Consortium Industrie Recherche pour l'Optimisation et la QUantification d'incertitude pour les données Onéreuses

POST-DOCTORAL PROPOSAL

Metamodels on non-Euclidean spaces

Partner: Institut de Mathématiques de Toulouse

The kernel regression method is widely used since it fits well within the frame of Bayesian formalism to provide a model for uncertainty quantification. The method is most often deployed in an Euclidean framework, i.e. the space of input variables is R^d with its natural metric. The main underlying mathematical object is then a kernel of positive type over this space. The objective of the post-doct is the study of extensions of positive type kernels to non-Euclidean structures, such as trees, graphs, Riemanian manifolds (sphere, Grassmanian, etc.), finite Fock spaces, etc.
The post-doc will be driven by a cyclone application provided by the partner BRGM of CIROQUO. In this application, the aim is to predict the maximal wave height observed at some location, given the cyclone trajectory as input. We wish to investigate the performance of a non-Euclidean approach, against standard ones. Since it is almost intractable to compute geodesics or other geometric values on the Banach manifold of trajectories, we will focus on a graph representation based on the already available sampled data. The work may be organized as follows :

- state-of-the-art study
- construction of graphs capturing the main characteristics of the trajectory
- construction of adapted kernels on graphs, e.g. based on Laplacians
- application to the cyclone case study

The outcome of this research will lead to a publication in an applied mathematics journal. Depending on the time available, other kind of data provided by partners of CIROQUO may be considered.

Note that the post-doctoral work will take place in the framework of the CIROQUO consortium.

Contacts

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Practical information

- Location : Institut Mathématiques de Toulouse.
- Starting date : from September 2022 (flexible).
- Duration : 1 year
- Net salary : minimum 2120 euros / per month (depends on experience).

Requested skills

PhD in applied mathematics or machine learning. Programming skills in R or Python.

Références

Das, K. C. (2004). The Laplacian spectrum of a graph. Computers & Mathematics with Applications, 48(5-6), 715-724.

Jones, P. W., Maggioni, M., & Schul, R. (2008). Manifold parametrizations by eigenfunctions of the Laplacian and heat kernels. Proceedings of the National Academy of Sciences, 105(6), 1803-1808.

Kondor, R. and Pan, H. (2016). The multiscale Laplacian graph kernel. Advances in Neural Information Processing Systems, 29.

Kriege, N. M., Johansson, F., and Morris, C. (2020). A survey on graph kernels. Applied Network Science, 5(1):1–42.

Rohmer, J., Roustant, O., Lecacheux, S., and Manceau, J.-C. (2022). Revealing the interlevel dependence structure of categorical inputs in numerical environmental simulations with kernel model selection. Environmental Modelling & Software, 151:105380.