SECTOR: Higher Education Institution

LOCATION: France, Grenoble

RESEARCHER PROFILE:

□ First stage researcher,

INSTITUTION: Univ. Grenoble Alpes, University of Innovation

One of the major research-intensive French universities, Univ. Grenoble Alpes\(^1\) enjoys an international reputation in many scientific fields, as confirmed by international rankings. It benefits from the implementation of major European instruments (ESRF, ILL, EMBL, IRAM, EMFL*). The dynamic ecosystem, grounded on a close interaction between research, education and companies, has earned Grenoble to be ranked as the 5th most innovative city in the world. Surrounded by mountains, the campus benefits from a natural environment and a high quality of life and work environment. With 7000 foreign students and the annual visit of more than 8000 researchers from all over the world, Univ. Grenoble Alps is an internationally engaged university.

A personalized Welcome Center for international students, PhDs and researchers facilitates your arrival and installation.

In 2016, Univ. Grenoble Alpes was labeled «Initiative of Excellence ». This label aims at the emergence of around ten French world class research universities. By joining Univ. Grenoble Alpes, you have the opportunity to conduct world-class research, and to contribute to the social and economic challenges of the 21st century ("sustainable planet and society", "health, well-being and technology", "understanding and supporting innovation: culture, technology, organizations" "Digital technology").

* ESRF (European Synchrotron Radiation Facility), ILL (Institut Laue-Langevin), IRAM (International Institute for Radio Astronomy), EMBL (European Molecular Biology Laboratory), EMFL (European Magnetic Field Laboratory)

Key figures:

- + 50,000 students including 7,000 international students
- 3,700 PhD students, 45% international
- 5,500 faculty members
- 180 different nationalities
- 1st city in France where it feels good to study and 5th city where it feels good to work
- ISSO: International Students & Scholars Office affiliated to EURAXESS

\(^1\) https://edu.univ-grenoble-alpes.fr/en/
Deep learning, a branch of Artificial Intelligence, is now successfully used for solving a wide range of problems and is considered as a true revolution in computing. It is a game changer in many application areas, from the Transport and Health domains, to the Industry one. However, as good as it is, deep learning is not free from issues of its own. It is compute- and memory-intensive: it requires very large data centers for the learning phase and is thus responsible, in part, for the growth of the Cloud CO2 emissions. This scheme being unsustainable in the long run, there is a clear trend right now for embedding AI capabilities closer to edge and endpoint devices. This is referred to as AI-Edge computing.

Spiking Neural Networks (SNN) are the third generation of neural networks. They are more bioinspired (i.e. handling spikes) and are usually considered as more energy efficient than their classical-coded counterparts. The energy gain comes from (1) the lightness of the base operation (accumulation, instead of multiplication-accumulation as in classical coding) and (2) the activity sparsity thanks to the spike coding. The other advantage of SNNs is that they can exploit information in the Temporal Domain, as well as information contained in the Spatial Domain, while classical-coded neural networks can only exploit the latter one. SNNs are thus considered as good candidates for future Edge AI implementations, exploiting spatial and temporal information from various sensors.

However, although SNNs can exploit rich temporal dynamics, this advantage is only theoretical: it cannot be exploited to its full potential, since efficient spatio-temporal learning algorithms are currently lacking (in much the same way as the Gradient Descent algorithm was lacking to conventional neural networks, before its invention in the 1980s). Such algorithms are needed for exploiting deep SNNs, which are mandatory to compete with the deep topologies of classical-coded networks.

The aim of this PhD thesis subject is to develop learning algorithms for SNNs that can exploit spatio-temporal correlations in a supervised or unsupervised manner. Unsupervised learning will be used for learning time series, such those coming from vibrations or sounds, while supervised learning will be used for classification purposes.

The PhD candidate will be immersed in a dynamic research environment and will integrate a multi-disciplinary team of machine learners, circuit designers and technologists, working on Industrial, Health and Automotive Edge AI applications. He/She will have access to state-of-the-art research facilities, meaning access to large computing power for running experimentations, to databases and to large collections of publications. He/She will also benefit from a Europe-wide network of recognized researchers.

This PhD thesis will be complemented, in the foreseeable future, by another one dealing with architecture and circuit design. Its goal will be to implement an SNN hardware accelerator, leveraging the learning algorithms developed during the course of this thesis.

The research work will consist in:
· Doing a comprehensive analysis of the state of the art algorithms and methods: Spatio-Temporal Back-Propagation, Spike timing dependent plasticity (STPD), Reward STPD ...
· Proposing efficient implementations of online unsupervised and supervised learning algorithms. This will imply working on the neuron model, the derivation issue, the learning rules ... This will have to be grounded in sound mathematical analyses and formulas
· Working on algorithms and models for both feedforward and recurrent SNN topologies (getting inspiration from the LSTM model and Back-Propagation Through Time)
· Implementing the models and algorithms in deep learning frameworks, either in-house or Open Source (this implies being familiar with Python and/or C/C++)
· Adapting the obtained algorithms and models for being efficiently implemented in hardware (reducing the memory footprint and computing power), without compromising too much on the quality of results or learning convergence

Expected skills

Technical: Embedded System Design and Validation (design, System level and HDL modeling languages, CAD tools), Python/C/C++ and scripting, Signal Processing.
Knowledge about system level and digital front-end design and validation, assembly language, machine learning algorithms, data science, etc.

Personal: Determination, perseverance, trustworthiness, autonomy, adaptability, initiative, good communication skills

Languages: English: at least B2 equivalent, excellent reading and writing level, good speaking level. Fluency in French is a plus but it is not mandatory.

ELIGIBILITY CRITERIA
Applicants must hold a Master's degree (or be about to earn one) or have a university degree equivalent to a European Master's (5-year duration).

Applicants will have to send an application letter in English and attach:
- Their last diploma and transcript of last 2 years scores.
- Their CV focusing on the technical topics developed and implemented in projects and labs
- A short presentation of their scientific project (2 to 3 pages max)
- Letters of recommendation are welcome.

Address to send application: alexandre.valentian@cea.fr; lorena.anghel@grenoble-inp.fr