Artificial Neural Network for Plant Tissue Culture

Abdul Qadir and Dr. Bushra Noman
SZABSIT
Karachi, Pakistan.

Abstract: *Most often it is a bit difficult to have a mathematical model to evaluate the biological processes, because they are used to be very complex. In fact many of the biological process have not yet been modeled. The Artificial Neural Networks can help us to have accurate description and evaluation of those biological processes in plant science like tissue culture and it will help us to create a system that can model real world plant tissue culture which further will then make us to be able to properly execute the real world process by first examining the result through "ANN for Plant Tissue Culture".*
Through the "ANN for Plant Tissue Culture" we can have different data sets feed into the system and then analyze them so that it could become possible for us to modify or add new inputs and have required outputs for our database to have a new understanding.

Keywords: *Artificial Neural Networks, Plant Tissue Culture, Neural Fitting Tool, Neural Network Tool*

INTRODUCTION

The Plant tissue culture is none but a method or a process where multiplication and growing of cells, tissues and organs of plants gets cultured in a fully well energized liquid media under a clean and controlled environment. So, as Plants have the capability of being cultured in vitro to give thousands of genetically and also morphologically identical plants from a single plant. Production wise this is an asexual process used commercially to propagate plants. As we all know that the Plant science is very huge and there are millions of species existing, for the very same reason focus will be only on one of these species called as Banana.

With the help of biotechnology, required genetic traits can be transferred from one organism to the other by the transfer of DNA. Plant tissue culturing can result in many more plants with desirable DNA that regenerated from small pieces of the transformed plant tissue. Commercially tissue culturing demands high input due to production of many new plants in a very short period of time. The commercial tissue culture uses combination or mixture of nutrients, hormones, proper clean environment in terms of temperature and pollution to have sterilized like condition which makes tissue culturing able to produce very new plants in shorter period of time.

Some more than 2000 years ago it was discovered that how a brain behaves and what is its' architecture, building upon that foundation laid by Aristotle the efforts were made to innovate a machine that can think like our brain and for very reason Artificial Neural Networks came into being.
The Artificial Neural Network is a system that is used to process the information, just as our brains do, it is an step towards the mapping of highly complex and massively parallel human brain with billions of neuron having trillions of interconnections into an artificial brain, so, keeping those limitations in mind, modern computing machines could easily be overcome as some of the tasks can be done easily done by humans but are very hard for the conventional computing devices based on the architecture of Von Neumann machine with algorithmic approach. These tasks are: Recognizing Patterns like friends, hand-writing, recalling content addressed memory approximately, and common sense reasoning. The basic task of neural networks is to process the input patterns and produce an output pattern relating to given input.

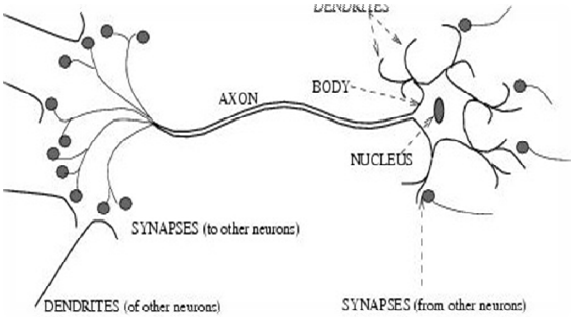
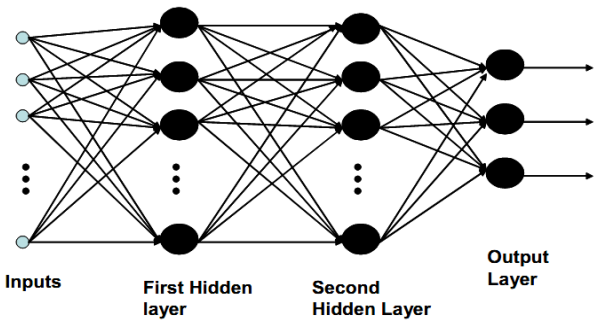


Fig: – A Biological Neuron

Each neuron possesses a body, an axon, and many dendrites that can be in one of the two states: firing and rest. The Neurons tend to fire if the total incoming signals or stimulus exceeds the threshold level. The other important portion is Synapse, a thin gap between axon of one neuron and dendrite of another neuron. Signal exchange Synaptic strength.
Where as an artificial neural network is a set of nodes known with multiple names like neurons or processing elements. Each node used to have input as well as output and each node performs a computation by its weighted connections between nodes.
Connectivity gives the structure of the net. That can be computed by a Neural Network primarily determined by their connections and weights.



Methodology

The great ability of Artificial Neural Networks to predict almost any kind of given problem was utilized. The study was aimed to model a system that could have prediction capability in Plant Tissue Culturing which is another exciting technology. The focus was to merge these two technologies' power in the system for valid predication in plant tissue culturing. The initial work was based on the requirements of having the most valid and required data sets to be used as input for the neural network to get trained, a target set of data sets to get achieved by the neural network depending upon learning mechanism of the network and testing data sets to be used after the training of Artificial Neural Network for Plant Tissue Culture so that its' validity of predication could be guaranteed. At the start of work Banana explants were brought into the tissue culturing lab for tissue culturing and their initiation was done with best possible and flexible data sets each having different mixture of plant growth factors used for initiation of Banana plant tissue culture. The total of nine data sets and each having seven elements of growth promoters were used. The progress of initiated explants was monitored after every two days and on the very 50^{th} day, the overall all data sets were collected and recorded as final to be used in training and testing of Artificial Neural Network for Plant Tissue Culture.

Considering the enormous ability of neural networks, two types of neural network trainings used are – supervised learning that is learning with a teacher and unsupervised learning which is known as learning without a teacher. To maximize the validity of prediction, three different neural networks were created, each using different method of learning.

