Subject:
Design by AI of innovative multi-physical systems integrating smart materials.

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Abstract (up to 10 lines):
The objective of this thesis is to develop a deep learning and multi-criteria optimisation method for multi-physical systems integrating smart active materials. The optimisation algorithm is bioinspired and should be used for the synthesis of mechanical architectures, while deep learning should enable to learn by reinforcement the optimal trajectories of a series of representative tasks. The hybridisation of these two algorithms can be achieved by a sequential and/or synchronous approach, to be studied. The mechanical architecture is of a modular nature, each module reflecting a type of smart material and its properties. The systems thus designed can be physically developed for validation.

Skills:
We are looking for a master's degree student motivated by Artificial Intelligence, innovative materials, active systems. The ideal profile includes a first experience in AI programming.

Keywords:
Deep learning, Bio-inspired multi-criteria optimisation, Smart materials, Multiphysics active systems.
Description (up to 1 page):
AI has been used to perform material modelling [1], structure/mechanism optimisation [2], [3], image analysis [4], automatic programming [5]. The recent evolutions in deep learning reinforce the interaction capabilities of the developed systems with their environment [6]. At the same time, the development of smart active materials reacting to multi-physical stimuli (electricity, magnetic field, pressure, heat, etc.) [7], [8] has led to the design of innovative architectures for these systems [9].

These evolutions make it necessary to develop AI algorithms specifically adapted to the design of multi-physical systems and to the definition of the tasks they enable to perform. The interest is, for example, to obtain a global design approach taking into account, during the same optimisation cycle, the possibilities of physical design and trajectory shape generation for the achievement of the desired tasks. Such an approach would make it possible to preserve the interactions between architectural synthesis and task implementation synthesis during optimisation. The targeted tasks will include follow-the-leader trajectories, where the system must progress along a path without deviating from it, as well as scanning a volume, useful for domestic and medical applications.

The solution will be based on the construction of a hybrid method integrating two algorithms known for their efficiency in multi-criteria optimisation (bio-inspired such as evolutionary algorithm or particle swarm) and learning by reinforcement (neural networks). The nature of hybridisation will be studied during the thesis with determination of the degree of sequential/parallel synchronisation between the two algorithms. The system architectures will be modular, each module considering a type of smart material, its shape, and its physical properties.

Artificial neural networks

Bioinspired optimisation

Innovative design: multiphysics system + task

aggregating candidate solutions
References (up to ½ page):


How to candidate?
Send an email with CV, cover letter, and grades for the available years of study (including the first semester of the current year) to the following addresses: frederic.chapelle@sigma-clermont.fr, yuri.lapusta@sigma-clermont.fr.