Role: Research Engineer – Intern

Your future role

Alstom data science & AI department is looking for a research intern for its predictive maintenance activities. The intern will contribute to developing advanced machine learning models and data-driven solutions aimed at improving the reliability and efficiency of railway systems.

Predictive maintenance is a data-driven approach that uses real-time monitoring and analytics to predict equipment failures before they occur, enabling timely and cost-effective maintenance for railway assets such as point machines and track circuits. Multiple predictive models exist, including recent deep learning predictive maintenance models [1], but the latter often lack statistical guarantees, which are key for safe deployment in railway systems.

The main research topic of the internship will be uncertainty quantification (UQ) for time series, with an emphasis on developing novel algorithms with rigorous UQ estimates. Conformal prediction [2] is a promising set of techniques, since they provide statistically valid UQ estimates at a low computational cost and with little to no assumptions on the underlying predictive model. However, their application to time series is challenging, since the classical exchangeability (e.g., i.i.d.) assumption is typically violated. Recent papers addressed this issue, either by studying the effect of distributions shifts [3] or by working with various types of time series [4,5,6,7]. The intern (then PhD candidate) will establish a state of the art of such methods, and then design new algorithms suited for predictive maintenance activities (e.g., for point machines and track circuits), analyze their theoretical properties, and evaluate their practical performances on industrially relevant data. Both public and private datasets of railway equipment with failures will be available for the research activities.

To foster the use of Trustworthy AI algorithms, Alstom recently entered the DEEL (Dependable, Explainable, and Embeddable Learning) project, led by the IRT Saint Exupéry and ANITI (Artificial and Natural Intelligence Toulouse Institute). The project involves academic and industrial partners in the development of dependable, robust, explainable and certifiable artificial intelligence technological bricks applied to critical systems.

The internship will be a direct collaboration with our partners (IRT Saint Exupéry and ANITI), with a professor from the research lab co-supervising it. The goal is to conclude the internship by the start of a CIFRE PhD lasting 3 years on uncertainty quantification for time series. The successful candidate will be encouraged to publish their results in international venues, to participate to the DEEL open-source library PUNCC [8], and to contribute to knowledge sharing on uncertainty quantification within the ALSTOM company.

MANDATORY:

- Last-year student in a Master of Science or Engineering degree
- Expert knowledge of Python and PyTorch/TensorFlow
- Strong mathematical background. Knowledge of fundamentals in modern statistics, including time series, signal processing, and machine learning theory.
- Experience with machine learning algorithms tuning and validation

- Data visualization
- Experience with LINUX environment (shell scripting) and modern development stack (git, agile methodologies)

IDEAL CANDIDATE

- Technical person, problem solver with good communication skills, research oriented
- Proven track record for designing stable solution, testing and debugging
- Passionate about AI/ML, with a motivation to advance the state of the art of algorithms
- Willing to pursue a PhD with a CIFRE contract in the DEEL project
- Fluent English. French is a plus.

References

[1] W. Li and T. Li. Comparison of deep learning models for predictive maintenance in industrial manufacturing systems using sensor data. Scientific Reports, 15:23545, 2025.

[2] A. Angelopoulos, S. Bates. Conformal Prediction: A Gentle Introduction. Foundations and Trends® in Machine Learning, 16, 494-591, 2023.

[3] R.F. Barber, E.J. Candès, A. Ramdas, R.J. Tibshirani. Conformal prediction beyond exchangeability. The Annals of Statistics, 51, 816-845 , 2023.

[4] I. Gibbs, E.J. Candès. Conformal inference for online prediction with arbitrary distribution shifts. Journal of Machine Learning Research, 25, 1-36, 2024.

[5] M. Zaffran, O. Feron, Y. Goude, J. Josse, and A. Dieuleveut. Adaptive Conformal Predictions for Time Series. ICML 2022.

[6] C. Xu and Y. Xie. Conformal Prediction for Time Series. IEEE Transactions on Pattern Analysis and Machine Intelligence, 45, 11575-11587, 2023.

[7] F. Schlembach, E. Smirnov, I. Koprinska, and M. H. M. Winands. Conformal multistep-ahead multivariate time-series forecasting. Machine Learning, 114, 165, 2025.

[8] DEEL program. PUNCC: a conformal prediction library. https://github.com/deel-ai/puncc