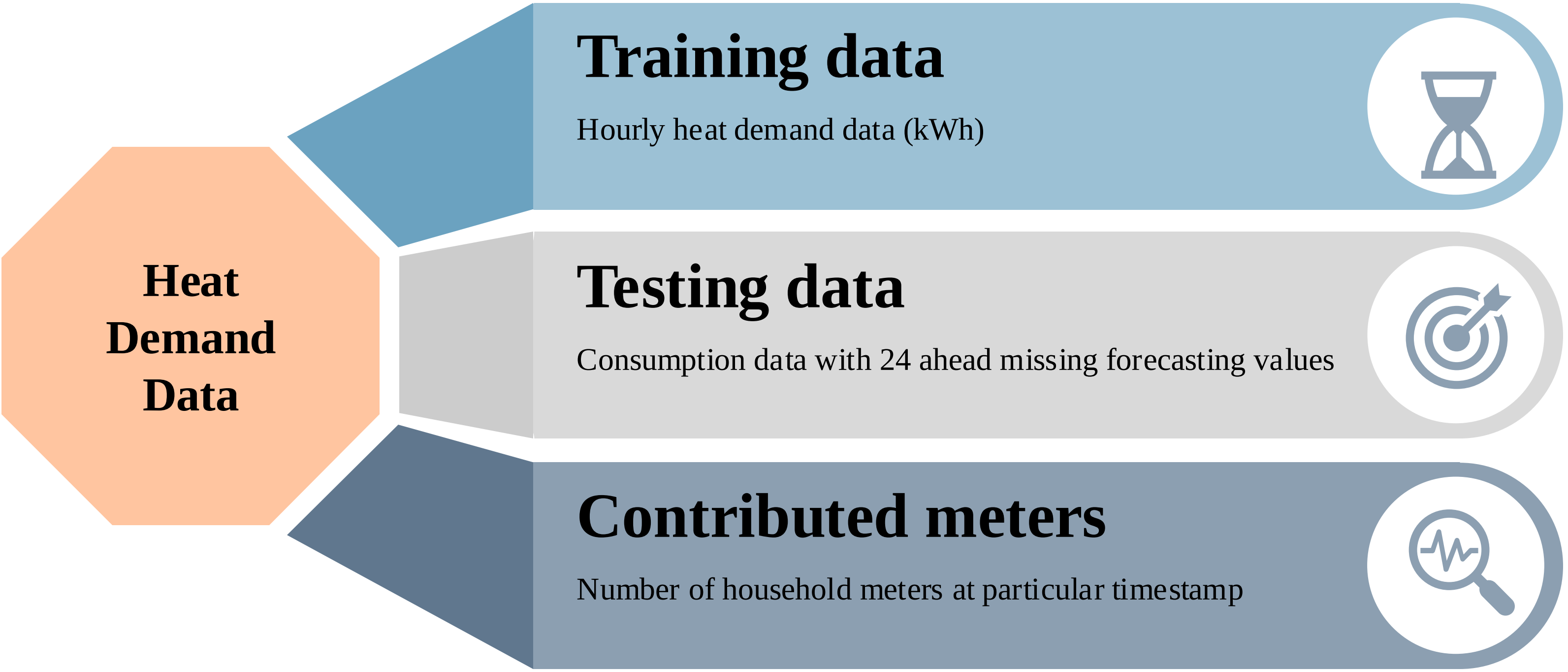
Forecasting model

Prediction for next 24 hours

Dataset Overview

Time Series Challenge

Heat Demand Data for urban population



Dataset Overview

Time Series Challenge

Water Demand Data for urban and rural population

Water Demand Data

Training data

Hourly water demand data

Testing data

Consumption data with 24 ahead missing forecasting values

Contributed meters

Number of household meters at particular timestamp

Dataset Overview

Time Series Challenge

Weather Data:

