

## Internship

### Fairness in Machine Learning on Graphs

#### Context

Fairness is a major ingredient for Safe and Trustworthy Artificial Intelligence (AI). It is central to have fair Machine Learning (ML) models in any AI system in major application areas, and it is even more crucial in medicine. Within this context, the ANR project FAMOUS aims to address fairness in Machine Learning with multimodality. This project brings forth experts in Machine Learning and Neuroscientists from 4 major research institutes in France and a company: *Laboratoire d'Informatique et Systèmes* (Marseille), *Institut des Neurosciences de la Timone* (Marseille), *Laboratoire Hubert Curien* (Saint Etienne), *LITIS Lab* (Rouen) and *Euranova* (R&D division in France). Within this environment, we are offering this Master's internship in the LITIS Lab at the INSA Rouen Normandy, with the possibility to pursue a PhD thesis.

#### Internship Description

Unfairness starts from the existence of biases in the datasets used to learn ML models. The main advances in deep learning in ML are due to learning an embedding of data in a latent space that is appropriate for the given task at hand. Thus, the performance of the ML model highly depends on the investigated embedding, and so does its fairness.

Dealing with graph data is more complex than Euclidean data due to their structure. This internship considers the problem of learning from a set of graph data – multiple graphs – (as opposed to graph mining of a single large-scale graph, e.g. social network). Since an explicit embedding of graphs into a Euclidean space suffers from information loss and restricted precision, graph embedding will be considered with graph neural networks (GNNs) [1, 2].

The internship aims to study bias-free embedding with GNNs. Within the last few years, there has been an increased interest in fairness-promoting graph embedding methods, mainly for node embedding in network mining with applications on social networks [3, 4, 5], and more recently using GNNs as black boxes [6]. Within this internship, the intern will explore this research direction of bias-free GNNs. She/he will investigate relevant methods and devise the appropriate algorithms to address datasets of MRI of the brain. It is worth noting that graph representations have demonstrated their relevance for characterizing MRI of the human brain, such as for the analysis of the brain activity and of its cortical folding. This application will be conducted within a narrow collaboration with the *Institut des Neurosciences de la Timone*.

The objectives of the internship are as following:

- 1- Familiarize herself/himself with fairness in GNNs.
- 2- Explore the most relevant methods on well-known graph datasets.
- 3- Devise appropriate method for the MRI application at hand.
- 4- Gain hands-on with graphs constructed from brain MRI datasets.

These objectives will allow to lay the groundwork for advanced research in a subsequent PhD.



## Research Environment

This intern will conduct her/his research within the Machine Learning group in the LITIS Lab, under the supervision of Dr. Benoît Gaüzère and Prof. Paul Honeine. This internship will be conducted within the research project FAMOUS, and within a strong collaboration with the *Institut des Neurosciences de la Timone*.

## Applicant Profile

- Student in final year of Master or Engineering School, in applied mathematics, data science, artificial intelligence, or related fields
- Strong skills in data analysis and Machine Learning
- Good programming skills in Python and the scientific ecosystem numpy/pytorch
- Interest in neuroscience and/or ML fairness

## Duration and Location

- The internship will last 5 to 6 months, starting from February or March 2024.
- It will be located at INSA Rouen Normandie, within the ML team of LITIS lab, France.

## Application

Interested candidates are invited to send by email a CV, a cover letter expressing their interest and background in the subject, and academic transcripts. Reference letters may also be beneficial.

## Contacts

Benoit Gaüzère : [benoit.gauzere@insa-rouen.fr](mailto:benoit.gauzere@insa-rouen.fr)

Paul Honeine : [paul.honeine@univ-rouen.fr](mailto:paul.honeine@univ-rouen.fr)

## References

- [1] M. Balcilar, G. Renton, P. Héroux, B. Gaüzère, S. Adam, and P. Honeine. “Analyzing the Expressive Power of Graph Neural Networks in a Spectral Perspective”. In: ICLR. 2021.
- [2] M. Balcilar, G. Renton, P. Héroux, B. Gaüzère, S. Adam, and P. Honeine. “When Spectral Domain Meets Spatial Domain in Graph Neural Networks”. In: ICML - Workshop on Graph Representation Learning and Beyond. 2020.
- [3] A. Bose and W. Hamilton. “Compositional fairness constraints for graph embeddings”. In: *ICML*. 2019.
- [4] J. Kang, J. He, R. Maciejewski, and H. Tong. “Inform: Individual fairness on graph mining”. In: ACM SIGKDD Int. Conf. Knowl. 2020.
- [5] J. Palowitch and B. Perozzi. “Debiasing Graph Representations via Metadata-Orthogonal Training”. In: IEEE/ACM ASONAM. 2020.
- [6] E. Dai and S. Wang. “Say No to the Discrimination: Learning Fair Graph Neural Networks with Limited Sensitive Attribute Information”. In: WSDM. 2021.