

**Proposal for Tutorial on**

# **An introduction to Time Series Forecasting with case studies in NLP**

**Proposed by**  
Sandhya Singh  
Kevin Patel

**Under direction of**  
Prof. Pushpak Bhattacharyya

**Department of Computer Science & Engineering  
IIT Bombay**

## **Abstract**

A time series (TS) is a sequence of observations annotated with timestamps. The timestamp adds the temporal dependency that offers additional structure to data. One can thus study this structure and use it to predict future values. This falls under the purview of time series forecasting (TSF)[1,2].

TSF have many applications such as stock market prediction, sales prediction etc. Previously, it was often expert driven; domain experts often relied on their knowledge to tackle these applications. However, with the advent of technologies like IoT and progress in related technologies, there has been an explosion in the volume of time series data. Thus, this area is moving on from expert-driven approaches to data-driven approaches. Especially, with the rise of deep learning, these data driven approaches are getting better at dealing with complex patterns in time series, enabling applications such as weather forecasting, energy prediction etc [3,4].

From a shallow perspective, text is also a sequence of words. However, this is not the case, as is evident from use of parse trees etc. for various NLP tasks. Nevertheless, we believe an NLP researcher should be well acquainted with time series techniques, as time series could manifest at different levels in NLP e.g. sentiment as a trend over the course of a review, opinion as a trend over a sequence of tweets [5, 6] etc. Additionally, there is always the curiosity pertaining to similarity between time series and natural language text, and the possibility of exploiting the knowledge of one to address other.

The objective of this tutorial is to introduce novice to the field of TS, show examples of time-series manifesting in NLP and demonstrate popular libraries for working with TS.

## **Proposed Duration: Half Day**

### **Outline Plan**

#### **Part I: Basics of Time Series Forecasting (30 slides, 60 mins)**

- Introduction
  - What is TS, TSA, TSF?
  - Why TSF?
  - Application areas
- Components of TS

- Univariate, Multivariate
  - Trend, Seasonality
  - Stationarity
- Classical approaches for TS (with Demo)
  - Data preparation and visualization
  - Basic statistical models (Naïve forecasting, EWMA model, ARIMA model)
- Evaluation Metrics
  - RMSE,
  - NRMSE
  - MAPE

## **Part II: ML and DL techniques for forecasting (30 Slides with demo, 30 mins)**

- SVM for TSF
- FF network for TSF
- LSTM model for TSF

## **Part III: Case Studies on TS in NLP (30 slides, 45 mins)**

## **Part IV: Popular TSF Libraries[ (Demo, 30 minutes)**

- Statsmodels library
- Prophet Library

## **Conclusion and Discussions (3/4 slides, 10 minutes)**

### **Presenter:**

#### **Sandhya Singh**

*Project Staff, CFILT, IIT Bombay*

Sandhya Singh has submitted her PhD thesis at Banasthali Vidyapith, Rajasthan in July, 2019. She is currently associated with CFILT lab, IITB and is working on a project involving time series forecasting. She has published papers on machine translation and natural language generation.

#### **Kevin Patel**

*PhD Scholar, Dept of Computer Science & Engineering, IIT Bombay.*

Kevin Patel is a PhD student at IIT Bombay, since July 2014. He is investigating different aspects of word embeddings and the role they play in deep learning for NLP. He has published papers on both theory and applications of deep learning and word embeddings at various top NLP conferences such as **ACL**, **EMNLP**, **IJCNLP**, **COLING** and **GWC**. He is currently

investigating how to explain the decisions made by deep neural networks for NLP, and what role do word embeddings play in this explainability. He has also delivered tutorials on deep learning in the past at **ICON'15**, **ICON'17** and **ICON'18**. His home page is at the following url: <https://www.cse.iitb.ac.in/~kevin.patel/>

All the above are guided by:

**Dr. Pushpak Bhattacharyya, FNAE**

Director and Professor of Computer Sc and Engg, IIT Patna

Professor on Lien, CSE Department IIT Bombay

Distinguished Alumnus, IIT Kharagpur.

Ex-President Association for Computational Linguistics

Ex-Vijay and Sita Vashee Chair Professor, CSE Dept., IIT Bombay.

<http://www.cse.iitb.ac.in/~pb>

**References:**

1. Hyndman, R.J., & Athanasopoulos, G. (2018) Forecasting: principles and practice, 2nd edition, OTexts: Melbourne, Australia.
2. Hamilton, James Douglas. *Time series analysis*. Vol. 2. Princeton, NJ: Princeton university press, 1994.
3. Chatfield, Chris. *The analysis of time series: an introduction*. Chapman and Hall/CRC, 2003.
4. Chen, Y., Keogh, E., Hu, B., Begum, N., Bagnall, A., Mueen, A., Batista, G.: The ucr time series classification archive (July 2015)
5. Guokun Lai, Wei-Cheng Chang, Yiming Yang, and Hanxiao Liu. 2018. Modeling Long- and Short-Term Temporal Patterns with Deep Neural Networks. In *The 41st International ACM SIGIR Conference on Research & Development in Information Retrieval* (SIGIR '18). ACM, New York, NY, USA, 95-104.
6. O'Connor, Brendan, et al. "From tweets to polls: Linking text sentiment to public opinion time series." *Fourth International AAAI Conference on Weblogs and Social Media*. 2010.
7. Grover, A., Kapoor, A., Horvitz, E.: A deep hybrid model for weather forecasting. In: Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. pp. 379-386. ACM (2015)
8. Taylor SJ, Letham B. 2017. Forecasting at scale. PeerJ Preprints 5:e3190v2 <https://doi.org/10.7287/peerj.preprints.3190v2>
9. Li Y, Yu R, Shahabi C, Liu Y. Diffusion convolutional recurrent neural network: Data-driven traffic forecasting. arXiv preprint arXiv:1707.01926. 2017 Jul 6.
10. Shih, S.Y., Sun, F.K. and Lee, H.Y., 2018. Temporal Pattern Attention for Multivariate Time Series Forecasting. *arXiv preprint arXiv:1809.04206*.
11. Bao W, Yue J, Rao Y (2017) A deep learning framework for financial time series using stacked autoencoders and long-short term memory. PLoS ONE 12(7)
12. Bohdan Pavlyshenko. Using Stacking Approaches for Machine Learning Models. In Proceedings of the 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP), Lviv, Ukraine, 21–25 August 2018.