Karlsruhe Institute of Technology

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QUBO Decoding on Spiking Neural Network Hardware Using Asynchronous Ising Machine Models

Bachelor's Thesis/Master's Thesis

Project

Many decoding problems in error-correcting codes can be formulated as quadratic unconstrained binary optimization (QUBO) problems. While QUBO-based decoding offers strong performance and flexibility, conventional solvers often suffer from high computational complexity and limited scalability, especially in high-throughput or low-latency scenarios. This motivates the exploration of alternative computing paradigms that can efficiently solve QUBO problems.

Spiking neural networks (SNNs) provide a hardware-efficient, event-driven computing framework with massive parallelism and low power consumption. In particular, the Asynchronous Ising Machine (AIM) model offers a natural way to represent QUBO problems through coupled binary variables evolving via local, asynchronous updates. The dynamical behavior of AIMs can be emulated using spiking neurons, enabling distributed and energy-efficient optimization.

This thesis aims to investigate QUBO-based decoding algorithms implemented on spiking neural network hardware using AIM models. The work will focus on mapping decoding problems to AIM dynamics, analyzing convergence and decoding performance, and evaluating complexity, latency, and energy efficiency through simulations and hardware-oriented studies.

Tasks

1. Investigate QUBO-based decoding algorithms
2. Get familiar with AIM dynamics and programming

Requirements

- ✔ Knowledge of error-correcting codes
- ✔ Good programming skills

Institute

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