Hamilton Institute

Requiem for the Spike

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Abstract

The big open question in neural coding is: "what's the neural code?". At the single neuron level, at least in cortex, evidence is mounting that the code is primarily firing rate. For populations, however, the question is wide open. Rate is certainly one possibility, but another is that information is carried in the precise patterns of action potentials. While ultimately the answer will come from experimental data, in the meantime we can approach the problem from a purely theoretical point of view. In particular, if patterns are to carry information, they must be repeatable, and we can ask: does the massively recurrent connectivity in realistic networks place intrinsic limits on repeatability, and thus on the extent to which patterns can carry information?

Using a simple model of randomly connected networks, we find that, at the microscopic level, network dynamics is chaotic. This implies that patterns of spikes are not repeatable (except in the somewhat uninteresting regime in which the input to a network dominates over the recurrent connections). We show in particular that this microscopic chaos has a strong, deleterious effect on the ability of networks to use spike pattern codes to process time-varying stimuli. Moreover, we argue that chaos is a general feature of networks – it applies even to those that are not random, but have structured connectivity. The upshot of this analysis is that networks are likely to communicate by firing rate, not by detailed patterns of action potentials.

Venue: Seminar Room, Hamilton Institute, Rye Hall, NUI Maynooth

Time: 1.00 - 2.00pm (followed by tea/coffee)

Travel directions are available at www.hamilton.ie

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