Colloquium d'Informatique de Sorbonne Université

Nanodevices for Bio-inspired Computing

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Amphi Charpak

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In the last five years, Artificial Intelligence has made striking progress, now defeating humans at subtle strategy games, such as Go, and even Poker. However, these algorithms are running on traditional processors which have a radically different architecture than the biological neural networks they are inspired from. This considerably
slows them down and requires massive amounts of electrical power, more than ten thousand times what the brain typically needs to function. This energy dissipation is not only becoming an environmental issue, but it also sets a limit to the size of neural networks that can be simulated.
We are at a point where we need to rethink the way we compute, and build hardware chips directly inspired from the architecture of the brain.
This is a challenge. Indeed, contrarily to current electronic systems, the brain is a huge parallel network closely entangling memory and processing.
In this talk, I will show that, for building the neuromorphic chips of the future, we will need to emulate functionalities of synapses and neurons at the nanoscale. I will review the recent developments of memristive nano-synapses and oscillating nano-neurons, the physical mechanisms at stake, and the challenges in terms of materials. Finally, I will present the first achievements of neuromorphic computing with novel nanodevices and the fascinating perspectives of this emerging field.

Julie Grollier is a researcher director in the CNRS/Thales lab in France. Her Ph.D. was dedicated to the study of a new effect in spintronics : the spin transfer torque. After two years of post-doc, first in Groningen University (Netherlands, group of B.J. van Wees), then in Institut d'Electronique Fondamentale (France, group of C. Chappert), she joined CNRS in 2005. Her current research interests include spintronics (dynamics of nanomagnets under the spin torque effect), and new devices for cognitive computation (in particular memristors).
Julie has over 100 publications, and is a frequent invited speaker in international conferences. She is also a Fellow of the American Physical Society. In 2010 she was awarded the Jacques Herbrand prize of the French Academy of Science, and in 2018 the Silver Medal of CNRS for her pioneering work on spintronics and brain-inspired computing. She is the recipient of two prestigious European Research Council grants: "NanoBrain" project (Memristive Artificial Synapses and their integration in Neural Networks, 2010-2015) and "BioSPINSpired" project (Bio-inspired Spin-Torque Computing Architectures, 2016-2021).
Julie is now leading the nanodevices for bio-inspired computing team that she initiated in 2009. She is also chair of the interdisciplinary research network GDR BioComp, coordinating national efforts for producing hardware bio-inspired systems.

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