

## Graphs, Algorithms and Neural Networks

Prologue: The list below is adaptive, resilient, abundant, as well as complex, revealing a rich pattern of interconnections which store and add information and follow a processing pattern characterized by a slow but massively parallel processing order which is also fault-tolerant and subject to anarchic (not quite) control. **The emphasis will be on Neural Networks.** Graphs will provide topological fundamentals for the course. Several algorithms to implement learning rules are discussed in detail. MATLAB Neural Network Toolbox is used and recommended for solving problems.

Goal: To develop good theory for good practice.

- Basics of neuroscience, McCulloch-Pitts neuron, linear threshold function (Chapter 1)
- Linear graphs: terminologies, Eulerian and Hamiltonian graphs, multipartite graphs, layered graphs, matrix representations of graphs, Voronoi diagrams (Notes provided from text by N. K. Bose and P. Liang, McGraw-Hill, 1995).
- Adalines and Madalines, LMS learning algorithm, Hebbian learning, perceptron learning algorithm, learning and generalization (Chapter 2)
- Feedforward and feedback networks, supervised learning in general, multilayer feedforward network and backpropagation method, radial basis function network (Chapter 3)
- Unsupervised learning networks; Hamming net and MAXNET, competitive learning network, ART, LVQ, role of reinforcement learning (Chapter 4)
- Associative memory; Hopfield feedback network and its convergence; Boltzmann machine and its learning algorithm (Chapter 5)
- Neural network applications (spread over the course); solutions to traveling salesman problem, image processing by neural networks, data compression through neural network approaches, character recognition, pattern classification and control and communication applications of neural nets (selected items).

Text: F. Ham and I. Kostanic, *“Principles of Neurocomputing for Science and Engineering Applications,”* McGraw-Hill Book Co., 2001

Reference: N.K. Bose and P. Liang, *“Neural Network Fundamentals with Graphs, Algorithms and Applications,”* McGraw Hill Book Co., 1995

References: Several kept on reserve (list provided separately)

Why?: R. E. Bellman and E. Cooke, *“Algorithms, Graphs and Computers,”* Academic Press, 1970 (Call T57.83B4, Engr. Library) serves to provide justification for the title of this course. Note “Neural Networks” replaces “Computers.” Graphs have been richly exploited in the latter and this course emphasizes the need for that to happen in the former. Algorithms have to cater to the restrictions and assumptions in brain-style processing.

Epilogue: If we are convinced that brain-style processing is the best, is it realistic to mimic neuro-synaptic biological mechanisms by Artificial Neural Systems?