Neuromorphs of Group Becker at KIT

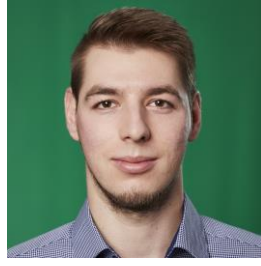# Development and Deployment of SNNs on FPGA for Embedded Applications
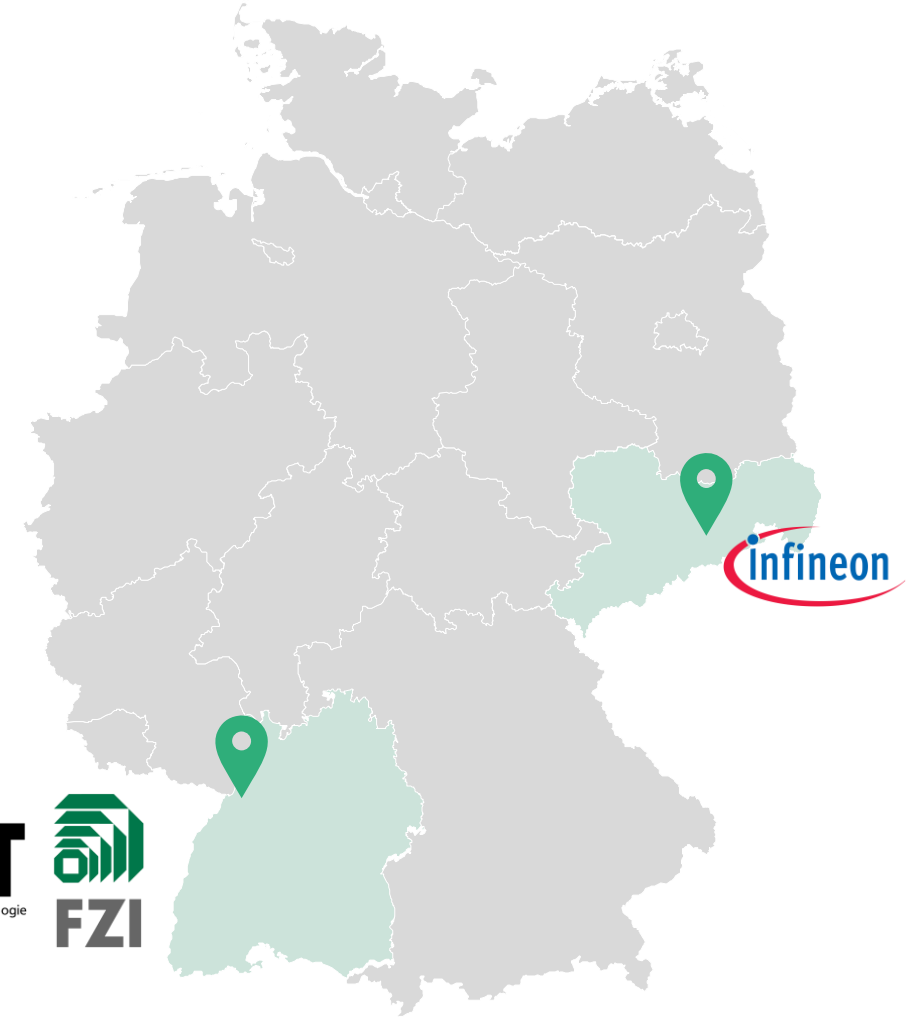
28.03.2025

Our Group

Prof. Becker
(KIT)

Klaus Knobloch
(Infineon)

