

Multiclass classification for multivariate Hawkes processes

Keywords: Supervised classification, Hawkes processes, LASSO, Machine learning

Context: Multiclass classification is one of the most studied statistical framework, arising in many fields which range from medical applications to social studies. However, a major challenge is to provide learning algorithms tailored for temporal data. The aim of the internship is to study the multiclass problem where the features are events sequences. In social network monitoring it could be tweets sequences for example. In neuroscience, such data can consist of recorded spike trains on several neurons from different populations. In this context, the data are assumed to come from a mixture of Hawkes processes. Hawkes processes, originally introduced by [1], are used to model sequences where past events influence or trigger future events.

Objectives: A preliminary work of [2] studies a classification algorithm in the case where we consider univariate Hawkes processes. One of the challenge of the internship is to extend the procedure to the case of multivariate Hawkes processes. This model can be seen as a graph classification problem when the multivariate Hawkes process is interpreted as a connectivity graph. This generalization relies on high-dimensional statistical techniques, such as LASSO type procedure [3], and stochastic calculus tools. The implementation of the procedure will be an important part of the internship. More precisely, the objectives of the internship are to

1. implement the classification procedure in `Python`,
2. study its numerical and theoretical properties,
3. compare the procedure with other algorithms such as recurrent neural networks (LSTM).

Supervisors: Christophe Denis (LAMA, Université Gustave Eiffel), Charlotte Dion-Blanc (LPSM, Sorbonne Université), Laure Sansonnet (UMR MIA-Paris, AgroParisTech, INRAE, Université Paris-Saclay)

Required skills: M2 level trainee in statistics/machine learning/optimization. Python programming. Applicants should send a CV and transcripts of the last two years to christophe.denis@u-pem.fr, charlotte.dion_blanc@sorbonne-universite.fr, laure.sansonnet@agroparistech.fr

Practical informations:

- Date: April-September 2022
- Location: LPSM, Sorbonne Université
- Gratification: around 550 euros net per month

References

- [1] Hawkes, A. Spectra of some self-exciting and mutually exciting point processes. *Biometrika*, 1971.
- [2] Denis, C., Dion-Blanc, C., and Sansonnet, L. Multiclass classification for Hawkes processes, 2021.
- [3] Bacry, E., Bompain, M., Gaïffas, S., and Muzzy, J-F. Sparse and low-rank multivariate hawkes processes. *JMLR*, 2020.