

We are living in an exciting era, where practical technologies and theoretical concepts from different fields, such as computer science, microelectronics, nanoscience, brain science, communication and more, merge to create what would have been considered science fiction only decades ago. For instance, the "Internet of Things (IoT)" has already made smart homes, remote medical monitoring and autonomous transport an everyday reality. All of these systems and many more are based on some kind of data (temperature/blood pressure/speed/etc.), which is collected, communicated, processed and leveraged to actuate devices. However, despite the impressive progress we are witnessing each day, there are some bottlenecks that are slowing down the development of ever more accurate, speedy and energy-efficient solutions to the challenging problems that scientists and engineers are trying to tackle.

In this research, the team proposes a paradigm change in the way data is converted from its raw collected form to digital formats (using a device known as an analog-to-digital converter (ADC)), where it can be efficiently processed and made useful. (The same concepts apply for the reverse direction of digital-to-analog converters (DACs), where digital data interfaces with the physical world.) The outstanding achievement of the proposed methodology lies in its excellent figure-of-merit (FoM), defined as an optimal compromise between high accuracy and speed and low energy consumption. A second breakthrough advantage of the proposed methodology is its ability to adapt to very different demands, in contrast to the highly customized solutions offered by the current methodologies for specific applications. This advantage also finds expression in significant cuts in development costs and time-to-market for new devices, since they do not need to meet rigid application-specific specifications.

The key concept underpinning the proposed methodology is machine learning (ML). In ML the device "learns" the nature of the data from an initial training set and then uses this system model to predict system behavior and optimize different system parameters that can be controlled. This, in itself, is a cutting edge tool that is at the forefront of engineering design in many different disciplines. Another key feature of this proposal is the employment of a state-of-the-art component called a memristor that is a miniature and energy-efficient storage device.

The authors have simulated their proposed converters and demonstrated an ultra-low FoM, well below the trendline of competing data conversion solutions from published literature. In other published journal papers they have reported initial experimental results proving the feasibility of their concept. They have also outlined future extensions of their published work to scale up their current work.