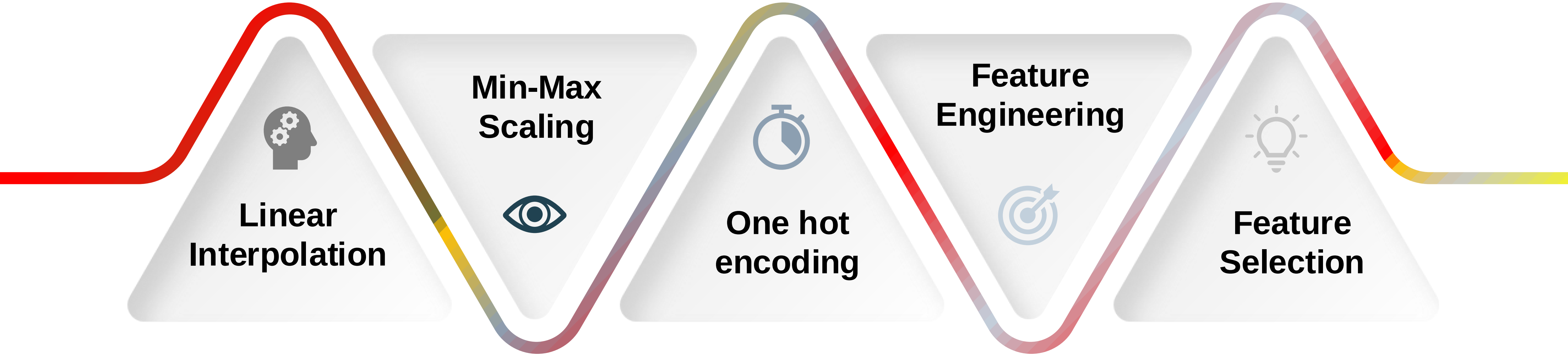
- Timestamp, Temperature, Feels like, Weather Description, Latitude, Longitude….. etc.

Data Pre-Processing

Time Series Challenge

Applied to numerical features to normalize the data

Introduces a new feature Consumption per Meter.



Used to estimate and fill missing heat consumption data.

Converts categorical variables into a binary matrix.

Dropping Irrelevant Features.

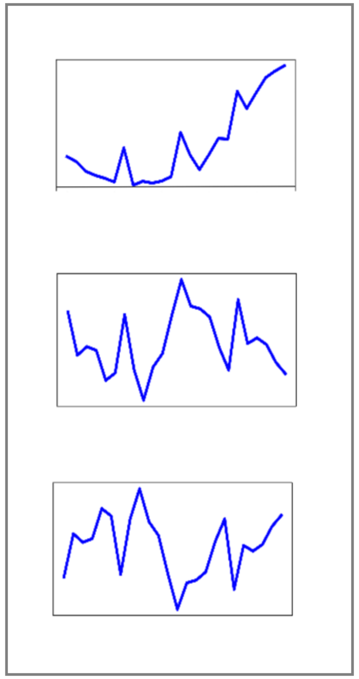
Architecture : Heat Demand Forecasting

Time Series Challenge

Heat consumption

Contributing meters

Weather data

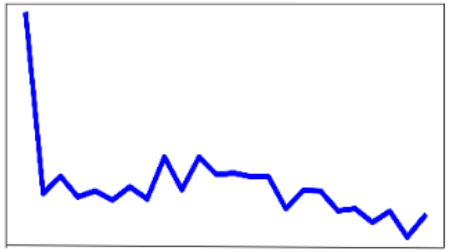


Input

LSTM Neural Network

1 input layer , 2 hidden layers with 256 neurons in each layer, 1 linear and 1 output layer

5 Layer LSTM Neural Network



Forecasted heat consumption for next 24 hours

Optimizer: Adam **Loss: MSE** **Batch size: 32** **Learning rate: 0.001**

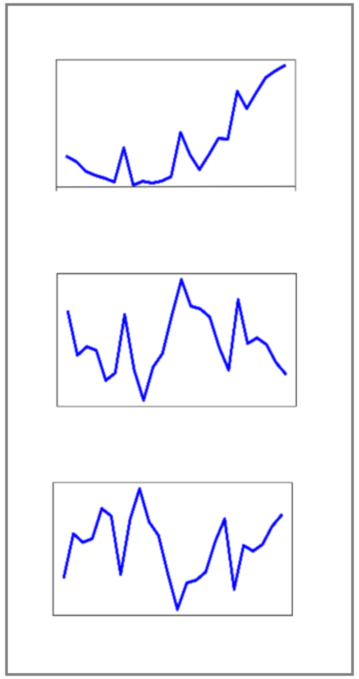
Architecture : Water Demand Forecasting (Urban)

