

Neuromorphic Computing: Problems and Prospects

October 14th, 2024

Room E1-042, Østfold University College
Halden Campus, B R A veien 4 (Halden)



Preliminary Program for the Workshop

9:45 – 10:00

Welcome and Introduction to the Workshop
Maben Rabi, Østfold University College

10:00 – 11:00

Title: **Neuromorphic Systems for Embedded Applications**

Invited Talk: Federico Corradi, Eindhoven University of Technology

Abstract

Current computing architectures face inherent limitations, such as the memory access bottleneck and diminishing returns in performance improvements due to the cessation of Dennard scaling. These constraints highlight the need for alternative computational paradigms. Neuromorphic computing has emerged as a promising solution, leveraging brain-inspired architectures to achieve energy-efficient, real-time processing. At its core, neuromorphic hardware utilizes event-driven, massively parallel spiking neural networks (SNNs) to mimic biological neural activity at a fundamental level.

In this talk, I will discuss the principles underpinning spiking neural networks, focusing on state-of-the-art training algorithms and hardware implementations that emphasize event-driven computation and sensory processing. The neuromorphic paradigm supports ultra-low-power operation, making it particularly suited for edge AI and

embedded systems applications. I will present several prototype neuromorphic devices that meet the energy efficiency and cost constraints essential for Internet of Things (IoT) applications, including those in biomedical signal processing and radar sensing. These prototypes underscore the potential of SNNs to revolutionize embedded sensing and computing technologies, addressing critical challenges in real-time, low-power environments.

This version emphasizes scientific precision and the technical details of the neuromorphic approach, better aligning with a research-oriented audience.

11:00 – 11:15 Break

11:15 – 12:15

Title: **Reservoir Computing - Possibilities and Challenges**

Invited Talk: Alexander Stasik, Sintef

Abstract

This talk gives an introduction into the field of reservoir computing, starting from the fundamental concepts, covering some platforms and implementations of reservoirs and discussing some recent developments.

12:15 – 13:00

Lunch Break

13:00 to 14:00

Title: **Accelerating Recurrent Networks with Neuromorphic Hardware-Algorithm Co-Design**

Invited Talk: Alessandro Pierro, Intel

Abstract

Neuromorphic computing takes inspiration from the brain to design novel algorithms and hardware platforms. Leveraging sparse, event-driven, and massively parallel processing enables lower latency and better energy efficiency on critical machine intelligence workloads. This talk will cover the motivation and principles behind modern neuromorphic architectures, focusing on the Intel Loihi 2 research chip as a representative example. Through two case studies, we will discuss the hardware-algorithm co-design approach and how it can be applied to accelerate recurrent networks with the specific neuromorphic feature set. Our results on combinatorial optimization and sequence modeling show great promise for our approach to accelerate compute-intensive tasks, especially in edge and energy-constrained domains, and advocate for more hardware-informed design in computational sciences.

14:00 – 14:20

Spintronic-Based Neuromorphic: A Proposal for LIF Neurons by Magnetic Textures

by Alireza Qaiumzadeh, NTNU

14:20 – 14:30 Break

14:30 to 14:50

Neuromorphic Hardware Architectures for Real-Time Energy Efficiency
at the Edge: Inspiration vs. Experience
by Ali Muhtaroglu, Oslo Metropolitan University

14:50 to 15:10

Event-Based Eligibility Propagation with Additional Biologically Inspired
Features
by Hans E. Plesser, NMBU

15:10 to 15:30

In-Vitro Models for Neuromorphic AI
by Stefano Nichele, Østfold University College

15:30 – 16:00 **Open discussion**

Moderated by Maben Rabi, Ali Muhtaroglu, Stefano Nichele