PhD position: Machine Learning and Neural Encoding of Naturalistic Auditory Scenes

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NeuroMod, Université de Montréal, Montréal, Canada

1 Summary

Goals To model the perception of complex natural auditory stimuli using signals on dynamic brain graphs, and deep learning.

Research areas Artificial Intelligence, Deep Learning, Auditory Cognitive Neuroscience

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Director Prof. Michel Jezequel (IMT Atlantique)

Start date Autumn 2019

Institution PhD degree from both IMT Atlantique (Brest, France), and Université de Montréal (Montréal, Canada)

Deadline June 20th 2019

2 Research project

The project aims to model natural auditory perception using artificial neural networks and graph signal processing, applied to human functional magnetic resonance imaging (fMRI) and electroencephalograph (EEG) data. Recent advances in artificial intelligence are largely due to the outstanding performance obtained by deep neural networks on the classification of composite natural stimuli. Deep learning however still faces important challenges with natural auditory perception [1], in particular in complex, noisy scenes involving several simultaneous sources. This thesis will use human neuroimaging data to improve the ability of artificial networks to classify natural auditory stimuli.

Recent works have demonstrated the feasibility of building artificial models to link computational musical features with brain activity [2]. Such models perform as well as human listeners on both music, and simple speech discrimination tasks [3]. The internal layers of the deep networks have also been used to predict brain activity related to natural sounds, by modeling each individual voxel of fMRI activity using combinations of feature maps [3]. We propose to investigate extensions of the current approaches to consider graph convolutional networks [4], signal processing on graphs [5], and to model temporal signals on dynamic graphs [6]. We will build a series of artificial models, using extensive recordings of EEG/fMRI brain activity acquired from participants performing auditory tasks of increasing complexity.

3 Supervision and funding

This PhD project is a collaboration between the laboratories of Dr. Nicolas Farrugia and Dr Vincent Gripon (Brain Inspired Artificial Intelligence Project, at IMT Atlantique, Brest, France), and the lab of Dr. Pierre Bellec (NeuroMod - Courtois Project on Neuronal Modelling - CRIUGM, Department of Computer Science and Operational Research, Université de Montréal, Montréal, Qc, Canada). The candidate will be expected to share their time between Montreal and Brest.

IMT Atlantique is a public technological university focusing on the training of engineers at the MSc. level and junior researchers at the PhD level. Université de Montréal is a world-renowned institution, training elite scientist, and is currently one of the main hubs for artificial intelligence and neuroinformatics research in North America.

4 Candidate profile

- Master's degree in machine learning or computer science or biomedical imaging or signal / image processing or auditory perception / psychoacoustics, or Neurosciences.
- Basic knowledge of machine learning algorithms
- Solid programming skills
- At least one of: experience in experimental design, research experience in deep learning / machine learning of large datasets, research experience related to auditory or musical perception, laboratory experience in EEG or fMRI testing of human subjects.

5 How to apply

Send an email to `nicolas.farrugia@imt-atlantique.fr` and `pierre.bellec@criugm.qc.ca` with the following:

- a full curriculum vitæ
- recommendation letters or contacts from former teachers/advisors
- a cover letter stating your motivation and fit for this project

- Full university transcripts

Deadline for applications is June 20th 2019

References

[1] J. F. Gemmeke, D. P. Ellis, D. Freedman, A. Jansen, W. Lawrence, R. C. Moore, M. Plakal, and M. Ritter, "Audio set: An ontology and human-labeled dataset for audio events," in *Acoustics, Speech and Signal Processing (ICASSP), 2017 IEEE International Conference on*. IEEE, 2017, pp. 776–780.

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