Machine Learning Application Design and Benchmarking

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INTRODUCTION

Next generation neuromorphic architectures are scaling up to the human brain size complexity with millions of neurons and billions of synaptic connections. These massive hardware Spiking Neural Network (SNN) architectures will enable the Machine Learning (ML) application designers to design very large and deep SNNs for complex analysis, estimation and prediction tasks. One of the challenges that ML application designers face is the definition of suitable neural network architecture that results in higher accuracy with reliable application behaviour.

This project aims to propose and benchmark efficient SNN architectures for the following categories of applications:

- time-varying biological signal processing (ECG, EEG, etc.)
- spatial data processing (image, radar/Lidar input pattern)
- spatio-temporal data processing (video, radar/Lidar stream)

PROJECT PROPOSAL

The project aims to define efficient SNN architectures for the time-varying, spatial-data and spatio-temporal data processing applications. The project will explore SNN architectures using applications such as ECG arrhythmia detection, MNIST digit recognition, image classification and radar/Lidar stream classification using CARLsim/Caffe/TensorFlow/Brian2 (GPU-accelerated) simulators. Various neural network architectural combinations will be evaluated to achieve higher accuracy and compact implementation. The proposed SNN architectures will be benchmarked using training and test dataset accuracy and number of neural elements.

The proposed systematic SNN architecture exploration approach should help lower the neural elements and synaptic connectivity in the SNN application topology while increasing the application performance. Lower neural elements and synaptic connectivity directly translates to compact and low power neuromorphic architectures. Studying the SNN architecture options will also help design the efficient synaptic interconnect architecture for neuromorphic architectures.

REQUIRED SKILLS

- Bachelor’s/Master’s degree in Electrical/Electronic/Computer Science
- Strong programming and debugging skills in C/C++, Python and Matlab, GPU programming (CUDA with C/C++ and Python)
- Very good understanding of data structures and algorithms
- Basic understanding of spiking neural networks and machine learning algorithms
- Ability to develop large scale simulations using the neural network simulator platforms (CARLsim, Caffe, TensorFlow, etc.)

POSITION OFFERING

You will be part of the rapidly growing neuromorphic research team at IMEC-NL in Eindhoven. Together with other machine learning researchers, you will work on the challenging machine learning research problems. You will produce high quality conference/journal publications and master’s thesis.