Colóquio do Centro de Física da Universidade do Minho

Sexta-Feira, 13 de Dezembro às 14:30h
Auditório da Escola de Ciências, Gualtar

Electrochemical Ionic Synapses for Analog Deep Learning and Beyond

Bilge Yildiz
Massachusetts Institute of Technology

Resumo:

Deep learning is a powerful algorithm for machine learning applications such as computer vision and natural language processing. However, the training of these neural networks is limited by the traditional von Neumann architecture of our current CPUs and GPUs, which results in significant energy consumption. In this talk, I will share our work on the ionic electrochemical synapses, whose conductivity we can control deterministically by electrochemical insertion/extraction of dopant ions across the active device layer. The protons present very low energy consumption, on par with biological synapses in the brain, while magnesium ions present with better stability without the need for encapsulation. The modeling results indicate the desirable material properties, such as ion conductivity and interface charge transfer kinetics, that we must achieve for fast (ns), low energy (< fJ) and low voltage (1V) performance of these devices. Our findings provide pathways towards brain-inspired hardware that has high yield and consistency and uses significantly lesser energy as compared to current computing architectures.

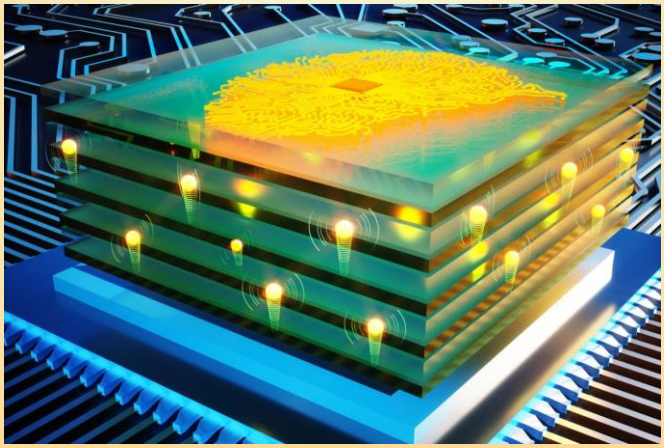

Illustration of an analog deep-learning processor powered by ultra-fast protonics. Credit: Ella Maru Studio, Murat Onen.

About the Speaker:

Yildiz is the Breene M. Kerr (1951) Professor in the Nuclear Science and Engineering and the Materials Science and Engineering Departments at Massachusetts Institute of Technology (MIT). Yildiz's research focuses on laying the scientific groundwork to enable next generation electrochemical devices for energy conversion and information processing. Yildiz's teaching and research efforts have been recognized by the Argonne Pace Setter (2006), ANS Outstanding Teaching (2008), NSF CAREER (2011), IU-MRS Somiya (2012), the ECS Charles Tobias Young Investigator (2012), the ACerS Ross Coffin Purdy (2018), the LG Chem Global Innovation Contest (2020), and the Royal Society of Chemistry's Faraday Medal (2024) awards. She is a Fellow of the American Physical Society (2021), the Royal Society of Chemistry (2022), and the Electrochemical Society (2023) and an elected member of the Austrian Academy of Science (2023).