Neuromorphic Evolutionary Optimisation with Spiking Search and Control

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Metaheuristics are powerful yet computationally expensive on von Neumann hardware. Repeated memory access, synchronous population updates, and energy cost grow with problem dimensionality and population size. Neuromorphic hardware offers an alternative substrate where computation is event-driven, memory is collocated, and parallelism is native. Notwithstanding, the existing neuromorphic optimisation implementations remain problem-specific, and general-purpose spiking search has not been established [1]. This work reports two frameworks from the NeurOptim research initiative (`https://neuroptim.org`), each exploring a different route to make optimisation emerge from spiking dynamics. Figure 1 illustrates both architectures, which are described as follows.

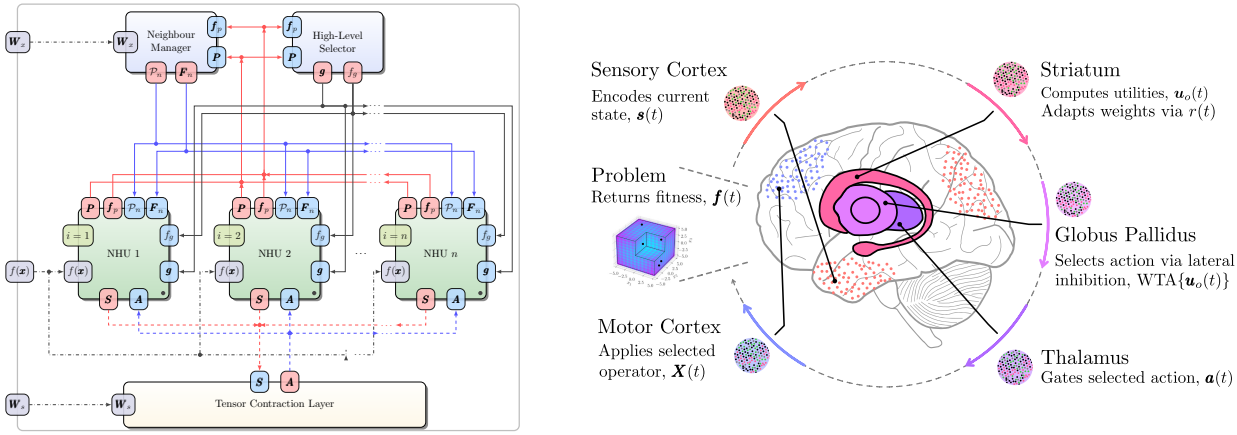

Figure 1: (Left) NeurOptimiser: n asynchronous neuromorphic heuristic units coordinated by three processes. (Right) NEVO: spike-driven operator selection through a Cortico-Basal-Thalamic Loop.

NeurOptimiser [2] is grounded in the Nheuristics paradigm and realised as a decentralised spiking network inspired by Constraint Satisfaction Processors. Each candidate solution is embedded in the internal state of a spiking neuron, and a population of such neurons evolves asynchronously under spike-triggered heuristic updates. The implementation targets the Loihi 2 chip via Intel's Lava NC framework and achieves structured convergence up to 20D with sub-watt power estimates on the noiseless BBOB benchmark suite. NEVO [3] follows a complementary route built on the Neural Engineering Framework and a spiking Cortico-Basal-Thalamic control loop. Classical operators from well-known metaheuristics generate and evaluate candidates, while the spiking circuit observes the search state and selects the next operator online, yielding strong 2D-3D performance and acceptable behaviour in 5D under fixed resources on the same benchmark suite.

These two frameworks show that evolutionary search can be coordinated through spiking dynamics. NeurOptimiser embeds search operators directly inside spiking neurons; NEVO delegates operator selection to a spiking control circuit. Both currently run in software simulation, where spiking overhead is the main cost. On neuromorphic hardware, event-driven execution is expected to reduce this overhead and shift the bottleneck to objective evaluation. Open directions include hardware-backed validation, learned control policies, and tighter algorithm-substrate co-design.

[1] E.-G. Talbi, arXiv, 2505.16362, 2025.

[2] J.M. Cruz-Duarte and E.-G. Talbi, arXiv, 2507.08320, 2025.

[3] J.M. Cruz-Duarte and E.-G. Talbi, In Proc. WCCI/CEC, 2026. (In Press)