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Semester project report

Implementation of GRU algorithm on FPGA for epileptic seizure detection

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3. Introduction
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N-M-1 network under supervised learning

* + 1. Forward equations

Where N is the number of neurons in the first layer, the weights between layer 0 and 1 and the biases for each neuron of the second layer (layer 1). can be a sigmoid function, tanh, reLU or other non-linear functions. is the - neuron in the second (hidden) layer.

The example of a single output layer is taken:

Where M is the number of neurons in the 2nd layer, and is the output of the neural network.

* + 1. Error calculation

The error is a function of the parameters of the network and can be defined as follows:

is the target, i.e. the correct value of output for a given set of inputs. The goal of supervised training is to find the parameters of the network to minimize E.

* + 1. Gradient descent and backpropagation

To minimize E, one can to apply the gradient descent algorithm, therefore the partial derivatives of E should be calculated.

By making use of the chain rule:

The following expressions can be derived:

Then, to compute the derivative of the error with respect to the weights and biases of the first layer, one should apply the chain rule to the following expression:

Based on that, the new value for the coefficients can be computed, following the gradient descent algorithm. The following equations give the expressions for the coefficients at iteration k+1 based on the values at the previous iteration of the algorithm and is the learning rate which can be either constant or variable depending on the implementation and the requirements.

* + 1. Matrix formulation

Forward equations (single input sample and single output neuron)

Derivative of the error with respect to the parameters: