

Comparing Forecasting Models for Univariate Time-Series Analysis

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Motivation

- **Time-series forecasting** is the problem of predicting future values from past observations
- Traditional methods may fail for **complex data**

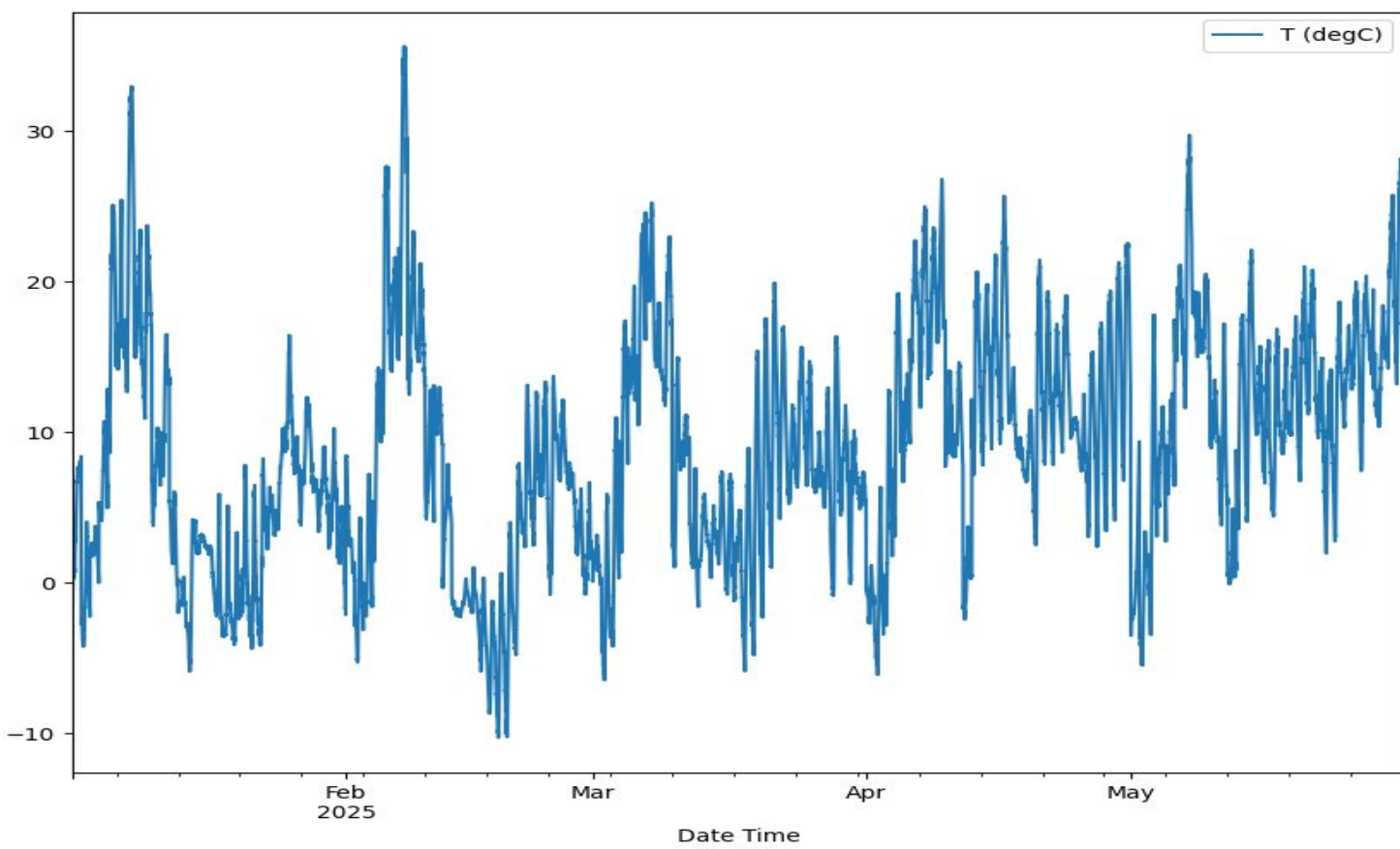


Figure 1. Temperature daily time series over 5 months

Research Question: Do neural networks perform better than traditional forecasting methods, and under which conditions?

