



Solving Constrained Minimax Problems with Spiking Neural Networks

Guillermo Martín-Sánchez¹, William F. Podlaski¹, Christian K. Machens¹

¹. Champalimaud Foundation, Lisbon, PT

Spiking neural networks (SNNs) serve as key models of brain function in neuroscience [1] and as energy efficient algorithms in engineering [2]. However, they remain difficult to build and interpret. In this work, we establish a theoretical connection between SNNs and minimax optimization — a broad class of optimization problems with links to decision making under uncertainty, zero-sum games, and optimal control. Building on existing results that link SNNs to convex optimization [4,5,6,7], we show that the dynamics of certain low-rank SNNs can solve minimax problems with quadratic objectives and linear constraints. We provide geometrical intuitions for how the minimax problem maps onto a network’s latent space, and how the latent dynamics of the spiking networks reaches the optimal solution. With this work, we hope to make a step forward in interpretability and usability of spike-based computation — not only serving as a viable framework to understand biological networks, but also opening avenues for neuromorphic implementations of energy-efficient optimization solvers.

Spiking neural networks, constrained optimization, minimax optimization, population geometry, low-dimensional dynamics