Neural networks and statistical learning for spatio-temporal data analysis

Master 2 Internship Proposal
Supervision: Radu S. Stoica (IECL) and Frédéric Sur (Loria)

1 Description

The aim of this internship is to study inference methods for spatio-temporal point processes able to characterize spatio-temporal data. Point processes are a probabilistic tool able to manage random configurations of points having random characteristics. Interactions among points can be introduced via Gibbs point processes [13, 7, 2]. Hawkes point processes may be also considered, since they were built in order to manage self-exciting processes [8, 9, 4, 5, 6].

The aim of this internship is to propose and to compare classical and modern learning tools for fitting spatio-temporal processes to data.

Classical learning algorithms are built using a typical probabilistic framework: modelling, simulation and statistical inference. The work during this internship will be done step-by-step. First, one dimensional data will be considered, and model (Hawkes processes) will be studied, simulated and fitted to real data. Second, novel procedures based on neural networks will be investigated. A very recent paper [11] models temporal point processes through recurrent neural networks. Software code is also publicly available [10]. The results will be tested and compared in order to assess the quality of both approaches.

The next step of the internship is to extend the previous approach to spatial data. The simulation of the proposed process should be able to deal with edge effects [4, 5]. Exploratory analysis should indicate what kind of interactions between points the data indicate [6]. The posterior distributions of the fitted model parameters are the targeted features able to characterize the seismic activity of each considered region [12]. In parallel to this last
step, a verification of the model may be required [3, 1, 2]. Regarding the approach based on neural networks, the extension to the spatial case requires to adapt the architecture of the networks. An extension to marked point process may be considered as well.

The aimed application domains are: astronomy, geology and image analysis.

2 Prerequisites and Funding

The interested candidate should have a M1 level in mathematics or applied mathematics and prepare her/his M2 degree. A strong interest for machine learning and neural networks is required. Engineering students with a thorough level in mathematics are also very welcome. The motivation of the student to continue with a PhD will also be considered. The internship provides also a grant (around 550 euros per month w.r.t. French rules). The internship duration is 6 months, and it may start anytime between February and April 2021.

3 Place

The internship will take place in Nancy at the Institut Elie Cartan de Lorraine. The successful applicant will also interact with members of the Inria research teams Pasta and Magrit.

4 Supervision

Radu S. Stoica
Professor
Université de Lorraine - IECL/Inria Pasta
radu-stefan.stoica@univ-lorraine.fr

Frédéric Sur
Professor
Université de Lorraine - LORIA/Inria Magrit
frederic.sur@univ-lorraine.fr
References