Time Series Challenge

Water consumption

Contributing meters

Weather data

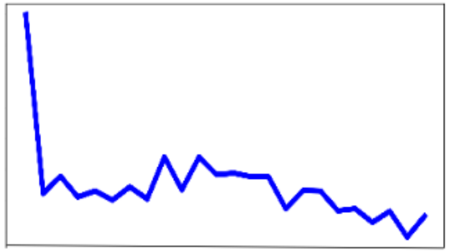


Input

LSTM Neural Network

1 input layer , 1 hidden layers with 256, 1 linear and 1 output layer

4 Layer LSTM Neural Network



Forecasted water consumption for next 24 hours

Optimizer: RMS

Loss: MSE

Batch size: 32

Learning rate: 0.0006

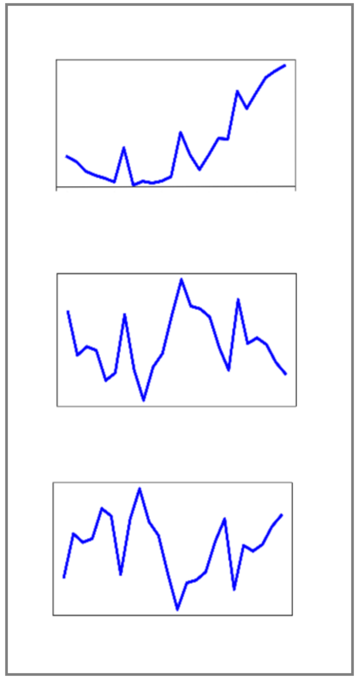
Architecture : Water Demand Forecasting (Rural)

Time Series Challenge

Water consumption

Contributing meters

Weather data

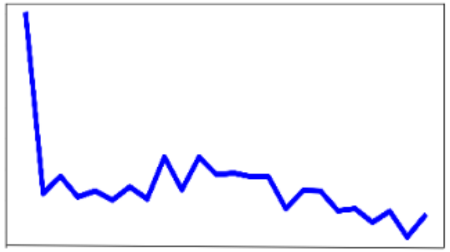


Input

LSTM Neural Network

1 input layer , 2 hidden layers with 256 neurons in each layer, 1 linear and 1 output layer

5 Layer LSTM Neural Network



Forecasted water consumption for next 24 hours

Optimizer: Adam

Loss: MSE

Batch size: 32

Learning rate: 0.01

Model Evaluation

Time Series Challenge

Evaluation Metrics:

- Mean Absolute Error (MAE) and MAPE were used to evaluate model performance.

Data/Metrics	MAE	MAPE (%)
Heat DMA	177.739	0.0653
Water DMA 1	1.604	0.137
Water DMA 2	0.489	0.221

