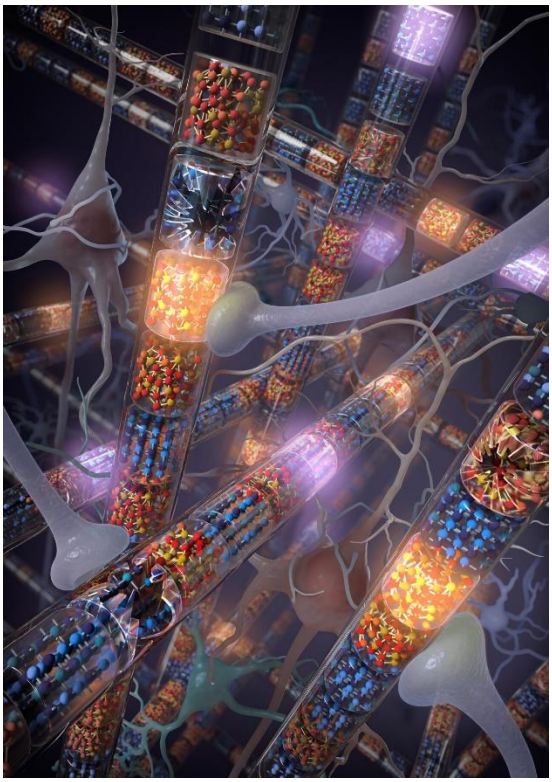
IBM Research –Zurich

Artificial General Intelligence:
Lifelong Learning Challenge



As we address many obstacles and open up new use cases for AI, we are moving toward a new paradigm that of general artificial intelligence. Here, we mainly focus on lifelong continuous learning and analogical reasoning aspects. Traditional neural networks require enormous amounts of data to build their complex mappings during a slow training procedure that hinders their abilities for relearning and adapting to new data. Memory-augmented neural networks (MANN) enhance neural networks with an external and *explicit* memory to overcome these issues. Access to this external memory, however, occurs via soft read and write operations involving every individual memory entry, resulting in a bottleneck when implemented using the conventional von Neumann computer architecture. To overcome this bottleneck, a promising solution is to employ a computational memory unit as the external memory performing analog in-memory computation [1]. However, a key challenge associated with in-memory computing is the low computational precision resulting from the intrinsic randomness and device variability that can be addressed by levering robust representations and transparent manipulations such as those used in hyperdimensional computing paradigm [2].

In such hybrid machine learning model, there are several challenges that need to be overcome at both algorithmic and hardware levels to realize **lifelong continuous learning engines**. This mainly includes exploring and developing efficient methods for compressing external memory contents and fast retrieval as well as in-memory computation (comparison, decomposition, or potentially reasoning).

We are inviting applications from students to conduct their Master's thesis work at IBM Research – Zurich on this exciting new topic. The work performed could span high-level algorithmic developments all the way to efficient realization on emerging hardware chips

comprising more than 1 million phase-change memory devices. It also involves interactions with several researchers across IBM research focusing on various aspects of the project. The ideal candidate should have a multi-disciplinary background, strong mathematical aptitude and programming skills. Prior knowledge on machine learning and AI is a bonus but not necessary.

If you are interested in this challenging position on an exciting new topic, please send your most recent curriculum vitae including a transcript of grades by email to:

Dr. Abbas Rahimi (abr@zurich.ibm.com) and Dr. Abu Sebastian (ase@zurich.ibm.com)

[1] A. Sebastian, M. Le Gallo, R. Khaddam-Aljameh *et al.* Memory devices and applications for in-memory computing. *Nature Nanotechnology* (2020). https://doi.org/10.1038/s41565-020-0655-z

[2] G. Karunaratne, M. Le Gallo, G. Cherubini, L. Benini, A. Rahimi, A. Sebastian. In-memory hyperdimensional computing. *Nature Electronics* (2020). https://www.nature.com/articles/s41928-020-0410-3