[Lab] Feedforward Neural Network (FFNN)

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Lab due: Before the end of today lab session
Evaluation: Code and explanation about the code (in groups of 2 or 3 people (preferably 3))
Remark:

- Only groups of two or three people accepted (preferably three).
- Before you leave today lab session, you need to show the lab task results to the professor.
- Neither late lab evaluation nor make-up lab session are possible.
- No plagiarism. If plagiarism happens, both the "lender" and the "borrower" will have a zero.
- Code yourself from scratch. No lab work will be considered if any ML library is used.
- Do thoroughly all the demanded tasks.
- Study the theory for the questions.

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1 Pre-Lab (Do this before lab session)

1. Download the data stored in the file `data_ffnn_3classes.txt` available on the course website. This dataset consists of three columns: $x1$, $x2$ and y. Notice that this is a multi-class problem (in particular 3 classes).

2. Note: Use all the given data as training data.

3. Implement the forward propagation of a feedforward neural network (FFNN) consisting of three layers, in which the hidden layer has K neurons (at your choice). Remember you need to arrive to show the error results (i.e., define X, $\overline{X}$, V, $\overline{\overline{X}}$, F, $\overline{F}$, W, $\overline{\overline{F}}$, G, and E).

2 Lab (Due before the end of today lab session)

1. Show graphically the training data with colors associated to their classes (you choose the colors).

2. Implement the back propagation of the above FFNN with the purpose to optimize the model parameters. That is, train your model to learn how to solve the above multi-classification problem.

3. Show that your algorithm converges by illustrating the error reduction at each iteration (either graphically or by listing the error values for the considered iterations).

4. Show the optimal parameter values for the hidden layer (v) and for the output layer (ω).

5. Show that your classifier works properly by comparing the predicted output values ($\hat{y}$) to the actual training output values (y).

6. Test your optimized model by doing forward propagation over the following test data set: (x_1, x_2)=$(2, 2)$, (x_1, x_2)=$(4, 4)$, and (x_1, x_2)=$(4.5, 1.5)$.

7. Show the test results graphically by plotting the test data points with the colors corresponding to their estimated output values.

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