161.326: Statistical Machine Learning
Assignment 3

Semester 2, 2010

This assignment is due on **Monday 18th October**, and is worth 20% of your grade. Each of the four questions is worth 5%. The assignment should be submitted through WebCT in the form of a zip file containing your write up (as a text file; Word or pdf file is also sufficient) and all of the programs that you used, as well as the output from them. We must be able to extract and run your code, and reproduce your results.

1. Divide the SA heart disease data into 2/3 training and 1/3 test data (the first 2/3 should be the training data). Modify the program 'heart_logreg.py' to include the quadratic terms $xi \times xi$ (be careful with 'famhist'). Identify a good parsimonious model using the z-values, and validate this on the test data by examining its error rate against models using up to three parameters more. Discuss.

2. Modify 'heart_nbc.py' (lecture slides 9.46) to classify the iris data available on Stephen's website (attached as 'iris.txt'). Randomly select 2/3 of the data as a training set and 1/3 as a test set, and evaluate the error rate relative to that of linear discriminant analysis (lecture slides 8.23-8.26). Repeat 100 times and discuss.

3. Convert the GA to use real-valued chromosomes and use it to find the minima in Rosenbrock's function:

$$f(x_1, x_2) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2. \tag{1}$$

   This is a common problem to try since it has a long narrow valley, so finding the optimal solution is not especially easy (except by hand: if you look at the problem, then guessing that $x_1 = 1, x_2 = 1$ is the minimum is fairly obvious).

   You will need to modify the representation and the way that mutation is done.

4. Implement a reinforcement learning that places noughts-and-crosses using Q learning. Make the opponent play completely randomly, so that any possible square can be used. (Hint: Describe the state with a string of 9 characters, with '.' for unused squares, 'x' and 'o' for the others. Then work out the winning/losing/drawing states, and an appropriate reward scheme.)