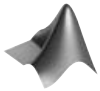
C Software

Introduction

We have used MATLAB, a numeric computation and visualization software package, in this text. However, MATLAB is not essential for using this book. The computer exercises can performed with any available programming language, and the *Neural Network Design Demonstrations*, while helpful, are not critical to understanding the material covered in this book.

MATLAB is widely available and, because of its matrix/vector notation and graphics, is a convenient environment in which to experiment with neural networks. We use MATLAB in two different ways. First, we have included a number of exercises for the reader to perform in MATLAB. Many of the important features of neural networks become apparent only for large scale problems, which are computationally intensive and not feasible for hand calculations. With MATLAB, neural network algorithms can be quickly implemented, and large scale problems can be tested conveniently. If MATLAB is not available, any other programming language can be used to perform the exercises.



The second way in which we use MATLAB is through the *Neural Network Design Demonstrations*, which can be downloaded from the website hagan.okstate.edu/nnd.html. These interactive demonstrations illustrate important concepts in each chapter. The icon to the left identifies references to these demonstrations in the text.

MATLAB, or the student edition of MATLAB, version 2010a or later, should be installed on your computer in a a folder named MATLAB. To create this directory or folder and complete the MATLAB installation process, follow the instructions given in the MATLAB documentation. Take care to follow the guidelines given for setting the path.

After the Neural Network Design Demonstration software has been loaded into the MATLAB directory on your computer (or if the MATLAB path has been set to include the directory containing thedemonstration software), the demonstrations can be invoked by typing **nnd** at the MATLAB prompt. All demonstrations are easily accessible from a master menu.

Overview of Demonstration Files

Running the Demonstrations

You can run the demonstrations directly by typing their names at the MATLAB prompt. Typing **help nndesign** brings up a list of all the demos you can choose from.

Alternatively, you can run the Neural Network Design splash window (**nnd**) and then click the Contents button. This will take you to a graphical Table of Contents. From there you can select chapters with buttons at the bottom of the window and individual demonstrations with popup menus.

Sound

Many of the demonstrations use sound. In many cases the sound adds to the understanding of a demonstration. In other cases it is there simply for fun. If you need to turn the sound off you can give MATLAB the following command and all demonstrations will run quietly:

```
nnsound off
```

To turn sound back on:

```
nnsound on
```

You may note that demonstrations that utilize sound often run faster when sound is off. In addition, on some machines which do not support sound errors can occur unless the sound is turned off.

List of Demonstrations

General

nnd - Splash screen.
nndtoc - Table of contents.
nnsound - Turn Neural Network Design sounds on and off.

Chapter 2, Neuron Model and Network Architectures

nnd2n1 - One-input neuron.
nnd2n2 - Two-input neuron.

Chapter 3, An Illustrative Example

nnd3pc - Perceptron classification.
nnd3hamc - Hamming classification.
nnd3hopc - Hopfield classification.

Chapter 4, Perceptron Learning Rule

nnd4db - Decision boundaries.
nnd4pr - Perceptron rule.

Chapter 5, Signal and Weight Vector Spaces

nnd5gs - Gram-Schmidt.
nnd5rb - Reciprocal basis.

Chapter 6, Linear Transformations for Neural Networks

nnd6lt - Linear transformations.
nnd6eg - Eigenvector game.

Chapter 7, Supervised Hebbian Learning

nnd7sh - Supervised Hebb.

Chapter 8, Performance Surfaces and Optimum Points

nnd8ts1 - Taylor series #1.
nnd8ts2 - Taylor series #2.
nnd8dd - Directional derivatives.
nnd8qf - Quadratic function.

Chapter 9, Performance Optimization

nnd9sdq - Steepest descent for quadratic function.
nnd9mc - Method comparison.
nnd9nm - Newton's method.
nnd9sd - Steepest descent.

Chapter 10, Widrow-Hoff Learning

nnd10nc - Adaptive noise cancellation.
nnd10eeg - Electroencephalogram noise cancellation.
nnd10lc - Linear pattern classification.

Chapter 11, Backpropagation

nnd11nf - Network function.
nnd11bc - Backpropagation calculation.
nnd11fa - Function approximation.
nnd11gn - Generalization.

Chapter 12, Variations on Backpropagation

nnd12sd1- Steepest descent backpropagation #1.
nnd12sd2 - Steepest descent backpropagation #2.
nnd12mo - Momentum backpropagation.
nnd12vl - Variable learning rate backpropagation.
nnd12ls - Conjugate gradient line search.
nnd12cg - Conjugate gradient backpropagation.
nnd12ms - Maquardt step.
nnd12m - Marquardt backpropagation.

Chapter 13, Generalization

nnd13es - Early stoppinng.
nnd13reg - Regularization.
nnd13breg - Bayesian regularization.
nnd13esr - Early stopping/regularization.

Chapter 14, Dynamic Networks

nnd14fir - Finite impulse response network.
nnd14iir - Infinite impulse response network.
nnd14dynd - Dynamic derivatives.
nnd14rnt - Recurrent network training.

Chapter 15, Associative Learning

nnd15uh - Unsupervised Hebb.
nnd15edr - Effect of decay rate.
nnd15hd - Hebb with decay.
nnd15gis - Graphical instar.
nnd15is - Instar.
nnd15os - Outstar.

Chapter 16, Competitive Networks

nnd16cc - Competitive classification.
nnd16cl - Competitive learning.
nnd16fm1 - 1-D feature map.
nnd16fm2 - 2-D feature map.
nnd16lv1 - LVQ1.
nnd16lv2 - LVQ2.

Chapter 17, Radial Basis Networks

nnd17nf - Network function.
nnd17pc - Pattern classification.
nnd17lls - Linear least squares.
nnd17ols - Orthogonal least squares.
nnd17no - Nonlinear optimization.

Chapter 18, Grossberg Network

nnd18li - Leaky integrator.
nnd18sn - Shunting network.
nnd18gl1 - Grossberg layer 1.
nnd18gl2 - Grossberg layer 2.
nnd18aw - Adaptive weights.

Chapter 19, Adaptive Resonance Theory

nnd19al1 - ART1 layer 1.
nnd19al2 - ART1 layer 2.
nnd19os - Orienting subsystem.
nnd19a1 - ART1 algorithm.

Chapter 20, Stability

nnd20ds - Dynamical system.

Chapter 21, Hopfield Network

nnd21hn - Hopfield network.