Feedback Neural Network (a.k.a. Recurrent Neural Network), K-means and PCA

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Lab due: Today
Homework due: Before the next 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.
- No late lab/homework will be accepted.
- No plagiarism. If plagiarism happens, both the "lender" and the "borrower" will have a zero.
- Code yourself from scratch. No lab/homework 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 Lab (Due today. Show the results to the professor.)

1.1 Recurrent neural network

1. Generate some input data (X) consisting of 40 sequences of 8 binary numbers, following a uniform distribution, where the probability of generating a "0" is the same as that of generating a "1". Make the output (y) for each sequence be the sum of its elements. Use 30 first sequences for training and the rest (10) of sequences for test.

1.2 K-means

1. Download from the course site the 2D data stored in `data_kmeans.txt` file. Use all these data for training your model.

2. Plot the data

1.3 PCA

1. Download from the course site the 2D data stored in `data_pca.txt` file. Use all these data for training your model.

2. Plot the data.

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2 Homework (Due before next lab session)

2.1 Recurrent neural network

1. Implement a sequential `adder` using the `Elman recurrent neural network (RNN)` with

   a) backpropagation,

   b) resilient propagation.

2. Show the results by comparing the outputs of your model to the actual output values for the two methods (backpropagation and resilient propagation).

3. Now, choose some (reasonably) large initial values for the model parameters and see the convergence for the two methods (backpropagation and resilient propagation).

4. Test your model with the two methods (backpropagation and resilient propagation) with the test data. Compare the results obtained from the two approaches.

2.2 K-means

1. Cluster the downloaded data using the K-means algorithm using the formulas seen in class.

2. Test your model with some new data, by generating these data by yourself.

3. Plot both training and test results in a 2D graph.

2.3 PCA

1. Implement the PCA algorithm from the formulas seen in class.

2. Indicate the principal axes of the data.

3. Test your model with some new data, by generating these data yourself.

4. Plot both training and test results in a 2D graph.