

## Junior Professor Chair

**Supporting institution/organization:** Université de Pau et des Pays de l'Adour (UPPA)

Nom du chef d'établissement/d'organisme : Laurent Bordes

Site concerné : Campus de Pau

Région académique : Aquitaine

**Partner institutions/organizations:** Inria

**Name of the project :** Green AI - Pau

**Keywords:** *Low power artificial intelligence*

**Contract duration:** 5 ans

**Scientific thematic:** Frugal methods for deep learning

**Section (s) CNU/CoNRS/CSS correspondante (s) :** sections CNU 26 et 27

### **Establishment strategy :**

In 2017, the I-site E2S UPPA label of excellence, led by the UPPA-INRAE-Inria-CNRS consortium, provided a decisive impetus to UPPA's research activities, which have evolved towards issues associated with energy and environmental transitions. Based on this dynamic, the ambition of UPPA for the future 2030 strategy, is, with the support of its academic and socio-economic partners, to build a multidisciplinary university visible at the national and international level in the sectors of excellence that contribute to the university renown, including the Laboratory of Mathematics and Applications of Pau (LMAP).

At the same time, UPPA and its partners want to create favorable conditions for the emergence of new original themes such as low-consumption artificial intelligence. This objective is based on the niches of excellence developed within the research units and on the university's ability to develop original and solid partnership relations, as evidenced by the deployment of 25 partnership chairs, 8 joint laboratories, and the coordination of the Carnot Institute ISIFOR. This theme is also perfectly in line with the UPPA's objective of social responsibility, with a desire for research to provide answers to societal issues.

### **Description of the Laboratory :**

LMAP brings together the entire mathematical community of UPPA, i.e. 54 researchers and teacher-researchers, on two sites: Pau and Anglet. Its themes are mainly related to applied mathematics:

- Mathematical analysis: analysis of deterministic or stochastic partial differential equations, optimisation, dynamic systems, mathematical modelling,
- Numerical analysis and simulation: discretization methods for PDEs, approximation, inverse problems, scientific computing and high-performance computing,
- Probability and statistics: stochastic modelling, probabilistic analysis, statistical data processing, big data, artificial intelligence, semi-parametric and non-parametric inference.

The fields of application mainly concern geo-resources, aerothermodynamics, the environment, health, operating safety and structural optimisation.

In addition, LMAP has skills in fundamental mathematics: projective algebraic geometry, low-dimensional topology. As multidisciplinary research is at the heart of LMAP's activity, we also have skills in fluid mechanics and heat.

Benefiting from a particularly favourable industrial fabric in the fields of petroleum engineering and aerothermodynamics, LMAP is developing a strong industrial partnership with both multinational companies and local SMEs.

#### **Summary of the research project :**

The target of the Chair is to yield AI learning algorithms having controlled energy cost. The key challenge is to reduce computational cost. From an algorithmic point of view, this project consists of developing alternatives to current deep learning methods. These methods are commonly based on the synchronised optimisation of a very large number of parameters by gradient descent, known to be very computationally intensive. There are several ways to improve energy efficiency: within training strategies, in inference methods (e.g. PAC-Bayesian approach), in algorithms that leverage learning data, etc.

The recruited person will have experience in implementing methods that are efficient in terms of computational costs in a deep learning context. The algorithms obtained in this Chair will be implemented, tested and developed on e.g. low-power and embedded computing platforms (edge computing). The results of his findings will be the object of a technology transfer and partnerships with the socio-economic world, and will bridge the partnership activity in Green AI already present at LMAP.

The Chair will also be part of the Regional AI Research Network (R3IA), coordinated by Inria, which will allow the Chairholder to regularly exchange with colleagues in the field from all regional ESR institutions. This project could be carried out in collaboration with the project teams of the Inria Bordeaux Sud-Ouest centre (e.g. Astral, Mnemosyne, Flowers).

#### **Summary of the teaching project :**

The ambition of this chair is to offer training to students to better understand machine/deep learning algorithms, to encourage the reasoned use of these methods, and to train students in low-consumption alternatives.

First of all, the person recruited will be involved in the teaching of statistics around Big Data in the MSID (Statistical Methods and Computer Science for Decision) and Big Data courses, within the Master's degree in Mathematics and Applications, in order to disseminate new skills in deep learning and in the optimisation of lighter neural networks, and to provide original training in low-power machine learning techniques and in the applications of data science to environmental problems. He or she will also participate in the animation of the courses of the GREEN University School of Research for Energy and the Environment concerned with big data and AI skills. In addition, he or she will be involved in undergraduate courses in which big data techniques are increasingly present.

Finally, the person recruited will provide scientific mediation activities for the general public and particularly for high school students on the contribution of mathematics to artificial

intelligence algorithms. He or she will also offer training to secondary school teachers (high school and preparatory classes) to make them aware of automatic learning techniques (deep learning, language processing) and low-power alternatives.