Graduate School of Science and Technology Master's Thesis Abstract

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Abstract

As the need for neural network (NN) learning and inference on edge devices rises, memristor crossbar (MC) devices have emerged in neuromorphic computing systems (NCS). These devices offer significant potential for accelerating the NNs. The occurrence of stuck-at faults (SAFs) within MC devices presents a huge challenge by markedly reducing the inference accuracy in NCS. In this study, we investigate some challenges associated with existing methods for SAF tolerance, focusing particularly on retraining and mapping. While retraining is capable of tolerating SAFs, it is a time-consuming process as it requires training for each different faulty MC device. In addition, the mapping methods are adopted to tackle SAFs in faulty MC devices. Although various mapping methods employ redundant MCs, several methods address SAFs by minimizing sensitivity variations in the NN's weights without relying on redundant MCs. Our research proposes a reliability-aware design framework for NCS that does not involve retraining. This framework integrates SAF-injected training and efficient mapping without using redundant hardware. To assess the effectiveness of our framework, we perform multiple experiments using a multi-layer perceptron (MLP) and the AlexNet model. Our experimental results indicate that the proposed framework significantly enhances the reliability of NCS, achieving high inference accuracy across different faulty MC devices.