MEMRISTORS AND NOVEL NANO-DEVICES FOR NEUROMORPHIC COMPUTING

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Thanks to the progress in Nanotechnologies and Material Science, physicists and condensed matter scientists have recently been able to build smart nano-devices with enhanced capabilities. Some of these new devices show functionalities that could be extremely interesting for neuromorphic computing. It has been demonstrated for example that some nano-resistors called Memristors can mimic Spike-Timing Dependent Plasticity. Other components, based on different materials, can exhibit stoschastic switching between two conductance states, as observed in biological ionic channels, or even controlled stochastic resonance. What is interesting with these devices, is that they are currently foreseen as the building block of next generation memories, to replace cache and hard drive memories of future digital computers. The industry is already developing dense networks of these nano-devices for classical digital memories. It is therefore no longer a dream to envisage to build on silicon chips large-scale, high density parallel networks of these devices using their full functionalities (STDP, controlled stochasticity...) for neuromorphic computing. What's more, the inherent qualities of massively parallel architectures : the speed, the tolerance to defects and the low power consumption are more and more appreciated these days when computer processors are heating so much that they cannot be used at all times, and when transistors are shrinking so much that they will not be reliable anymore. It is becoming a common thesis that neuromorphic chips will soon enter the market as a back up or accelerator of more traditional computing architectures. While physicists, architecture designers and computer scientists are extremely interested by these nano-devices and the possibilities that they open, it seems that biologists and neuroscientists are only mildly concerned and extremely cautious due to the incomplete understanding of the mechanisms at stake in our brains. They could however play a key role in pointing out the important functionalities that these devices should exhibit, and which connection patterns should be adopted. This presentation will review the recent advances related to these novel nano-devices for neuromorphic computing and explain the perspectives.