— Agenda

- *Presentation:* Hardware Introduction

- SNN Training

- Toolchain Introduction

- Export to NIR

- Mapping Introduction

- Deployment to Hardware

- Working with the Hardware

Docker Image
(**Update available!**)

```
Pull the docker image
docker pull nice2025tutorial/nice2025tutorial:latest
```
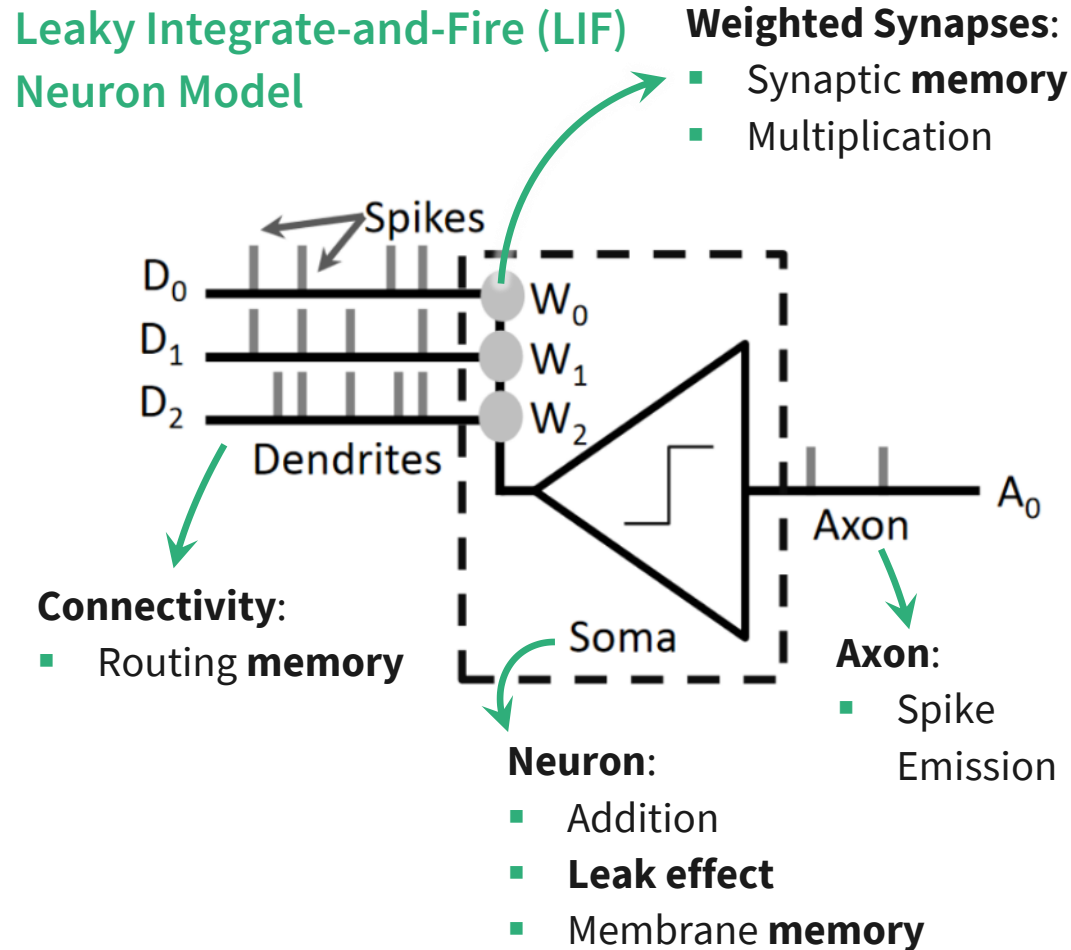
Neuromorphic Accelerator

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Perspective from the SNN Algorithm

What's being accelerated?

Leaky Integrate-and-Fire (LIF) Neuron Model

Weighted Synapses:
- Synaptic **memory**
- Multiplication

Connectivity:
- Routing **memory**

Neuron:
- Addition
- **Leak effect**
- Membrane **memory**

Axon:
- Spike Emission

Major concepts that influence the accelerator's architecture:

– **Locality** of information (stateful neurons)

– **Timestepped** processing (millisec. domain)

– **Sparse** processing ⎫
– **Sparse** messaging ⎭ **event-based**

– **Arbitrary** neural network **topologies**

– **Increase** in per-neuron **memory footprint** (more complex neurons compared to ANN)

→ One neuron is very simple, scaling up to 10k's of neurons and 100k's of synapses is a challenge

Please Write Us!

Slides on hardware implementation details available on request to:

pachideh@fzi.de
Cc nitzsche@fzi.de; neher@fzi.de

Expect the open source release of our accelerator & toolchain within 2025.

