Intézeti szeminárium

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Abstract:
The semiconductor industry is facing two major challenges: power consumption and reliability. This presentation is targeting the second one, reliability, aiming to follow on von Neumann’s prescient *The Computer and the Brain* (Yale University Press, 1958). In particular, we will take steps for deciphering the reliability schemes used by neurons, and present visualization results which are strongly supporting our claims. It is to be mentioned that the original tale from *The Computer and the Brain* is reversed, i.e., we aim to start from the Brain, and, relying on the latest discoveries, to get a better understanding of what is essential from biology, such as to achieve highly reliable nano-computing (i.e., similarly to what the Brain is doing). In this context, it is fascinating to remember what Robert Noyce, co-founder of Intel and co-inventor of the integrated circuit, mentioned more than 30 years ago: “Until now we have been going the other way; that is, in order to understand the brain we have used the computer as a model of it. Perhaps it is time to reverse this reasoning: to understand where we should go with the computer, we should look to the brain for some clues.” (“The Next 100 Years,” IEEE Centenary, 1984).

We will begin by shedding light on the gated ion channels, the elementary nano-devices of the Brain, and go on to argue about the very different ways they communicate. Deciphering the statistical (collective) behaviors of arrays of gated ion channels will be shown to rely on results published by de Moivre in 1738. These will be complemented by reliability analyses of the dynamic transport networks formed by the microtubules (which link to power consumption). We will show that these transport networks are generalization of the Moore-Shannon hammock networks introduced in 1956. Such investigations are in the early stages and not yet finalized, but our preliminary results are already revealing the outstandingly high reliability achievable by such schemes—even when the “devices” are absolutely random.

We conclude that the associated novel computational models expose one reason why our current silicon-based approaches are falling short of doing what the Brain does, and implicitly chart directions for research—both for the computing and for the VLSI/nano communities.

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