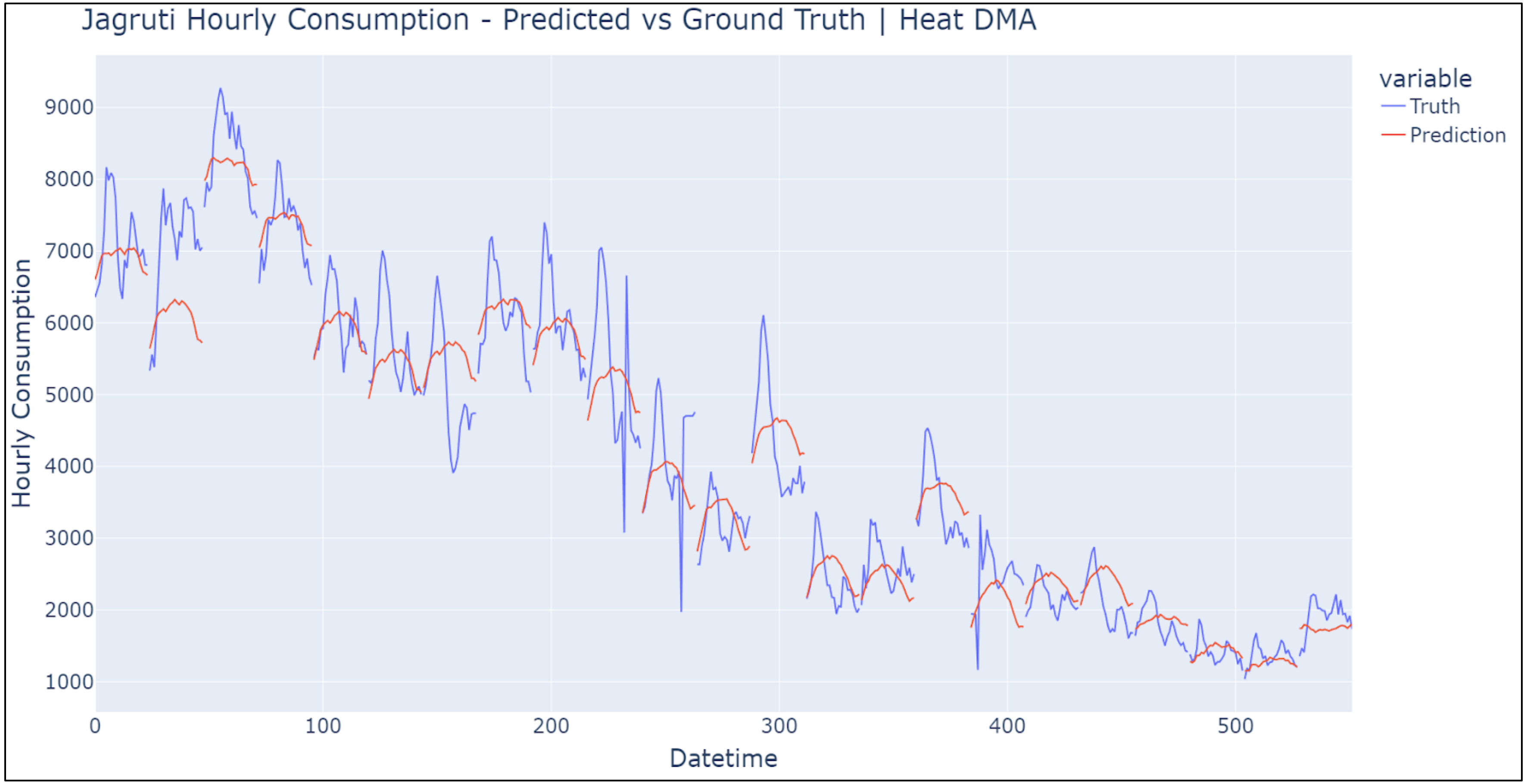
Deep Learning Based Forecasting Model from the lab

Data/Metrics	MAE	MAPE
Heat DMA	425.9	0.112
Water DMA 1	11.529	1.151
Water DMA 2	0.501	0.191

