**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