Chair of Integrated Digital Systems and Circuit Design

RWTH AACHEN UNIVERSITY

Master Thesis

Dedicated Hardware Implementation for Convolutional Neural Networks

In recent years Deep Neural Networks (DNN) are dominating – besides others – the domain of image recognition and classification. The impressive results are based on networks of steadily growing computational complexity including vast amounts of memory bandwidth. Even on modern CPU or GPGPU clusters, training of such networks can take from days to weeks.

In our research group we focus on the efficiency of such DNN, i.e., our objective is to preserve the high quality of the results while reducing computational complexity.

A selection of research works has already shown the immense potential of adopting non classical computing architectures. Being inspired by neuromorphic concepts, that is observing successful strategies in nature, there is still a long way to go. At the end, this research will result in smarter neural networks operating on embedded systems while continuing to learn (online learning).

Given the richness of this topic, we currently have a number of Master Theses open. The explicit topic will be discussed with the candidate.

One thread will focus on the modelling of different variants of such neural networks as well as perform their basic characterization in Matlab. This is accompanied with dedicated hardware implementations to accelerate the quantitative design space exploration by running on the latest high-end FPGA boards.

Any such thesis will be based on an existing implementation of such neural network at our institute to have a baseline for comparison and to ease the start for the prospective student. Please contact Johnson Loh or Cecilia Höffler for further details.

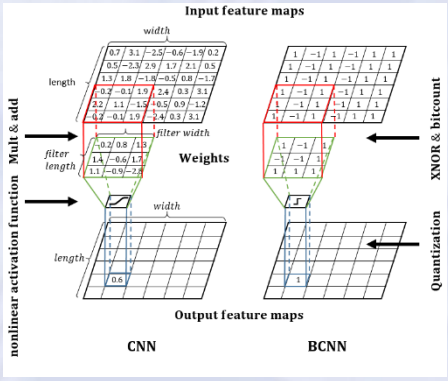

Fig. 1. Example of Convolutional Neural Network as binary and real valued implementation

Focal Areas for your Master Thesis

Binary Neural Network: In order to limit storage requirements and computational complexity, individual data words are reduced to single bits.
Logarithmic Neural Networks. Preserving a wide range of values while limiting precision.
Dropout Neural Networks: Neurons die, so do their artificial counterparts. Still quality is key.

Tasks

- Adapt existing neural network model (Matlab)
- Determine sensitive parameters
- Derive reasonable configurations
- Extend hardware implementation to match adapted simulation model
- Quantify trade-offs

Requirements

- Basic knowledge in artificial neural networks
- Strong knowledge in Verilog and/or VHDL
- FPGA programming experience is a plus
- Practical expertise in MATLAB
- Motivation and self organized working skills

Contact

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