Deep Learning Based Forecasting Model obtained by me

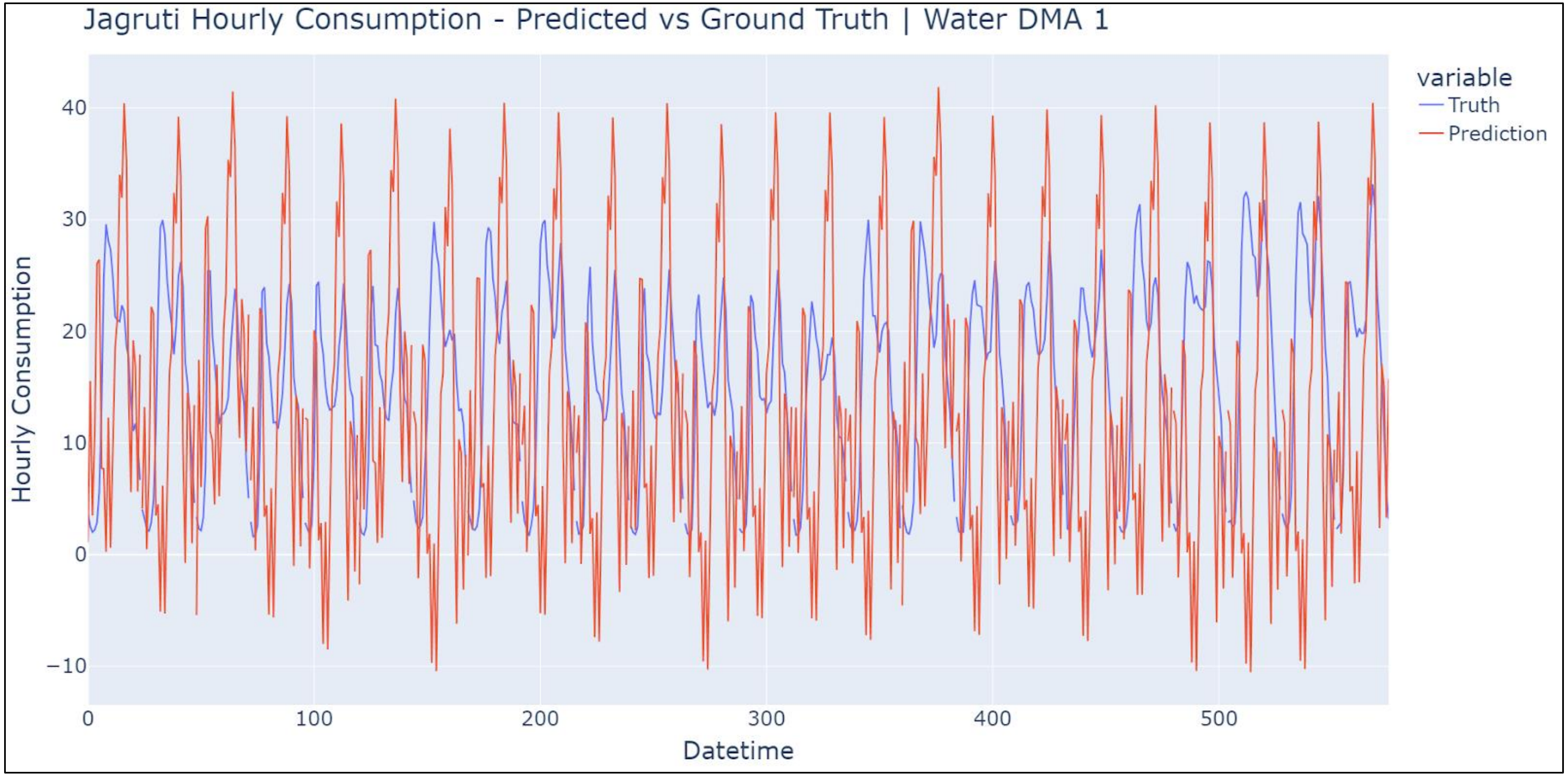
Model Evaluation

Time Series Challenge



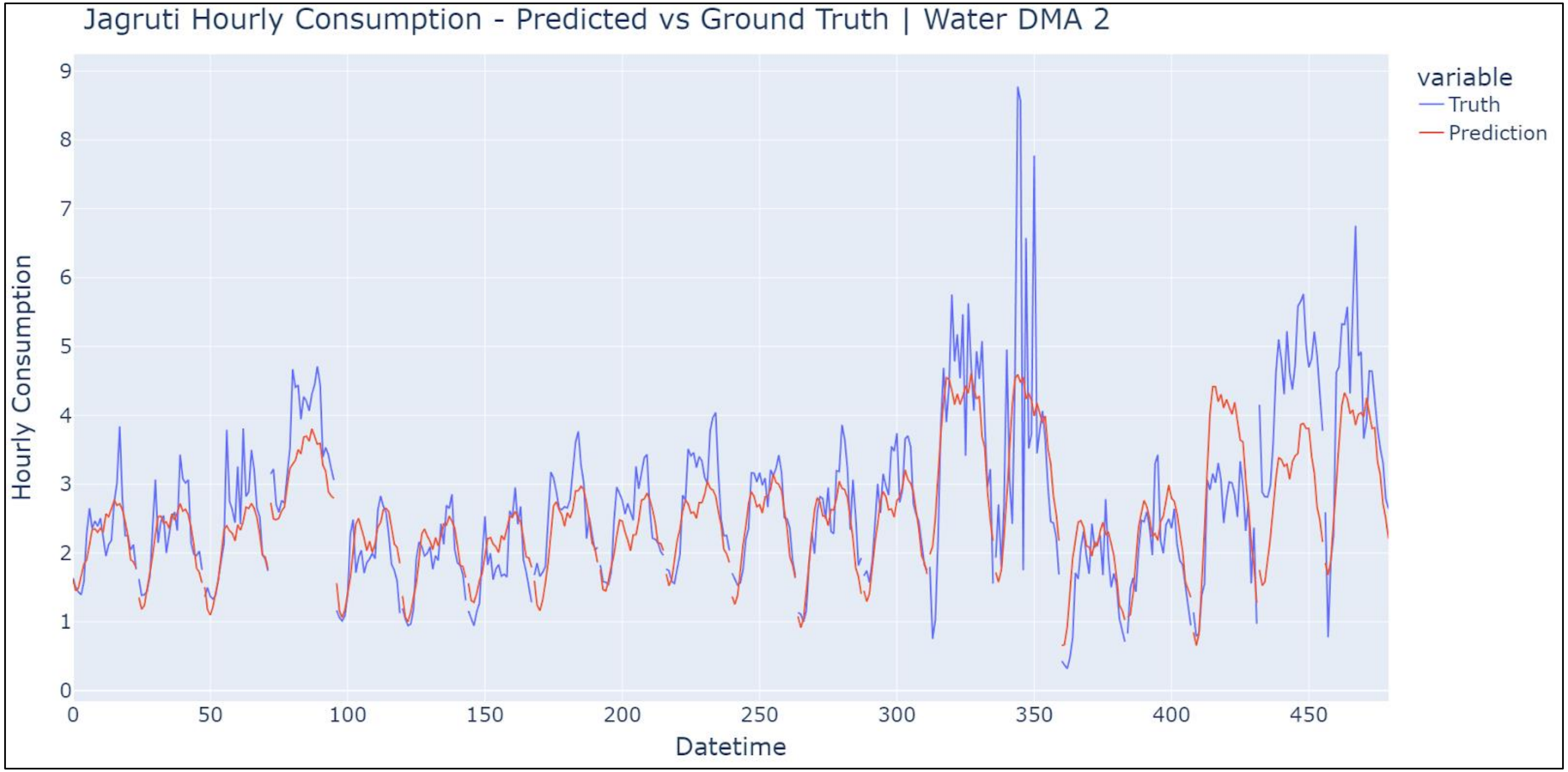
Model Evaluation

Time Series Challenge



Model Evaluation

Time Series Challenge



Conclusion

Heat and Water Demand Forecasting

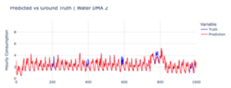
