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Performance Comparison of Transformer, LSTM, and ARIMA Time Series Forecasting Models: A Healthcare Application

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INTRODUCTION & AIM

Deep learning has significantly transformed time series analysis, particularly for long and complex datasets. Traditional methods may suffice for simpler time series, but deep learning algorithms excel in handling intricate patterns. This study evaluates time series forecasting models (ARIMA, LSTM, TFT) using vital sign data during sleep, a critical application for detecting abnormal patterns related to sleep disorders.

METHOD

Three models were evaluated for time series forecasting:
- **ARIMA**: A traditional statistical method for time series forecasting.

- **LSTM**: A recurrent neural network designed to capture long-term dependencies in time series data.

- **TFT (Temporal Fusion Transformer)**: A state-of-the-art deep learning model leveraging attention mechanisms.

The dataset consisted of heart rate data derived from ECG signals of 35 individuals during sleep, sourced from the Physionet Apnea-ECG database. Heart rate was extracted using the Pan-Tompkins Algorithm and interpolated to create an evenly spaced time series.

RESULTS & DISCUSSION

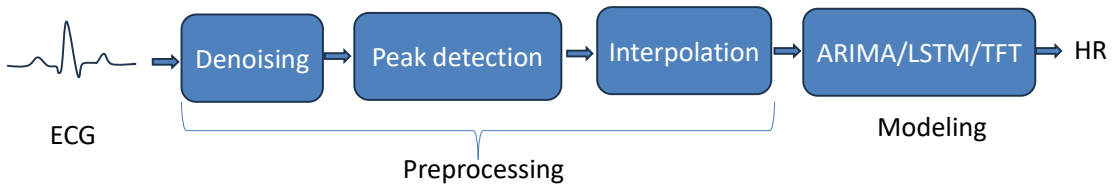
We compared ARIMA, LSTM, and TFT for forecasting heart rate during sleep (next two minutes based on past 30 minutes).

- **ARIMA**: MAE: 6.1 bpm, RMSE: 7.8 bpm
- **LSTM**: MAE: 4.3 bpm, RMSE: 5.9 bpm
- **TFT**: MAE: 3.8 bpm, RMSE: 4.7 bpm

TFT outperformed both ARIMA and LSTM, showcasing its ability to capture complex temporal dynamics in heart rate time series.

CONCLUSION

The results of this study demonstrate the superior performance of the TFT model in time series forecasting of heart rate data during sleep. Advanced deep learning techniques such as TFT can significantly improve accuracy in vital sign monitoring, enabling early detection of sleep disorders.



FUTURE WORK / REFERENCES

[1] Lim B, Zohren S. Time-series forecasting with deep learning: a survey. Philosophical Transactions of the Royal Society A. 2021 Apr 5;379(2194):20200209.
[2] Torres JF, Hadjout D, Sebaa A, Martínez-Álvarez F, Troncoso A. Deep learning for time series forecasting: a survey. Big Data. 2021 Feb 1;9(1):3-21.
[3] Henriques T, Ribeiro M, Teixeira A, Castro L, Antunes L, Costa-Santos C. Nonlinear methods most applied to heart-rate time series: a review. Entropy. 2020 Mar 9;22(3):309.
[4] Bahrami M, Forouzanfar M. Deep learning forecasts the occurrence of sleep apnea from single-lead ECG. Cardiovascular Engineering and Technology. 2022 Dec;13(6):809-15.