**COMP 3710 Applied Artificial Intelligence**

**Seminar/Lab 8.**

**Backpropagation Neural Network**

1. Objectives

* Image recognition with a backpropagation neural network

1. We are planning to train a backpropagation neural network to recognize digits.

Here is the algorithm.

For each training epoch

For each training image, Image

Outputs\_I = Inputs = Image;

For each node, j, in the hidden layer

Xj = sum of (Outputs\_I[i] \* Weights\_IH[i][j]);

Xj -= THRESHOLD; // If it is applicable

Outputs\_H[j] = activate(Xj); // Activation function

For each node, j, in the output layer

Xj = sum of (Outputs\_H[i] \* Weights\_HO[i][j]);

Xj -= THRESHOLD; // If it is applicable

Outputs\_O[j] = activate(Xj);

Outputs = Outputs\_O;

For each node, j, in the output layer

Errors[j] = Expected\_outputs[j] – Outputs[j];

For each node, j, in the output layer

Deltas\_O[j] = Outputs\_O[j] \* (1 – Outputs\_O[j]) \* Errors[j];

For each node, j, in the hidden layer

Dj = sum of (Weights\_HO[j][k] \* Deltas\_O[k]);

Deltas\_H[j] = Outputs\_H[j] \* (1 – Outputs\_H[j]) \* Dj;

For each node, j, in the hidden layer

For each node, k, in the output layer

Weights\_HO[j][k] += Alpha \* Outputs\_H[j] \* Deltas\_O[k];

For each node, j, in the input layer

For each node, k, in the hidden layer

Weights\_IH[j][k] += Alpha \* Outputs\_I[j] \* Deltas\_H[k];

1. Implementation of BNN

* Sigmoid activation function, not step function, should be used.
* Constants
  + NO\_TRAINING\_EPOCHS
  + NO\_IMAGES\_IN\_TRAINING\_DATA\_SET
  + NO\_NODES\_INPUT\_LAYER
  + NO\_NODES\_HIDDEN\_LAYER
  + NO\_NODES\_OUTPUT\_LAYER
  + THRESHOLD
  + ALPHA
* Global arrays
  + Training\_data\_set\_input[0][], Training\_data\_set\_input[1][] for ‘A’ and ‘B’ respectively
  + Weights\_input\_hidden\_layers[][] between input layer and hidden layer
  + Weights\_hidden\_output\_layers[][] between hidden layer and output layer
  + Outputs\_input\_layer[]
  + Outputs\_hidden\_layer[]
  + Outputs\_output\_layer[]
  + Expected\_outputs[0][], Expected\_outputs[1][] for ‘A’ and ‘B’ respectively
  + Errors[]
  + Deltas\_output\_layer[]
  + Deltas\_hidden\_layer[]

You need complete the posted program after you complete the exercise program.

1. Submission
   * The title of the mail should include your name, id, and COMP 3710.

* You need to submit the application in 3) by email.
  + Due:
    - 11:59 pm, March 11, 2019 – with bonus 10%
    - 6:00 pm, March 13, 2019 – with the full marks
    - 6:00 pm, March 14, 2019 – with penalty 5%
    - 6:00 pm, March 15, 2019 – with penalty 10%
* Total marks: 15