

31YB Tutorial 2: MLP/BP and ANN applications (on 6th November 2003)

Q1. Write a program (in any language, C++/Java etc.) which implements the PLR, and check that it works when used to implement/solve a simple 2-input AND problem.

Can you plot a decision surface for the PLR.

Q2. [NOT Examinable] To prove the learning algorithm for the Delta Rule, show that it implements gradient descent in a suitable measure of the error, E ? (For simplicity, assume that the output is equal to the activation level, that is, no activation function is employed)

Does the size of the learning coefficient η matter, discuss?

Try to extend the above DR to units with a non-linear activation function, such as the *tanh* and *logistic* functions?

Finally, try to extend the above to a Multi-Layered Perceptron, and derive the Back Propagation (BP) algorithm (also known as the Generalized Delta Rule)

Hint: A rule of partial differentiation:

If $E=(d-y)^2$ and $y=f(w)$, then partial derivative: $\partial E/\partial w = (\partial E/\partial y) \cdot (\partial y/\partial w) = -2 \cdot (d-y) \cdot (\partial y/\partial w)$

Q3. Calculate the number of weights in the following networks:

- A single-layer network (i.e. 1 layer of output units) with 20 units and 30 inputs (excluding bias).
- A layered feedforward MLP network with 10 inputs, 4 hidden units, and 5 output units. Each unit also has a bias input.
- A layered feedforward MLP network with M inputs, $H1$ units in the first hidden layer, $H2$ units in the second hidden layer, and N outputs. Each unit also has a bias input.

Q4. Discuss the issues of overfitting and generalization, and discuss how the concept of generalization applies to classification and regression problems. What does the curse of dimensionality mean.

Can one assess whether a neural network will generalize appropriately?

Q5. Is it normal to start up a Back Propagation (BP) problem from a number of different locations in weights space. If so, why?

Considering the answer to above, could one do better than simply selecting these start-points randomly?

Applications of ANN

Q6. Discuss how you may use a Neural Network for financial forecasting (predicting shares of a corporation for example)? What inputs and outputs would you choose, and why?

Q7. Discuss how one might apply ANN to the following problem:

A system is required to attempt to predict failures in a large motor inside a gas pumping station. The system has a number of sensors, measuring:

- Temperature of the motor rotor
- Speed of the motor rotor
- Gas flow rate
- Vibration level

In addition, there is a microphone which can be used to monitor the sound produced by the motor.

In normal operation, the motor will run continuously; however, for the purposes of generating the test data, the motor can be started and stopped, and a variety of faults induced.

Q8. Discuss how neural networks can be used in:

- investment analysis:
- signature analysis:
- process control:
- monitoring:
- marketing: