Title: Graph Neural Networks with Attention to Understand the Colonization of Mosquito Larval Habitats According to their Biotic and Abiotic Characteristics.

Duration: 5 or 6 months
Supervision:
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The ANR project SERIOUS, started in October 2022, proposes to analyze the relationship between urban environment and the transmission of viruses by mosquitoes [1].
The objective of the research internship is to develop a method based on GAT (Graph ATtention Network) to better understand the conditional dependences between some measured characteristics of water in natural urban reservoirs, and the absence or presence of mosquito larvae in those reservoirs.

As part of this project and previous ones, data were collected in the Lyon metropolis, and are already available. The objective is to extract the causal relationship between those variables, e.g., T° might influence the presence of bacteria *b*, *b* can be correlated with the presence of mosquito larvae, but T° also influence the presence of larvae. The objective is to understand how each of these variables influence each other, simultaneously, thus forming a causal relationship graph.

The objectives of the internship are:
1)To become familiar with the data and the problem, in interaction with the microbiologists.
2) Use classic methods to infer a graph of conditional dependences between variables: Graphical Model Inference [2], frequent pattern discovery [3], Backbone Extraction [4].
3) Propose a new method based on GAT to infer the conditional dependency graph. Previous methods using GNN in that direction have been proposed [5,6], but not using the more recent GAT architecture.

Student profile:
Master in computer science(IA, ML, data science...), Complex Sytems or Applied Statistics, with an interest in interdisciplinarity.

References
[1] Duval, P., Antonelli, P., Aschan-Leygonie, C., Valiente Moro, C. (2023). Impact of Human Activities on Disease-Spreading Mosquitoes in Urban Areas. *Journal of Urban Health*. 100(3):591-611.
[2]https://en.wikipedia.org/wiki/Graphical_model
[3]https://en.wikipedia.org/wiki/Frequent_pattern_discovery
[4]Serrano, M. Á., Boguná, M., & Vespignani, A. (2009). Extracting the multiscale backbone of complex weighted networks. *Proceedings of the national academy of sciences*, *106*(16), 6483-6488.
[5]Schölkopf, B., Locatello, F., Bauer, S., Ke, N. R., Kalchbrenner, N., Goyal, A., & Bengio, Y. (2021). Toward causal representation learning. *Proceedings of the IEEE*, *109*(5), 612-634.
[6}Kipf, T., Fetaya, E., Wang, K. C., Welling, M., & Zemel, R. (2018, July). Neural relational inference for interacting systems. In *International conference on machine learning* (pp. 2688-2697). PMLR.