- LSTM models are highly effective for forecasting heat and water demand due to their ability to capture temporal and non-linear patterns in time series data.
- LSTM outperform traditional methods but require more data, computational power, and careful tuning.

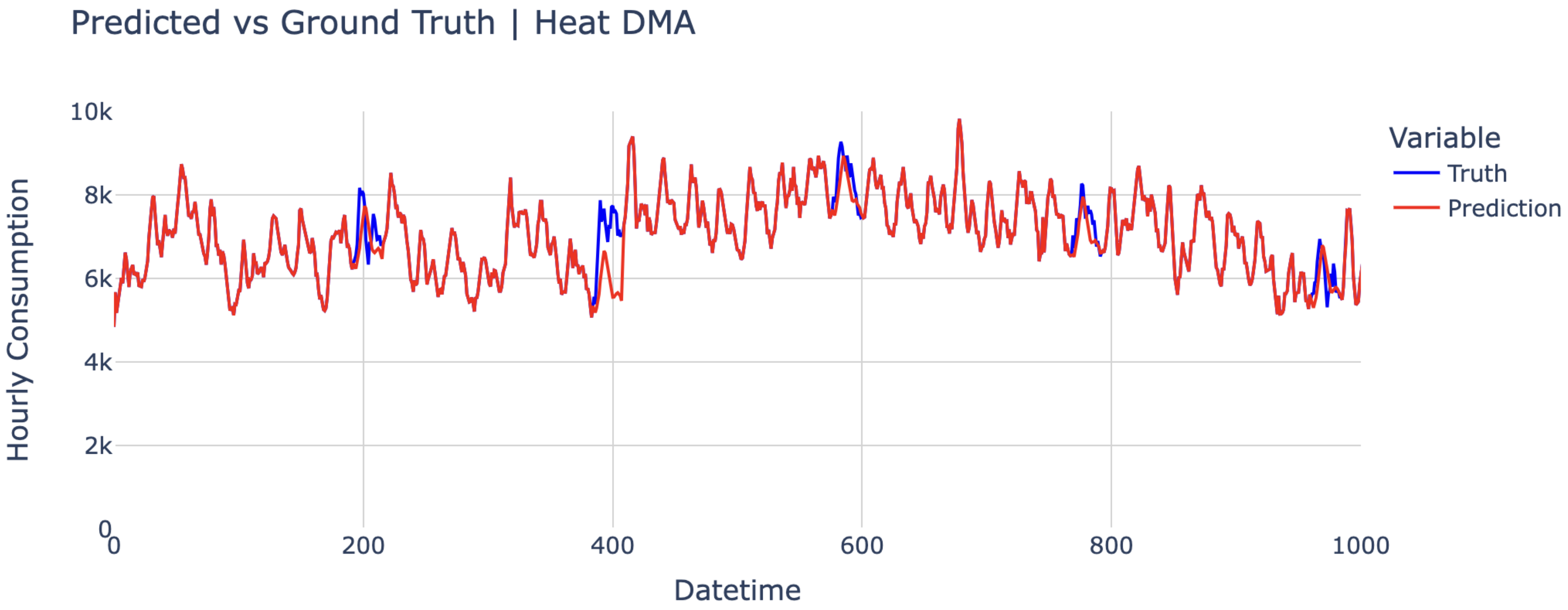
Data/Metrics	MAE	MAPE (%)
Heat DMA	177.739	0.0653
Water DMA 1	1.604	0.137
Water DMA 2	0.489	0.221

