Ph.D. research topic

- Title of the proposed PhD topic: Modeling and neuromorphic simulation of learning individuals based on the interaction between behavioral and neuronal activities
- PhD
- Research axis of the 3IA: AI for Computational Biology and Bio-inspired AI
- Supervisor: Alexandre Muzy, CNRS, alexandre.muzy@cnrs.fr
- The laboratory and/or research group: Laboratory I3S (http://i3s.unice.fr/en), Research group MS&N (http://msn.i3s.unice.fr/)

- The description of the topic:

Many electronic companies are currently experimenting new neuromorphic hardware architectures either at chip level (IBM, Intel) or at computer level (SpiNNaker (http://apt.cs.manchester.ac.uk/projects/SpiNNaker/) developed with ARM components). These specific architectures are still under development. Finding the faithful neuromorphic architecture is still a Graal because how (neuronal) components autonomously coordinate together to constitute states at the overall computer level is still mostly unknown. This is due to the intrinsic dynamic nature of the neurocognitive system, which learns to adapt constantly to changing environments. To breakthrough existing neuromorphic architectures, we believe that new fundamental brain-based modeling approaches and corresponding simulator software solutions need to be investigated to catch the learning dynamics of neurocognitive systems. These developments need to be conducted based on new biological experiments because of the exploratory nature of such research. These experiments are achieved in collaboration with IPMC laboratory at Sophia Antipolis and the Laboratoire de Neurosciences Cognitives in Marseille.

The Phd student will develop new learning algorithms able to learn to adapt to the interactions of an individual with its environment (from sensory/actions interactions to possible corresponding neuronal implementations). To achieve this goal, data from biocognitive experiments are used at behavioral and neuronal levels. During the experiments, a rat learns to find the paths leading to rewards (food) in a maze. A hierarchical modeling approach is used to decompose the rat model in behavioral submodels (corresponding to the paths tried in the maze) which are in turn decomposed in corresponding neuronal submodels. Based on both behavioral and neuronal activities, the Activity-based Credit Assignment [ACA] algorithm tries different combination probabilities: of behavioral submodels (based on the probability of taking a path or another) [CogACA] and neuronal models (based on the probability of neurons to fire or not). Reproducing the experimental learning dynamics of the rat at both behavioral and neuronal levels, should answer the question of simulating (cognitive) states in a top down approach (from the behavior to the activity). In a second time, based on this result, the phd student will have to design neuronal simulations able to reproduce the experimental data in a bottom-up...
approach where the neurons auto-coordinate together to constitute (cognitive) states. Spiking models of neurons will be developed using discrete event techniques [HPCS] and the GODDESS (http://msn.i3s.unice.fr/node/10) software library. The simulations will be implemented on SpiNNaker computer present at Université Côte d’Azur (Spiky (http://msn.i3s.unice.fr/node/7)) in cooperation with ARM company. This fundamental approach at modeling and simulation level should open new perspectives for designing new neuromorphic architectures for ARM, based on real biocognitive experiment data.

References

