Experimental Validation of Back Propagation Algorithms for Pattern Recognition

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Abstract--- The proposed thesis aims at validating an Artificial Neural Network based Optical Character Recognition (OCR) system for its parameters. The basic idea is to tune an OCR to help people with visual impairments in learning and studies.To make this happen we study the parameters of BP algorithm and optimize them to ensure the best performance of the system using only characters. Selected algorithms are modelled and tested in MatLAB, in order to better understand the parameters.

I. INTRODUCTION

A. Background

Many forms of technology can help individuals with learning disabilities to capitalize on their strengths and bypass, or compensate for, their disabilities. Such technologies are called “Assistive Technologies”. All the technologies that can enhance the performance of people with disabilities can be conceptualized as Assistive technologies. As defined by the Individuals with Disabilities Education Act Amendments of 1997[1], assistive technology is "any item, piece of equipment, or product system . . . that is used to increase, maintain,

or improve functional capabilities of individuals with disabilities".[1]

Assistive technology is an umbrella term that comprises assistive, adaptive, and rehabilitative devices for people with disabilities and encompasses the process used in selecting, locating, and using them. Assistive technology upholds greater independence by enabling people to accomplish tasks that they were formerly unable to achieve, or had great difficulty accomplishing, by providing enhancements to, or changing methods of interacting with, the technology needed to accomplish such tasks.

B. Problem Description

This work of Thesis is part of a bigger research project in the setting of an agreement between I.Ri.Fo.R./UICI (Institute for Research, Education and Rehabilitation/Italian Union of Blind and Low Vision people) and the University of Turin. Such project aims to research on assistive technologies for visually impaired people. The idea is to develop an Optical Character Recognition (OCR) system, which can help the people with visual impairments in education and learning. The main objective of this OCR would be to automatically generate accessible texts starting from inaccessible scientific books and publications.

[1] Technology-Related Assistance Act of 1988 (P.L. 100-407, Stat., 1046, p.102)

From the very beginning, the idea was to develop a model that works as a human nervous system, since human brain is typically very good at discriminating and recognizing quickly patterns such as characters. Therefore, we must understand the anatomy and the essential properties of the nervous system (i.e. Biological Neural Networks. After successfully understanding the properties of a human brain, we are able to design abstract models of the Artificial Neural Networks (ANNs)[3] as shown in figure1.

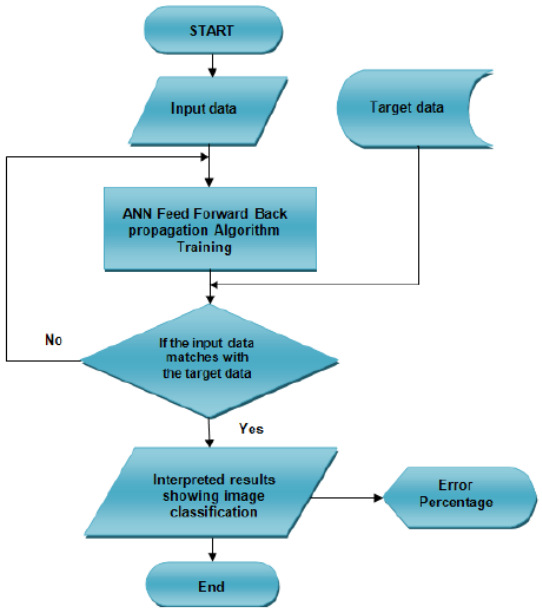

Figure 1: Flow chart showing the description of the ANN-FFBP algorithm. [1]

C. Objectives

A prior study on this topic was related to developing an ANN that could perform character recognition and people succeeded to do so but validation of the ANN was inevitable to proceed further. This thesis will prove to be a crucial step for doing so. BP algorithm consists of some important parameters, which should be optimized for the best performance of ANN and in this proposed thesis, optimization of those parameters has been performed to validate the ANN. An intensive testing and validation campaign was conducted to ensure the optimization of the parameters. It is important to discuss the parameters of ANN with BP algorithm like learning rate (eta), number of hidden neurons (N), the interval in which the weights are initialized (h) and the problems related to these parameters. The parameters must be optimized to get the best performance of the ANN.