References

[1] Kong, Yaxuan, et al. "Unlocking the power of lstm for long term time series forecasting." *Proceedings of the AAAI conference on artificial intelligence*. Vol. 39. No. 11. 2025.

[2] Beck, Maximilian, et al. "xlstm: Extended long short-term memory." *Advances in Neural Information Processing Systems* 37 (2024): 107547-107603.

[3] S. Siame-Namini, N. Tavakoli and A. Siame Namin, "A Comparison of ARIMA and LSTM in Forecasting Time Series," *2018 17th IEEE International Conference on Machine Learning and Applications (ICMLA)*, 2018, pp. 1394-1401

Experimental Procedure

- We fine-tune three different models for each forecasting task:
 - 1.) SARIMA(p, d, q)(P, D, Q, s)
 - 2.) Vanilla LSTM
 - 3.) sLSTM
- We evaluate using **Mean Absolute Error (MAE)** and **Root Mean Squared Error (RMSE)** as metrics

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_j - \hat{y}_j|$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{j=1}^n (y_j - \hat{y}_j)^2}$$

Dataset

- Weather data from Max-Planck Institute for Biogeochemistry
 - Recorded temperature in 10min intervals for 2025 in Germany
- We perform two types of forecasting:
 - **Short-term Horizon:** Lookback of 48 hours, prediction on 24 hours, resampled into 1hr intervals
 - **Long-term Horizon:** Lookback of 4 months, prediction on 1 month, resampled into 1d intervals

