# ANDANTE

Tools and methodologies for training and mapping a neural network on ANDANTE hardware targets

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## Objectives

- Leverage embedded NVM for designing new accelerators for edge AI applications
- Develop dedicated tools and methodologies to facilitate the training, simulation and deployment of neural network models on the targeted HW accelerators.
- Define the software-hardware co-design methodologies to pursue according to the targeted application

## Context

- High-level design choices must be made depending on the application, the type of sensor used (event-based sensor or not) and the size of the network, which may dictate analog or digital design.
- Each of those design choices requires a dedicated tool flow (Training, generation (RTL, schematic), mapping and simulation tools).

## Main Results

- A total of **16 tools** were developed in ANDANTE and are now **completed, half** of which is available in **open source.**

## Application-dependent high-level design choices

### What coding style to use?

Classical coding is Best for still inputs (e.g. images)

Event / Spike coding is Best for always-on, low-activity inputs (e.g. surveillance)

- Rate code is to be used for "Frame-type" inputs
- Temporal code is best on Temporal series (e.g. audio)

### What network topology?

A Deep, Feed Forward topology for high accuracy and fixed inputs applications

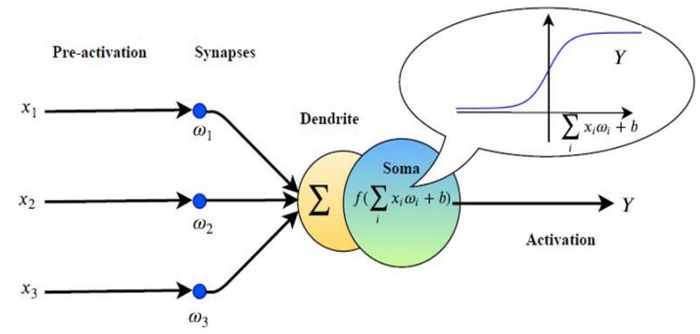
A Shallow, Recurrent topology for temporal series

### What implementation strategy?

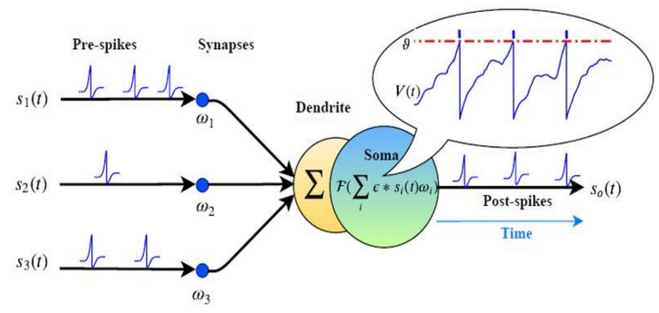
A Fully digital implementation is Mandatory for very deep, large, networks

An Analog mixed-signal implementation can be Efficient for shallower networks

Classical coding




Spike coding

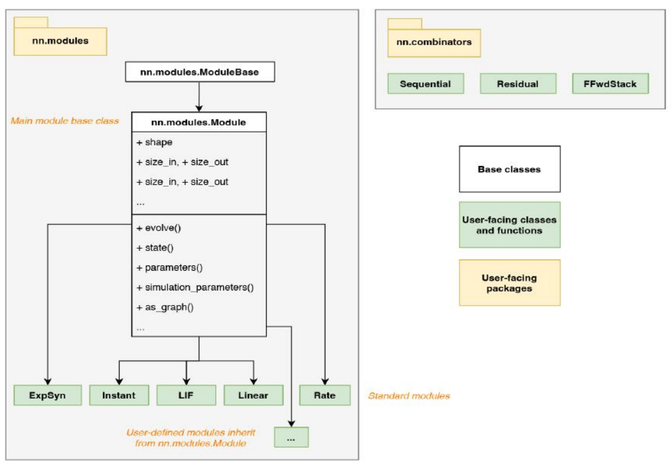



## Training tools

### Spike-coding

ANN-to-SNN conversion

Direct SNN training (Offline and On-chip learning)

