**Stochastic Computing-Based Energy Aware (SEA) Accelerators**

*Introduction*

*Duty Cycle Calculator*

The most important algorithm throughout the process of development was the duty cycle finder for all pulses. Using the duty cycle, all stages of operation (convolution, activation, and pooling) can be verified by comparing the program output to theorical values that were pre-determined. Additionally, using the duty cycles allowed for more efficient comparison of outputs between the C++ algorithm and MATLAB script because the vectors generated were at a length of 2 million. An additional helper function was made to find the average duty cycle over all pulses.

To find the duty cycle, the pulse is scanned until a rising edge is found and that value is stored. Then, the falling edge is found and stored. Finally, the rising edge that comes after the falling edge is found. Once all three values have been found, the ratio between the high pulse and low pulse can be calculated. This is a modified version of MATLAB’s duty cycle function that uses midpoints instead of rising and falling edges.

A picture containing shoji

Description automatically generated

**Figure 1:** Order of duty-cycle scanning

*Asynchronous Sigma Delta Modulator and Stochastic Computing Adder*

Prior to the development of this project, a behavioral model of the Asynchronous Sigma Delta Modulator (ASDM) and Asynchronous Stochastic Computing Adder (ASC adder) were created in MATLAB. The first step in developing the architecture was to convert the MATLAB script to C++. Afterwards, the test benches were made in C++ based off the ones modeled in MATLAB. The ASDM and ASC adder were verified by comparing the duty cycles generated within C++ to the MATLAB script.

*Convolution Function*

Once the ASDM and ASC adder were finished, the convolution function was the first stage that could be modeled. At first, a small-scale model was made using only 1 column with 4 rows as a proof of concept. For the memory cells, the array created by Neurosim was originally used, which was modified to remove unneeded dependencies and to change the read operation to return the conductance of a cell instead of calculating the current.