
Neural Network Theory and Applications

Homework Assignment 1

March 7, 2019

Due at March 27, 2019

1. Problem 1

- One variation of the perceptron rule is:

$$W^{new} = W^{old} + \alpha e p^T$$
$$b^{new} = b^{old} + \alpha e$$

where α is the learning rate. Prove convergence of this algorithm. Does the proof require a limit on the learning rate? Please explain.

2. Problem 2 - 01

- Suppose the output of each neuron in a multilayer perceptron network is

$$x_{kj} = f \left(\sum_{i=1}^{N_{k-1}} (u_{kji} x_{k-1,i}^2 + v_{kji} x_{k-1,i}) + b_{kj} \right)$$

for $k = 2, 3, \dots, M$ and $j = 1, 2, \dots, N_k$

where both u_{kji} and v_{kji} are the weights connecting the i -th unit in the layer $k - 1$ to the j -th unit in the layer k , b_{kj} is the bias of the j -th unit in the layer k , N_k is the number of units in the layer k ($1 \leq k \leq M$), and $f(\cdot)$ is the sigmoidal activation function.

3. Problem 2 - 02

- The structure of the unit is shown as the following figure, and this network is called multi-layer quadratic perceptron (MLQP).
- Please derive the back-propagation algorithms for MLQPs in both on-line learning and batch learning ways.

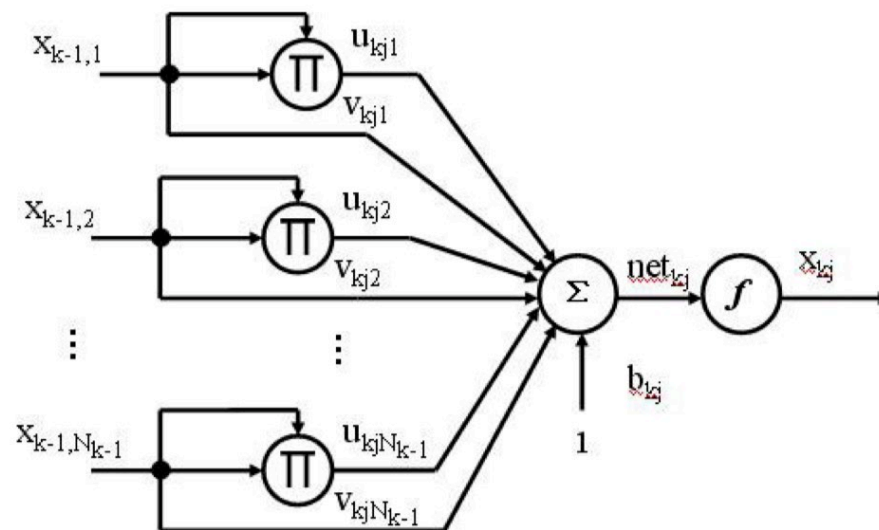


Figure 1: The structure of MLQP

4. Problem 3 - 01

- ❑ In problem 3, you should program a deep neural network with TensorFlow or PyTorch to solve an emotion recognition task.
- ❑ Model Structure
 - The deep neural network for this task is a three layer network: an input layer, an hidden layer, and an output layer. The neurons in the input layer should be the same as input feature dimensions. The number of hidden neurons is a hyperparameter which is chosen by yourself. And there are 3 output units for 3 emotions.

5. Problem 3 - 02

□ Data Description

- The provided data contains differential entropy (DE) features extracted from emotional EEG signals
- Emotions: positive, neutral, negative
- The data can be downloaded from this link:
<http://gofile.me/4gVYW/24rIP0NRX>

6. Problem 3 -03

□ Questions

- Run your code to classify three emotion states (positive, neutral, negative) and compare the training time and generalization performance of different hidden units and learning rates.

7. Report Format Requirement

- ❑ You must submit a complete report with solution details. And it is recommended to write your report with Latex.
- ❑ You must compress all your files into a ".zip" file or a ".rar" file, and the name of the compressed file is in the format "student id _ your name _ homework number" (1234567_newton_1.zip).
- ❑ Submitting your homework from this link:
<http://bcmicloud.quickconnect.to/sharing/MRSSpGF4S> and filling your student number in the webpage to upload.

8. Grading policy

- ❑ The basic rule is, if any cheating activities are identified, **both participants will be given ZERO scores for that homework.**
- ❑ Grading
 - Submission with excellent codes and report, will be given A+.
 - Submission with both good codes and report, will be given A.
 - Submission with some deficiencies in codes or report, and basically no big problems, will be given A- or B+.
 - Thought submission is not good enough, it can be given at least B, if we can identify that you have tried your best with independent and hard work

8. Late submission

- ❑ Homework is scored with full credit on the due date.
- ❑ It is scored with one less grade for late submission, i.e., your late submission will be degraded from A to B, or from B to C, if you miss the due date.