Institut für Geometrie

Geometrie-Seminar

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Seminarraum 2, Kopernikusgasse 24/IV

Tightening the Knot Between Biological and Artificial Neural Networks via Shapes from Spiking Neural Networks

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The application of shape analytics - topology, geometry, and graph theory- has proven its capacity for attaining new understanding of the brain or for designing new algorithms for artificial intelligence. With it, researchers have uncovered internal representations called neural manifolds in brain regions like the hippocampus, or have described the axonal morphologies. Other efforts revolve around using shape analytics to probe how deep neural networks learn the weight distributions, or inversely, to use deep neural networks called geometric deep learning to encode the geometric structure of data. Yet, the connection between biological neural computing and today's artificial neural networks is quite loose, in that the models and algorithms implemented lack biological plausibility, thereby hindering explanations for the mechanisms underlying neural computation. My proposal is to study spiking neural networks, a more biologically plausible model which opens up the possibility to explain how the brain hierarchically computes information and advances artificial intelligence via neuromorphic computing. Additionally, I propose formulating questions from a systems engineering perspective, considering why a certain shape arises from the system's constraints in terms of trade-offs and design principles optimized for. In an aspiration for synthesis, preliminary works are presented showing how to leverage the shapes of (spiking) neural networks and their emergent dynamics to hypothesize mechanistic explanations of how neural computation works.

Michael Kerber