PhD on the topic: Energy-Efficient Online Learning Using Gain-Cell Memory-Based Compute-in-Memory Architecture

The REACT MSCA DN Project: Self-awareness in humans is an innate capability, arising from the brain's ability to process a multitude of sensory inputs. Emulating this functionality in electronic systems—commonly referred to as neuromorphic computing—holds the potential to create highly intelligent machines capable of supporting a wide range of everyday applications, from autonomous vehicles to smart navigation systems. However, realizing neuromorphic computing in practice presents significant challenges, particularly in the areas of energy efficiency, reliability, and security.

The REACT MSCA Doctoral Network addresses these challenges by developing a neuromorphic platform that is inherently self-aware in terms of energy consumption, secure operation, and system reliability. As part of this initiative, 15 Doctoral Candidates (DCs) will be trained through a comprehensive, interdisciplinary program spanning material science, device physics, computer architecture, hardware prototyping, compiler design, simulation and emulation tools, as well as cybersecurity, reliability, and system verifiability.

REACT offers a uniquely structured training environment, combining academic excellence with industrial collaboration. DCs will benefit from close mentorship by leading researchers and industry experts, while also developing essential skills in scientific writing, research ethics, time management, and entrepreneurship.

By the conclusion of the REACT project, participants will be well-equipped to pursue impactful careers across academia and industry, with the REACT program serving as a strong foundation for their future success.

Organization:

Eindhoven University of Technology is an internationally top-ranking university in the Netherlands that combines scientific curiosity with a hands-on attitude. Our spirit of collaboration translates into an open culture and a top-five position in collaborating with advanced industries. Fundamental knowledge enables us to design solutions for the highly complex problems of today and tomorrow.

The mission of the Department of Electrical Engineering is to acquire, share and transfer knowledge and understanding in the whole field of Electrical Engineering through education, research and valorization. We work towards a 'Smart Sustainable Society', a 'Connected World', and a healthy

humanity (‘Care & Cure’). Activities share an application-oriented character, a high degree of complexity and a large synergy between multiple facets of the field.

Research is carried out into the applications of electromagnetic phenomena in all forms of energy conversion, telecommunication and electrical signal processing. Existing and new electrical components and systems are analyzed, designed and built. The Electrical Engineering department takes its inspiration from contacts with high-tech industry in the direct surrounding region and beyond.

The department is innovative and has international ambitions and partnerships. The result is a challenging and inspiring setting in which socially relevant issues are addressed.

Research area:

The objective of this project is to develop a gain-cell memory-based compute-in-memory (CIM) architecture to enable energy-efficient online learning at the edge. Conventional edge devices are limited by constraints in power, latency, and memory bandwidth, which poses significant challenges to real-time learning when using traditional von Neumann architectures. By leveraging gain-cell memory, which offers high density and low leakage, and integrating mixed-signal computation directly into memory arrays, the proposed approach significantly reduces data movement and energy consumption. To ensure dependable operation under real-world conditions, efficient fault detection and recovery mechanisms will also be evaluated and integrated, addressing the susceptibility of analog and in-memory computing to noise, process variation, and soft errors. The primary objective is to design a CIM system capable of performing key learning operations, such as vector-matrix multiplication and weight updates, within the memory itself, thereby enhancing energy efficiency and computational throughput. This architecture will be optimized for lightweight, adaptive learning tasks commonly encountered in edge scenarios, such as sensor fusion.

Qualification & Eligibility:

- Mobility Rule: Candidates must not have resided or carried out their main activity in “**host country**” for more than 12 months in the 3 years immediately before the recruitment date.
- PhD Rule: Applicants must not already possess a doctoral degree at the date of recruitment.
- Master degree or equivalent in Electrical Engineering, Computer Science, or related field with excellent grades.
- Sound knowledge of computer hardware design and synthesis tools (ASIC, FPGA).
- Good programming and scripting skills.
- Excellent English communication, presentation, and writing skills.
- Must be a team player.
- Knowledge of computing-in-memory is an added advantage.
- Knowledge of emerging non-volatile memory technologies is an added advantage.

Conditions of employment:

A meaningful job in a dynamic and ambitious university, in an interdisciplinary setting and within an international network. You will work on a beautiful, green campus within walking distance of the central train station. In addition, we offer you:

- Full-time employment for four years, with an intermediate assessment after nine months. You will spend a minimum of 10% of your four-year employment on teaching tasks, with a maximum of 15% per year of your employment.

- Salary and benefits (such as a pension scheme, paid pregnancy and maternity leave, partially paid parental leave) in accordance with the Collective Labour Agreement for Dutch Universities, scale P (min. € 2,901 max. € 3,707).
- A year-end bonus of 8.3% and annual vacation pay of 8%.
- High-quality training programs and other support to grow into a self-aware, autonomous scientific researcher. At TU/e we challenge you to take charge of your own learning process.
- An excellent technical infrastructure, on-campus children's day care and sports facilities.
- An allowance for commuting, working from home and internet costs.
- A Staff Immigration Team and a tax compensation scheme (the 30% facility) for international candidates.

Application:

Interested candidates should submit the following documents online through the application link in this website, and concurrently at the application portal in the project website Vacancies – project-react.eu.

- A cover letter motivating your application and detailing the motivation to apply for this specific PhD project (1 page max).
- An academic CV.
- A research statement (2 pages max) describing your personal research interests and previous research projects.
- A certified list of grades from your undergraduate degree(s) up to the moment of application (in case your MSc degree has not yet been awarded).
- The names and e-mail addresses of 2 academic referees who are willing and able to write recommendation letters for you, including the supervisor of your MSc research project.

You may apply for this position until 30 September 11:59pm Dutch local time (CET) by means of the project website Vacancies – project-react.eu. Applications will be evaluated as received.

For information you can contact:

- Dr. Manil Dev Gomony, m.gomony@tue.nl

Please do not use the e-mail address(es) above for applications.