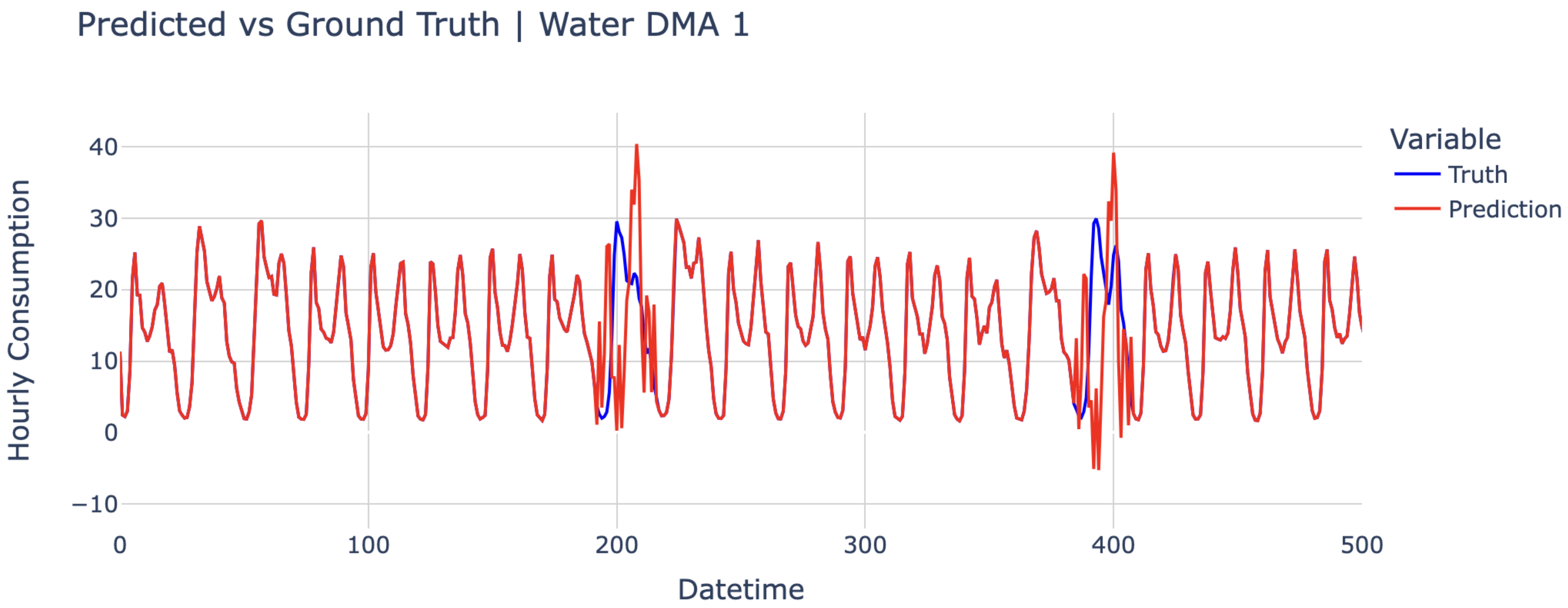
DMA	RMSE	MAPE	MAE
Heat	219.406	0.0653	177.739
Water 1	2.013	0.137	1.604
Water 2	0.641	0.221	0.489