II. MAIN ACTIVITIES CARRIED OUT

A. Implementation in MatLAB

The algorithm that we are currently working on is completely designed using MatLAB[2]. The problem definition of character recognition is not that simple, therefore, we have to define a path, and by following that path, we will achieve our desired goals. We can define the whole character recognition problem in to following major steps.

- Definition of Training and Validation Data sets
- Training
- Testing

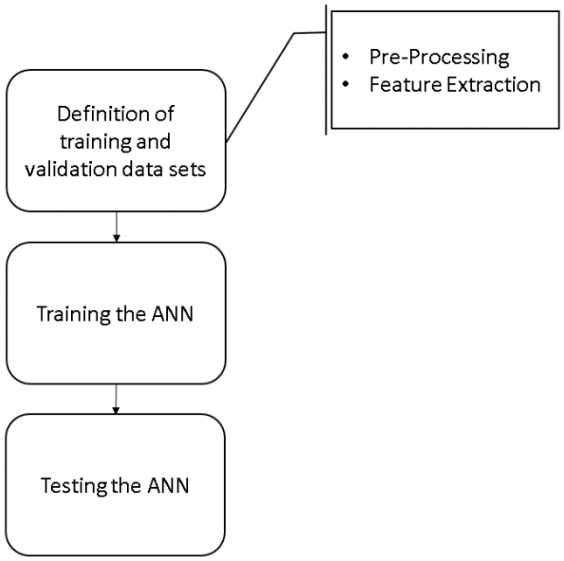

Figure 2: Stepwise activities for the parameter validation of BP algorithm

[2] https://it.mathworks.com/

III. EXPERIMENTAL RESULTS ANS FINAL REMARKS

A. Results

For the optimization of number of rows and number of columns of the training sets, we create training sets with six different values of nr and nc each, and validate the performance of the ANN. The ANN is trained for 36 different matrices using all possible values of nr and nc and parameters of BP algorithm are fixed (i.e. eta, N and h). Then ANN is validated for all the values of nr and nc. Outcomes of this test prove that the performance of the ANN does not depend on nr and nc. This is an important result, which allows us to reduce the number of data sets and make the training and testing phase faster.

After that, we train the ANN with different values of parameters eta, N and h with four selected dimensions of nr and nc. The experimental results suggest that the best values of eta, N and h, are 0.8, 120 and 0.4 respectively.

Experimental Results of Validation		
Parameters	Optimal Values	Remarks
nr	N/A	This parameters does not affect the ANN performance
nc	N/A	This parameters does not affect the ANN performance
eta	0.8	Optimal value is 0.8 as it gives the best performnace
N2	120	Performnace is better as N2 increases
h	0.4	Performnace is better as h decreases

Table 1: Experimental results for the optimal values of nr, nc, eta, N2 and h.

Furthermore, another test is carried out but this time with a training set that contain fonts of size 11 and 10. Therefore, this time we have a larger training set. We train the ANN and test it and the results are the same as stated above. Therefore, we come to know that, the performance of the system does not suffer a lot by changing the values of nr and nc, but it does change a lot when the different values of parameters of BP algorithm are used and the ANN performance is the best, when the values of eta, N and h are 0.8, 120 and 0.4. Therefore, we can see that as the number of neurons in the hidden layer increases the performance of the ANN is better. The performance of the ANN in terms of percentage of error and number of training steps is optimal when h decreases.

B. Conclusion and Future Work

This brief summary has summarized the activities carried out for the work of thesis and the results that have been achieved. The experimental results of thesis has given many interesting results that can be useful in the future. A possible future work can be validation of the same ANN for mathematical symbols and formulae. The activities would remain the same more or less except the fact that there will be need of creating new data sets for training and validation that contain mathematical symbols. After successful validation the project will go into development phase where an OCR system will be developed, that can recognize text documents that contain characters and mathematical symbols as well.

REFERENCES

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[3] Byrne, J. H. (2016). Introduction to neurons and neuronal networks.