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Title: Modelling computations in brain circuits with low-rank neural networks

Abstract:

Our brain consists of billions of neurons, arranged in a multitude of areas and densely interconnected through trillions of synapses. How do interactions within this large complex network support the computations that are required by our everyday behaviour? Current experimental technologies enable the investigation of this question in animal models on a large scale. However, due to the heterogeneity and complexity of the resulting data, building mechanistic models of computations in neural circuits that are together interpretable, flexible, and data-grounded remains challenging.

In this presentation, I will introduce a new class of mathematical models, named low-rank neural networks, aiming to address these challenges. These models are rooted in the idea of integrating concepts and tools from dimensionality reduction, a statistical approach that has demonstrated promise in the analysis of experimental data, into neural network models. The key strength of low-rank networks is that they can be easily analysed mathematically, by using tools from statistical physics and random matrix theory. I will show how this formalism can be used to address standing theoretical questions in neuroscience and artificial neural networks. I will also briefly discuss how those models can be used to extract insight from large-scale experimental data, with a focus on neural data collected from multiple cortical areas in the brain of non-human primates.