

1 Basic concepts of Neural Networks and Fuzzy Logic Systems	1-1
1.1 Biological Fundamentals of Neural Networks	1-5
1.2 A simplistic model of a biological neuron	1-8
1.3 Taxonomy of neural networks	1-13
1.4 Models of artificial neurons	1-15
1.5 Types of activation functions	1-19
1.6 A layer of neurons	1-23
1.7 Multi-layer feedforward neural networks	1-25
1.8 Static and Dynamic Systems — General Concepts	1-26
1.9 Continuous-time dynamic systems	1-27
1.9.1 Discrete-time dynamic systems	1-28
1.9.2 Example: A continuous-time generator of a sinusoid	1-30
1.9.3 Example: A discrete-time generator of a sinusoid	1-32
1.10 Introduction to learning	1-34
2 Perceptron	2-1
2.1 A Perceptron as a Pattern Classifier	2-3
2.2 Example — a three-synapse perceptron	2-6
2.3 Selection of weights for the perceptron	2-7
2.3.1 Selection of weights by off-line calculations — Example	2-8
2.4 The Perceptron learning law	2-9
2.5 Implementation of the perceptron learning law in MATLAB — Example	2-14
2.6 A modified perceptron learning rule	2-22
2.7 Intersection of a cube by a plane. A 2-D case.	2-24
2.8 Design Constraints for a Multi-Layer Perceptron	2-26
3 ADALINE — The Adaptive Linear Element	3-1
3.1 Linear approximation of a p -variable function	3-2
3.2 Method of steepest descent	3-13
3.3 The LMS (Widrow-Hoff) Learning Law	3-18
3.4 A Sequential Regression algorithm	3-22
3.5 ADALINE as an adaptive linear filter	3-29
3.5.1 Adaptive Prediction with Adaline — Example (adlpr.m)	3-31
A.P. Papliński	0-1

3.5.2 Adaptive System Identification	3-34
3.5.3 Adaptive Noise Cancelation	3-36
4 Feedforward Multilayer Neural Networks — part I	4-1
4.1 Multilayer perceptrons (MLPs)	4-3
4.2 Detailed structure of a Two-Layer Perceptron — the most commonly used feedforward neural network	4-7
4.3 Example of function approximation with a two-layer perceptron	4-8
4.4 Structure of a Gaussian Radial Basis Functions (RBF) Neural Network	4-9
4.5 Example of function approximation with a Gaussian RBF network	4-10
4.6 Error-Correcting Learning Algorithms for Feedforward Neural Networks	4-11
4.7 Steepest Descent Backpropagation Learning Algorithm for a Multi-Layer Perceptron	4-15
4.7.1 Output layer	4-16
4.7.2 Hidden layer	4-19
4.7.3 Alternative derivation	4-22
4.7.4 The structure of the two-layer back-propagation network with learning	4-26
4.8 Example of function approximation (fap2D.m)	4-29
5 Feedforward Multilayer Neural Networks — part II	5-1
5.1 Image Coding using Multi-layer Perceptrons	5-1
5.2 Paint-Quality Inspection	5-6
5.3 NETtalk	5-10
5.4 Efficient initialization of the learning algorithms	5-12
5.5 Why backpropagation is slow	5-17
5.6 Examples of error surfaces	5-18
5.7 Illustration of sensitivity to a learning rate	5-22
5.8 Heuristic Improvements to the Back-Propagation Algorithm	5-24
5.8.1 The momentum term	5-24
5.8.2 Adaptive learning rate	5-25
5.9 Line search minimisation procedures	5-26
5.10 Conjugate Gradient Algorithm	5-29
5.11 Newton's Methods	5-31
5.12 Gauss-Newton method	5-33
5.13 Levenberg-Marquardt algorithm	5-37
A.P. Papliński	0-2

5.13.1	The algorithm	5-37
5.13.2	Calculation of the Jacobian matrix	5-38
5.13.3	Output layer	5-39
5.13.4	Hidden layer	5-40
5.13.5	Some computational details	5-43
5.14	Speed comparison	5-44
6	Self-Organizing Neural Networks	6-1
6.1	Supervised and Unsupervised Learning	6-1
6.2	Hebbian learning	6-5
6.2.1	Basic structure of Hebbian learning neural networks	6-5
6.2.2	Stable Hebbian learning	6-8
6.2.3	A single neuron case — the Oja's rule	6-10
6.3	Self-Organizing Principal Component Analysis	6-13
6.3.1	Structure of a single synapse implementing the Generalised Hebbian Learning	6-14
6.3.2	A matrix form of the Generalised Hebbian Learning	6-15
6.4	Example of image compression using GHA	6-18
7	Competitive Neural Networks	7-1
7.1	The similarity-Measure Layer	7-2
7.2	The Competitive Layer	7-7
7.3	Unsupervised Competitive Learning	7-12
7.4	Competitive Learning and Vector Quantization	7-18
8	Self-Organizing Feature Maps	8-1
8.1	Feature Maps	8-4
8.2	Learning Algorithm for Self-Organizing Feature Maps	8-8
8.3	A demo script sofm.m	8-11