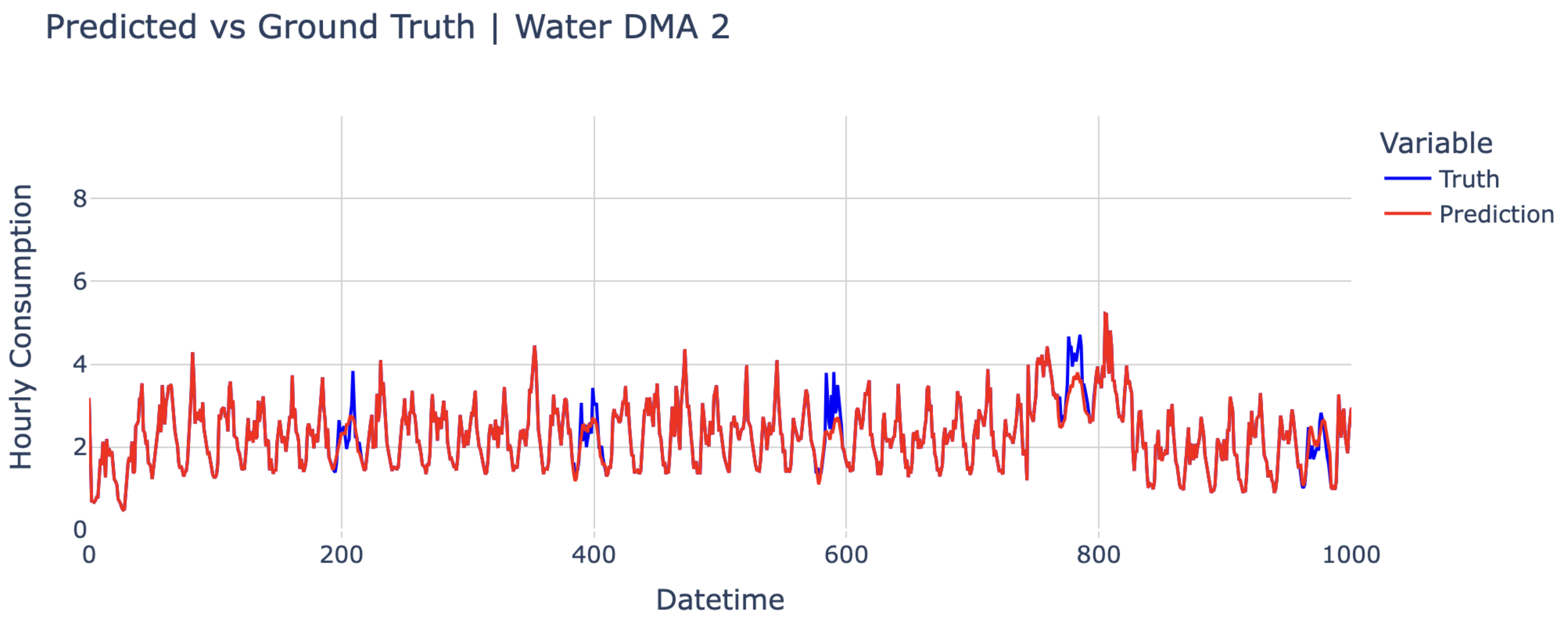
Table: Deep Learning Based Forecasting Model from the lab

Data/Metrics	MAE	MAPE (%)	RMSE
Heat DMA	368.01	9.43	535.12
Water DMA 1	11.52	115.17	14.27
Water DMA 2	0.50	19.19	0.73




Predicted vs Ground Truth | Heat DMA
Hourly Consumption
10k
8k
6k
4k
2k
0
0
200
400
600
800
1000
Datetime
Variable
Truth
Prediction


Predicted vs Ground Truth | Water DMA 1
Hourly Consumption
40
30
20
10
0
−10
0
100
200
300
400
500
Datetime
Variable
Truth
Prediction


Predicted vs Ground Truth | Water DMA 2
Hourly Consumption
0
2
4
6
8
0
200
400
600
800
1000
Datetime
Variable
Truth
Prediction

Thank you !