Post-doctoral position on causal reasoning for time series

Objectives Datasets structured as time series are available in many applications: provided by FMRI to study brain activity, summarizing the monitoring activity to detect IT anomalies, to name just a few of applications. However, as with any machine learning study, it is important to take into account the intrinsic causal structure to improve the decision as causal relations are crucial to predict the evolution of a system. If there have been several works dedicated to inferring causal graphs between time series (as [5]), few studies have been dedicated to causal *reasoning* and to the identification problem, which consists in computing, from data observed without any intervention, the probability of occurrences of events conditioned with variables forced to specific values.

[2] for example derived conditions of indeitification, comparable to the back-door and front-door criteria, from which they proposed a method to compute causal effects. However, their development concerns Granger causality [3], which does not correspond to true causal relations. More recently, [1] revisited Pearl's original proposal [4] and developed algorithms for complete identification of Dynamic Causal Networks (DCNs) with hidden variables. However, the DCNs they consider are not entirely general. The objectives of this post-doctoral project is to fully address the identification problem in the context of time series, and develop in this same context appropriate counterfactual reasoning procedures.

Context This project fits within the Grenoble Computer Science Lab (called LIG, http://www.liglab.fr/en) and the Interdisciplinary Institute in Artificial Intelligence MIAI@Grenoble Alpes (https://miai.univ-grenoble-alpes.fr/). MIAI@Grenoble Alpes is one of the four AI Institutes created by the French government to accelerate R&D, teaching and innovation in AI in France.

To apply Interested candidates should send a complete CV with a list of publications and two reference letters to Emilie Devijver (emilie.devijver@univ-grenoble-alpes.fr) and Eric Gaussier (eric.gaussier@univ-grenoble-alpes.fr). Candidates should be pursuing internationally recognized research in ML/AI, with a strong interest in causal inference and causal reasoning.

Starting date and duration The postdoc is intended for 2 years, starting as soon as possible and no later than June 2021.

Location The work should take place on the University Campus in Grenoble, France.

References

[1] G. Blondel, M. Arias, and R. Gavaldà. Identifiability and transportability in dynamic causal networks. *Int J Data Sci Anal*, 3:131–147, 2017.

[2] M. Eichler and V. Didelez. Causal reasoning in graphical time series models. In *Proceedings of the Twenty-Third Conference on Uncertainty in Artificial Intelligence*, UAI'07, page 109–116, Arlington, Virginia, USA, 2007. AUAI Press.

[3] C. Granger. Some recent development in a concept of causality. *Journal of Econometrics*, 39(1-2):199–211, 1988.

[4] J. Pearl. Causal diagrams for empirical research. *Biometrika*, 82(4):669–688, 12 1995.

[5] J. Runge, P. Nowack, M. Kretschmer, S. Flaxman, and D. Sejdinovic. Detecting and quantifying causal associations in large nonlinear time series datasets. *Science Advances*, 5(11), 2019.