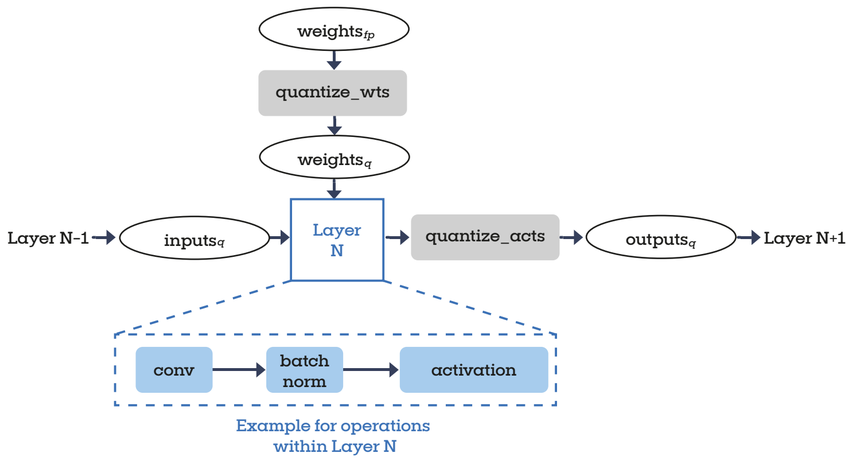



Offline Training tool for SNN

### Classical coding

Transfer learning

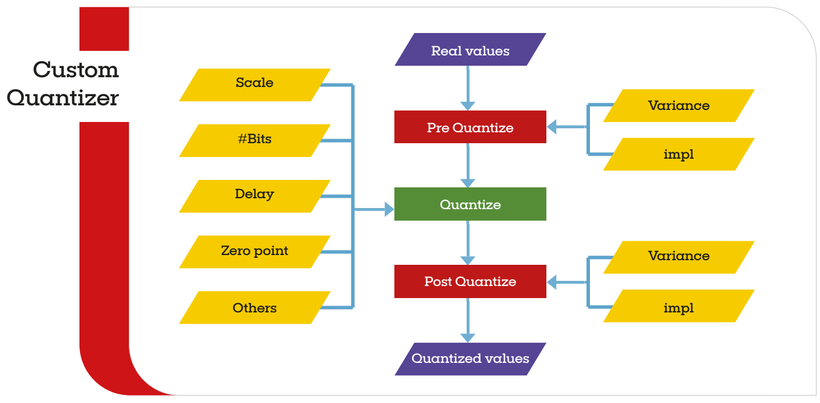
Quantization Aware Training: Reduces memory footprint and enables the use of embedded NVM




QAT training: Weights and activations quantization

### HW-aware training for mixed-signal implementations of ANN ASICs

Takes non-idealities into account during the training phase



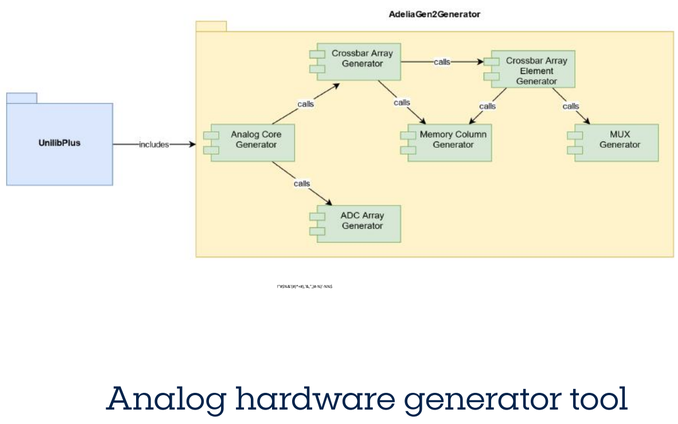

HAT (hardware-aware training) tool

## Generation, Mapping and Simulation tools

### Hardware generator

Writes RTL (for digital NN)

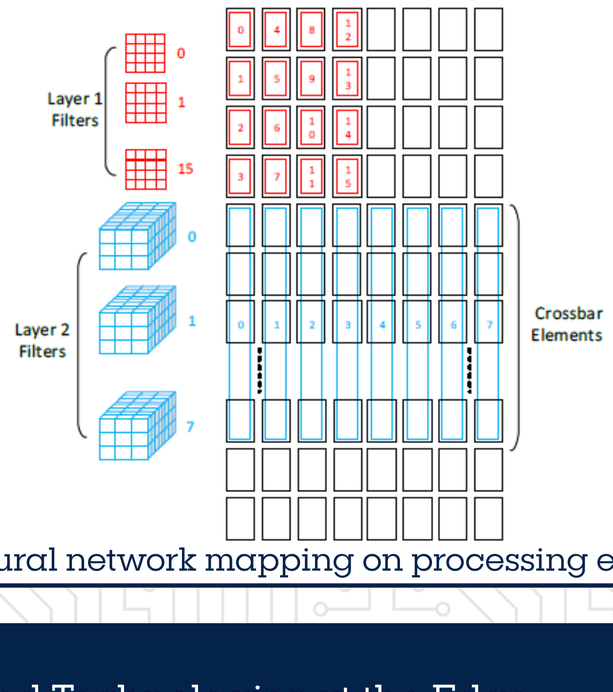
Generates schematic and layout (for analog NN)




Analog hardware generator tool

### Neural Network mapper on hardware

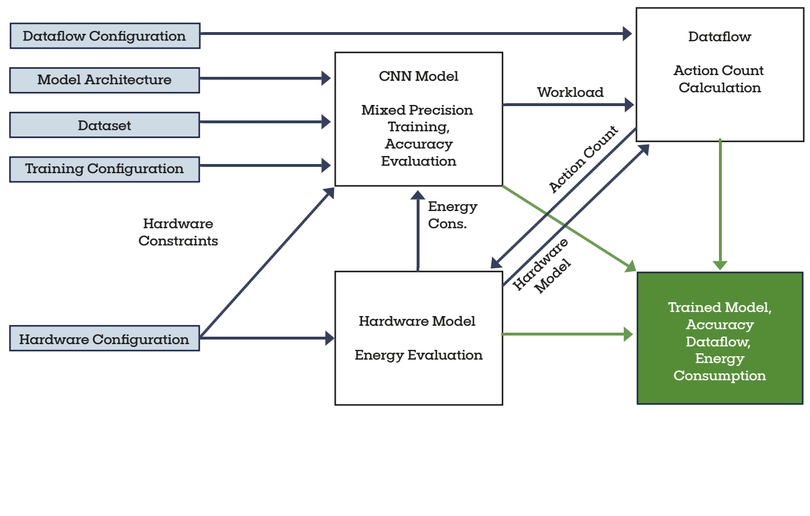
Maps onto Processing engines or NVM arrays




Neural network mapping on processing engines

### Simulation

Estimates power dissipation




Hardware power estimation tool

**ANDANTE**

AI for New Devices And Technologies at the Edge

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"This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement № 876925. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Belgium, Germany, Netherlands, Portugal, Spain and Switzerland"

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