LENGTHS OF ATTRACTORS AND TRANSIENTS IN NEURONAL NETWORKS WITH RANDOM CONNECTIVITIES

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For brains of higher organisms the actual connectivity between the neurons is largely unknown. Thus meaningful modeling of neuronal dynamics often requires an assumption that these connectivities are somewhat typical for a certain probability distribution of digraphs. One can then explore the expected dynamics of a given model on networks that are randomly drawn from this distribution.

In this talk I will present recent results of this type that were jointly obtained with Sungwoo Ahn of Indiana University-Purdue University Indianapolis for Erdős-Rényi distributions of digraphs and models of neuronal dynamics as constructed in [1]. There is some evidence that these models may adequately represent the dynamics in neuronal tissues for which the puzzling phenomenon of dynamic clustering has been experimentally observed [2].

Among the most important properties of a finite-state dynamical system are the lengths of attractors (which in this case must be cycles of states that are visited infinitely often), and the lengths of transients, that is, the number of steps before an attractor is reached. We obtained scaling laws for the medians of these characteristics as the number n of neurons (nodes in the digraph) approaches infinity. These exhibit a phase transition as the mean indegree c moves through the critical window in which the giant strongly connected component of the digraph appears. Both below and above the critical window median lengths of attractors scale like a constant while median lengths of transients scale at least like $\log n$. However, right at the lower end of the critical window median lengths of attractors scale faster than any given polynomial, while median lengths of transients scale polynomially.

There are a number of open problems in the topic covered by this talk, some of which will be described at the end.

References

[1] Ahn, S., Smith, B., Borisyuk, A., and Terman, D. (2010). Analyzing neuronal networks using discrete-time dynamics. *Physica D* **239**, 515–528.

[2] Terman, D., Ahn, S., Wang, X., and Just, W. (2008). Reducing neuronal networks to discrete dynamics. *Physica D* **237**, 324–338.

Date: November 10, 2013.