Prepare the tutorial files

```
# 1. Clone the tutorial repository
git clone https://github.com/nice2025tutorial/nice2025tutorial.git

# 2. Pull the docker image
docker pull nice2025tutorial/nice2025tutorial:latest

# 3. Navigate to docker directory
cd nice2025tutorial/docker

# 4. Create the docker container and attach to a shell
docker compose up -d
docker exec -it docker-nice-1 bash
```
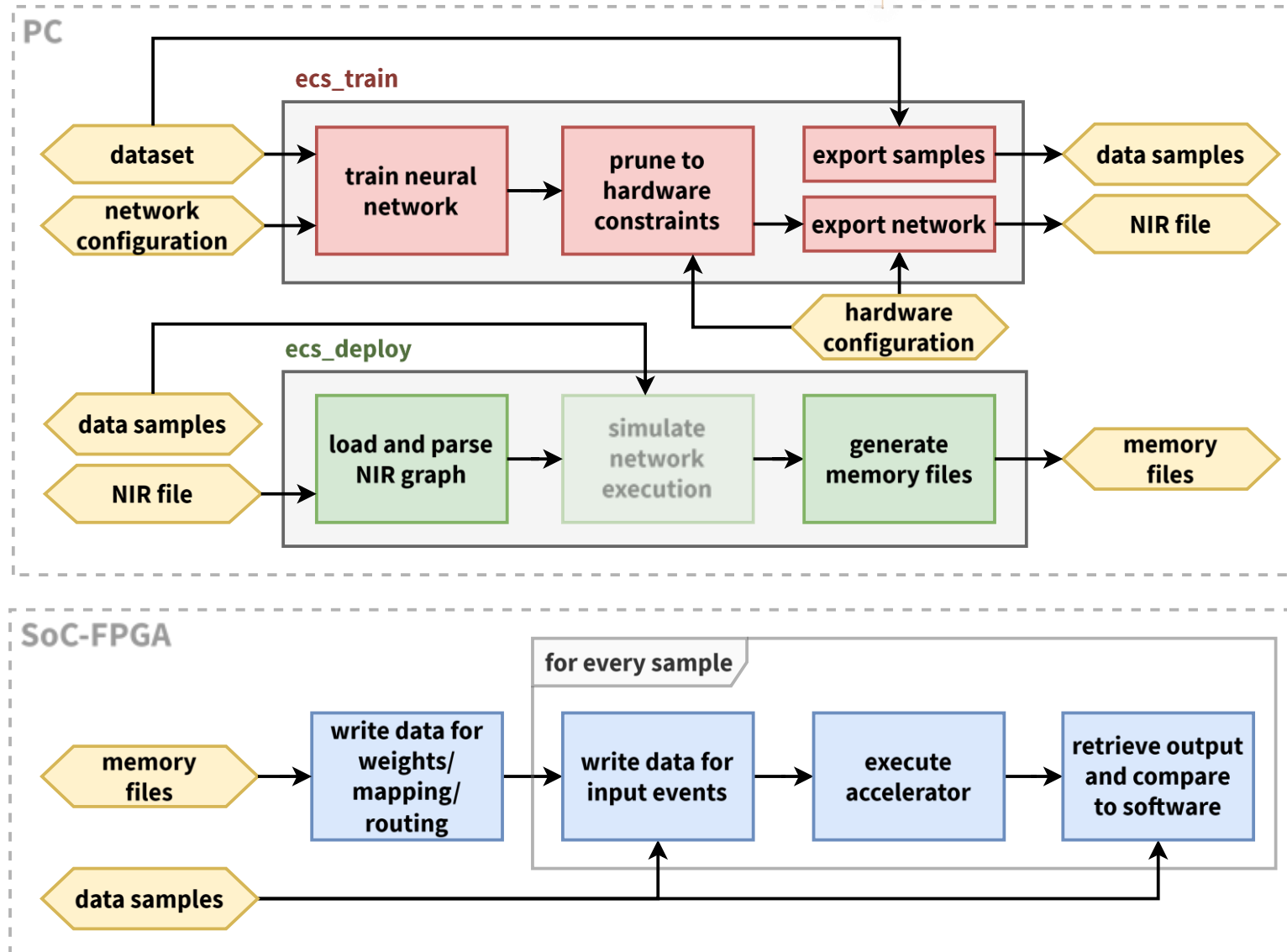
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Run the Jupyter server

```
# Inside the docker container shell
./start_jupyter.sh

~: Jupyter Server 2.15.0 is running at:
~:     http://127.0.0.1:8888/tree?token=xxxxxxxxxxxxxxxxxxxxxx
```

– Copy server URL into your browser

– Two notebooks provided:

    – `toolchain/main.ipynb`: Overview of end-to-end SNN development and deployment toolchain

    – `mapping/main.ipynb`: Sneak peek into mapping framework for arbitrary multi-core neuromorphic hardware accelerators

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Project Contributors

- Brian Pachideh (FZI/KIT)

- Sven Nitzsche (FZI/KIT)

- Moritz Neher (Infineon/FZI/KIT)

- Jann Krausse (Infineon/KIT)

- Carmen Weigelt (Infineon/KIT)

- Hella Toto Kiesa (FZI/KIT)

- Alexandru Vasilache (FZI/KIT)

- Leonard Knapp (FZI/KIT)

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