

## MA-Thesis

### Hardware-aware Evolutionary Training of Spiking Neural Networks

Training neural networks with evolutionary algorithms has been widely explored in the literature, and open-source libraries such as evoJAX make this approach accessible. It is particularly appealing for non-differentiable systems, including compact spiking neural networks (SNNs). However, many evolutionary SNN pipelines overlook weight quantization, despite its relevance for embedded AI.

This thesis shall investigate how quantization affects the evolutionary training of hardware-aware SNNs and its implications on network size and the number of time steps. The goal is to demonstrate quantization-aware evolutionary SNN training that can solve a control task. The choice for both the evolutionary algorithm as well as the control task can be discussed – initially, I suggest a simple genetic algorithm only optimizing the weights of a feed-forward SNN playing the snake game. The practical part implied prior experience with Python, ideally even with jax, as the pipeline shall be built on top of an existing code base. Prior experience with SNNs is highly desirable, but DNN experience is also sufficient.

#### Tasks

- Introduction to spiking neural networks.
- Introduction to the hardware of the spiking neural network accelerators (SENNA)
- Introduction to evolutionary algorithms for training spiking neural networks
- Implementation and documentation of the training pipeline
- Evaluation and integration into the SENNA software stack

#### Pre-requisites

- Strong mathematical skills
- Basic knowledge of machine learning and neural networks
- Strong programming skills in Embedded C/C++

#### Supervisors

Andreas Stoll, Fraunhofer IIS  
Prof. Dr. Ing. Cristian Axenie, M.Sc.

Fraunhofer Institute for Integrated Circuits  
SENNA – Spiking Neural Network Inference Accelerator  
<https://www.iis.fraunhofer.de/en/ff/kom/ai/snn/senna.html>