Architecture

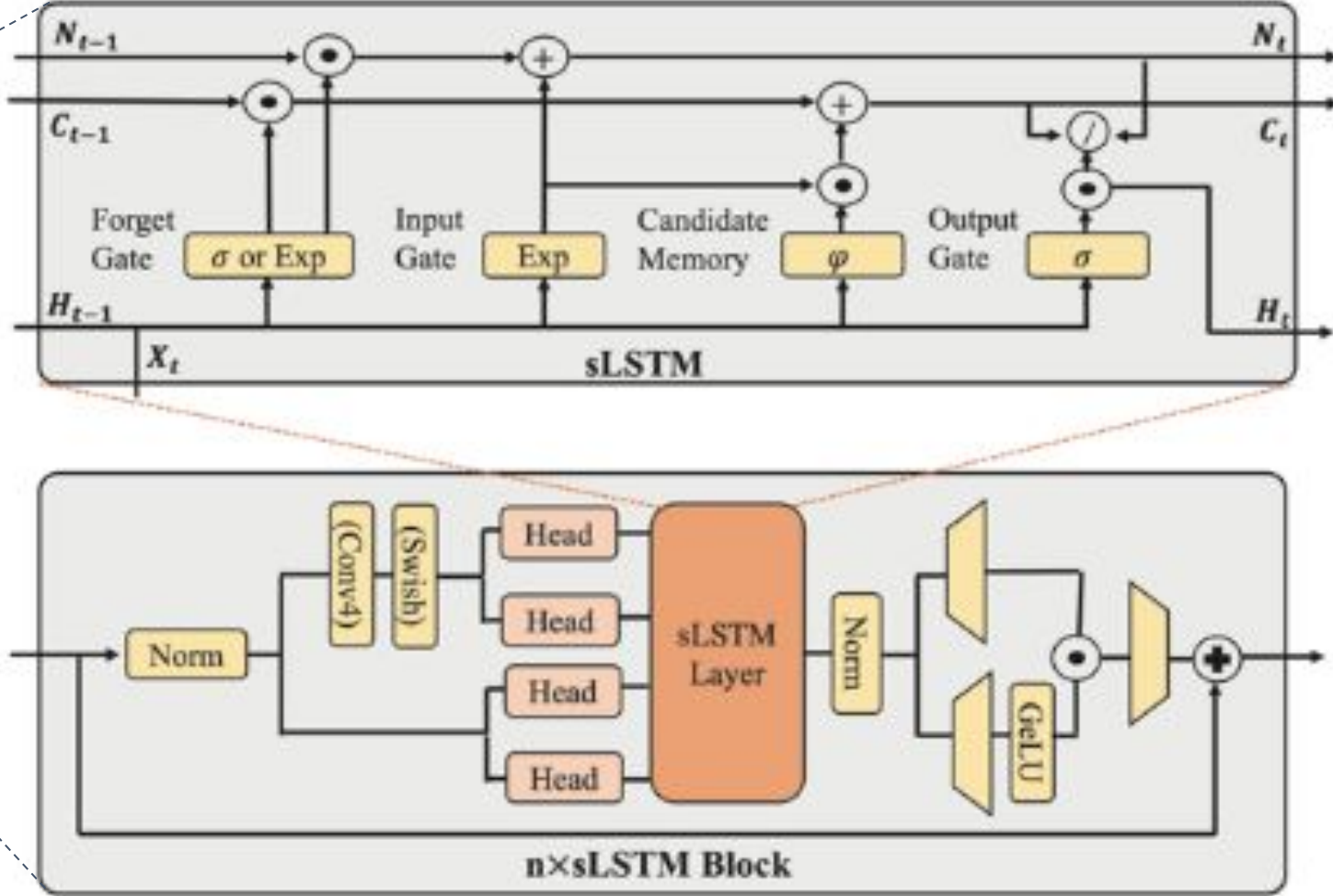
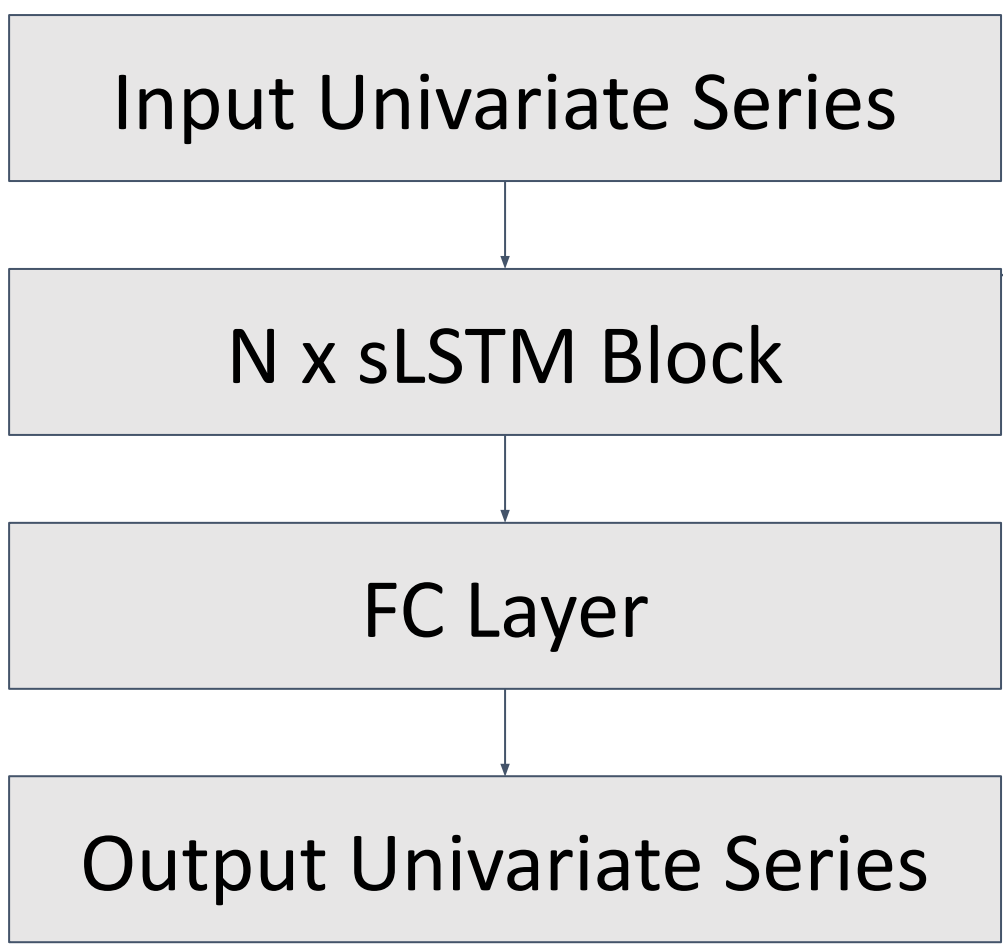


