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Introduction

The memristor's intrinsic device dynamics can be harnessed to efficiently conduct radionuclide classification computations. However, hardware implementations are limited by the finite number of memristor states and its distribution.

Methodology

A memristor-based neuromorphic computing radioisotope classifier platform is proposed and the effects of the memristor state distributions on classification precision are assessed. Neurophysiological mimesis is achieved by implementing a locally competitive algorithm (LCA) to enact a sparse coding computing capable of conducting radioisotope classification tasks. To calibrate the neuromorphic platform, radioisotope data from the United States National Nuclear Data Center was used. The classification accuracy assessment was conducted with different levels of signal-to-noise ratios: 100, 10 and 1.

Results

The radioisotope classification experiment was conducted for memristor state distribution where the weights mapped by the memristor are given by:

$$w_n = \left[\frac{x}{n-1} \right]^N, \text{ where } x \in [0, \dots, n-1]$$

Figure 1. Classification Accuracy with Linear Weight Distribution

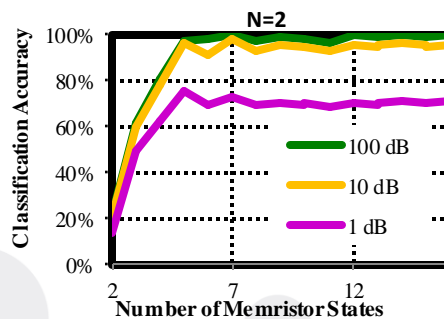
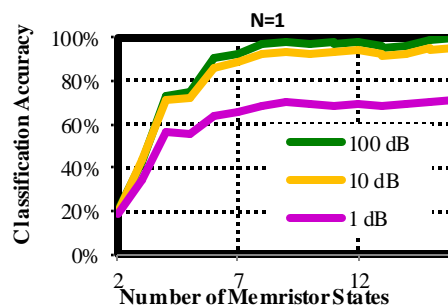


Figure 2. Classification Accuracy with Weight Distributions that have higher density in the low resistivity ranges.

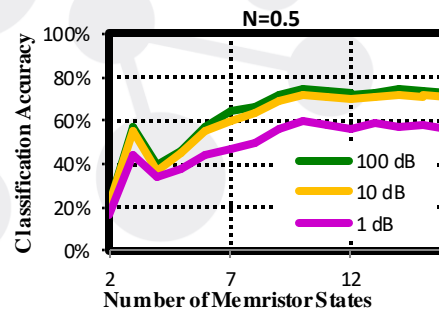
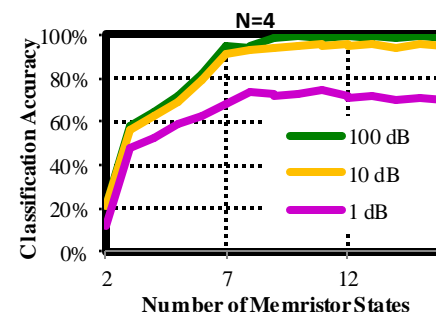
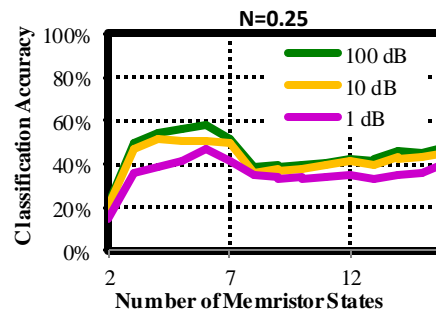


Figure 3. Classification Accuracy with Weight Distributions that have higher density in the high resistivity ranges.



Conclusions

An optimized local competitive algorithm has been assessed for the feasibility of its implementation to develop an energy-efficient radionuclide identification neuromorphic computing platform. The system was tested using spectra data obtained from the United States National Nuclear Data Center as the classification database dictionary. Identification accuracy was measured using test signals with 100, 10 and 1 signal-to-noise ratios. It has been shown that the system is highly effective for classifying radioisotopes with linear weight distribution even with high levels of noise present. A minor classification accuracy improvement was also observed for weight states distributions with a higher density of values in the low conductivity range. Therefore, it is concluded that a memristor-based radionuclide classifier should have at least 4 possible states mapping the algorithm's synaptic weights.

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Interest Conflicts: None