Percolating Consciousness

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Abstract

In this note the authors present an ephaptic theorem in the setting of resistor-networks.

In this paper the authors study the problem of modeling widespread ephaptic coupling in brain networks of neurons. Consider a two-input two-output setting. The input nodes (left-facing) are connected to the corresponding output nodes (right-facing) in the first scenario and both correspondingly and cross-wise in the second scenario. The second scenario represents ephaptic effects (see [1]) which propagate laterally. Our goal is to compare these two scenarios. In a first, quick, comparison, a quick computation shows that the second scenario has a slightly larger MIMO capacity than the first one.

Next, we consider the two scenarios as resistor networks. The second scenario network has two additional resistors as compared to the first one to model ephaptic transmission. As per Equation (2.4) of [2], this can only reduce the resistance between "A_0" and "A_1," two fiducial points. When we combine this with Theorem 1 of [2], and work in a two-dimensional setting where all sequences are points in $\mathbb{R} \times \mathbb{R}$, we obtain the following result:

Theorem 1. *If* $R_n^{'} \geq 2\left(\int_{[0,\infty)} \frac{1}{x} dF(x)\right)^{-1} \forall n$, *then* $\exists$ *a subsequence of ephaptic resistor networks that converges in probability to* $2\left(\int_{[0,\infty)} \frac{1}{x} dF(x)\right)^{-1}$.

This result is closely related to the theory of percolations [3]. In future work, we will study the critical probabilistic threshold where large scale synchronization can take place in networks of ephaptically coupled neurons in the nervous system, a study pertinent to the theory of the neural correlate of consciousness (NCC) [4].

References

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