Bachelor's / Master's / Semester Project

Developing Novel Algorithms and Architecture for Brain Inspired Computing Systems

Context & background:

Hyperdimensional (HD) computing (HDC), also known as vector symbolic architecture (VSA), is a brain-inspired computing paradigm that has been demonstrated to be effective in (1) solving cognitive tasks, such as analogical reasoning, (2) learning domains, such as text classification, gesture recognition, and latent semantic analysis, and (3) privacy and security problems. The term hyperdimensional comes from the fact that in the HDC realm, we deal with large spaces and vectors, which mimic many neurons and synapses in the brain's circuits.

The elements in the HDC paradigm have several features and properties, namely parallelism, simple operations/hardware friendliness, robustness, holistic representation, and randomness, that make them a suitable alternative to expensive DNN-based methods for some real-world applications.

In this project, we aim to evaluate the benefits of different HDC-based designs for several applications and develop software and/or hardware solutions to improve their accuracy, performance, and/or efficiency.

Expected effort:

This project can take shape as a semester, BSc, or MSc project.

In this project, the student will

- perform a comprehensive literature review on different applications that can benefit from an HDC-based design
- compare various HDC-based proposals
- propose novel ideas (in software or hardware) to improve the accuracy or performance of an application using the HDC paradigm

For preliminary readings please see:

- Pale, et al., "Multi-Centroid Hyperdimensional Computing Approach for Epileptic Seizure Detection." Frontiers in Neurology, 2022.
- Kleyko, et al., "Classification and recall with binary hyperdimensional computing: Tradeoffs in choice of density and mapping characteristics." IEEE transactions on neural networks and learning systems, 2018.
- Imani, et al., "Exploring hyperdimensional associative memory." In HPCA, 2017.

Requirements:

- Outstanding programming skills

- An interest in developing and evaluating new ideas, discovering why things do or do not work, making systems efficient and usable
- Strong work ethic

Plus Points:

- Background in HDC
- Background in computer architecture

Contact information:

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