Figure 2. sLSTM Architecture [1]

Results

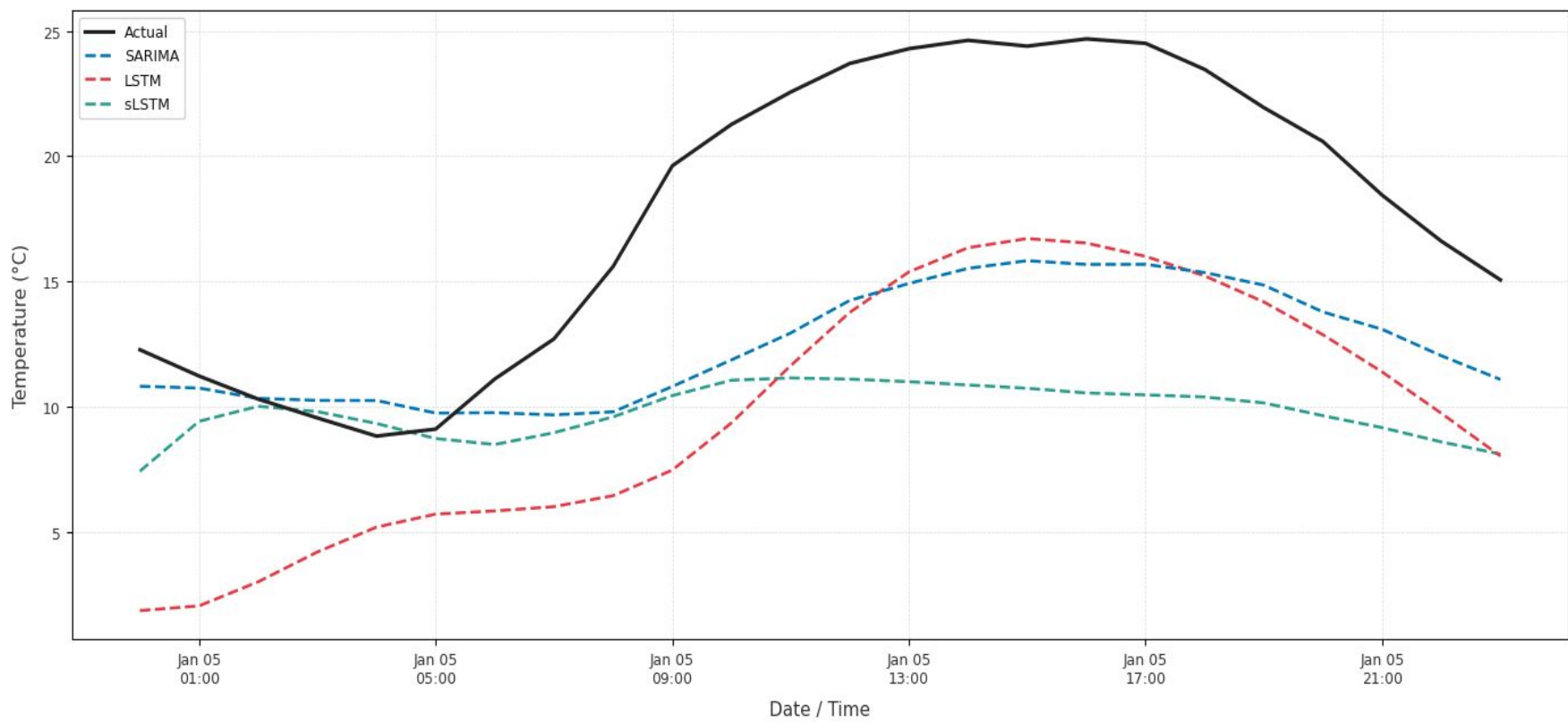


Figure 3. Forecasting of Short-term Horizon

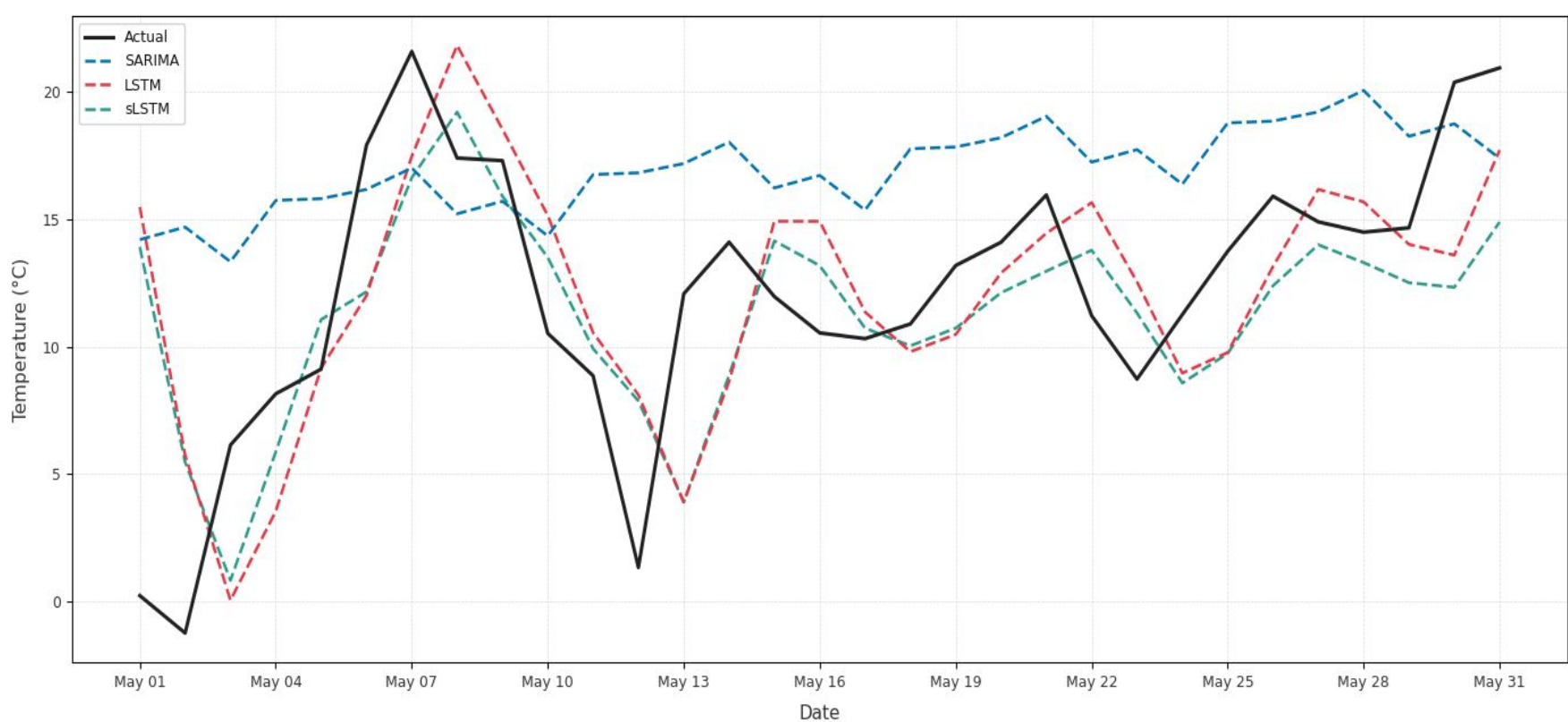


Figure 4. Forecasting of Long-term Horizon

Model	MAE	RMSE
SARIMA	5.5410	6.5480
LSTM	7.9800	8.2750
sLSTM	8.0340	9.4430
SARIMA (Long)	5.7720	6.7890
LSTM (Long)	3.8980	4.9040
sLSTM (Long)	3.7160	4.6470

Table 1. MAE and RMSE Comparison

Discussion

- SARIMA works well for **short-term forecasting**, while neural networks works well for **long-term forecasting**
- Neural networks are generally better for dealing with **nonlinear, high-dimensional data**
- **Choice of activation function** can influence how well LSTMs handle different types of data and tasks