[Lab] Feedforward Neural Network (FFNN)

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Lab due: Before the end of today lab session.
Evaluation: Show and explain the code and results to the professor.
Remark:

- Only groups of two or three people accepted (preferably three).
- No late homework will be accepted.
- No plagiarism. If plagiarism happens, both the "lender" and the "borrower" will have a zero.
- Code yourself from scratch **following the theory given in class**.
- **No pre-lab and lab works 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 Task

1. You need to submit also what you are expected to have done for the Pre-Lab session:

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

   b. Plot the data in 2D, each data with a color depending on its class.

   c. 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).

      * You need to show $X, \overline{X}, V, \overline{\overline{X}}, F, \overline{F}, W, \overline{\overline{F}}, G, E$.

      Remember: use all the data available in the file as training examples.

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 plotting the error reduction at each iteration.

4. What are the optimal parameter values for the hidden layer (V) and for the output layer (W)?

5. Show that your classifier works properly by comparing the predicted output values to the actual training output values (either with plot comparison or with list comparison).

6. Test your optimized model by doing forward propagation over the following test data set: $(x_1, x_2)=(0, 0)$, $(x_1, x_2)=(2, 2)$, $(x_1, x_2)=(4, 4)$, and $(x_1, x_2)=(4.5, 1.5)$.

7. Plot both the training and test classification results in 2D and compare them to the given data with given classes.

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