The fitting network function (nftool) and feed forward back propagation belonging to supervised learning were used for the training and testing of network were used where as in unsupervised method of learning the Self Organizing Map was used. The Neural Network Toolbox - Matlab 2009. The fitting network contained two layer feed forward network having seven input samples each having 7 types of data elements, a single hidden layer of 20 neurons with a sigmoid transfer function and the output layer of one neurons. The network was trained using Levenberg – Marquardt back propagation algorithm (trainlm) and was found best of all three neural networks trained.

Results and Discussion

All three networks were trained with nine input data sets each having seven elements that could be increased based on the type of explants and its' requirements. The fitting network contained two layer feed forward network having seven input samples each having seven types of data elements, a single hidden layer of 20 neurons with a sigmoid transfer function and the output layer of one Neuron.

Data set 1	Data set 2	Data set 3	Data set 4	Data set 5	Data set 6	Data set 7	Data set 8	Data set 9
2.5	0	1.5	1.5	1.5	2	0	1	0.5
0	1.5	1.5	1.5	2	1.5	0	1	0.5
0	0	0	0	0.5	0.5	1.5	1	1.5
5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	5	5	5	5	5	5	5	5
0.81	**2.83**	**1.68**	**2.76**	**2.04**	**2.96**	**1.05**	**3.49**	**2.62**

Table: Real Training Data sets

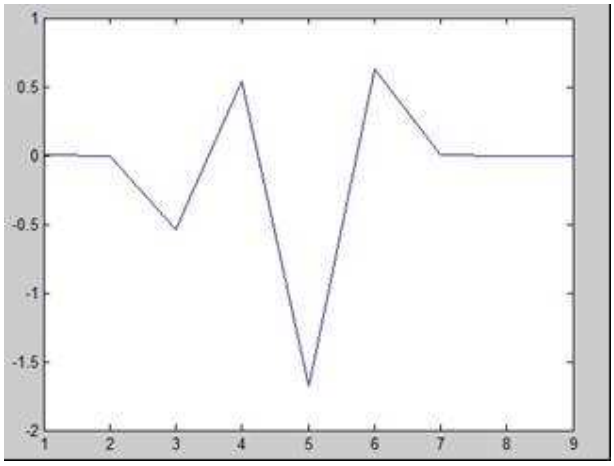


Fig: Mean Square Error

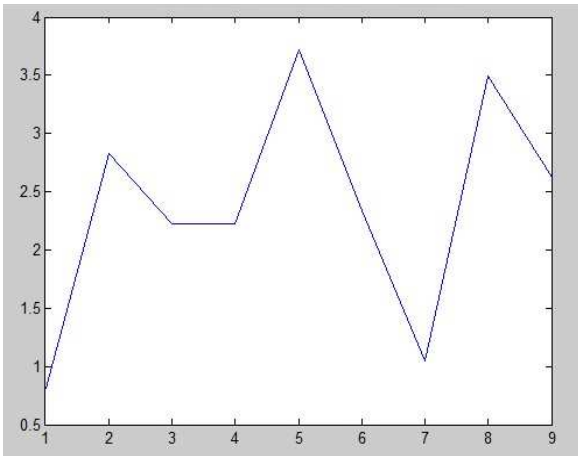


Fig: Output

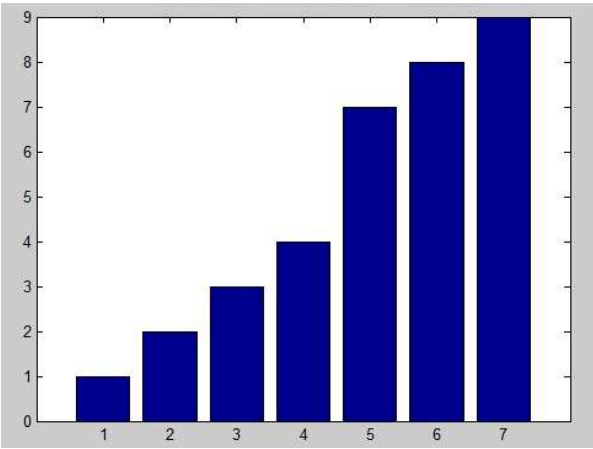
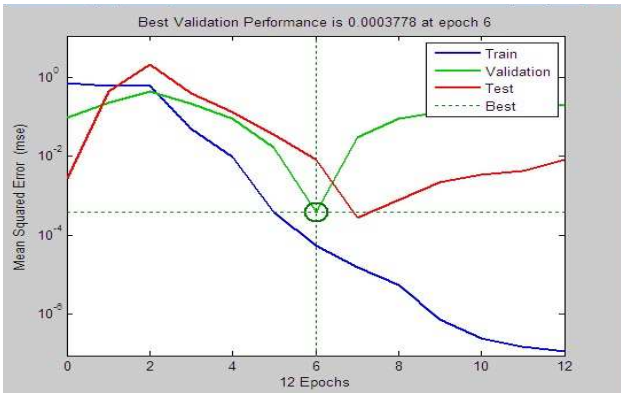


Fig: Training

Amongst all three networks, the fitting network contained two layers was found to be the most nearest to target and its' validity was also proved to be the best while being tested. Summarizing all of the above discussions, Artificial Neural Network is found to be very good solution for automation and prediction of in vitro culture of plants. It can help a great deal in saving up the resource like cost, labor, time, and could most possible efficient output results in plant tissue culturing. Artificial Neural network should be applied to prediction and automation of plant tissue culture.



REFERENCES

(1) Shakti Mehrotra, Om Prakash, B. N. Mishra & B. Dwevedi Efficiency of neural networks for prediction of in vitro culture conditions and inoculum properties for optimum productivity. Received: 30 January 2008 /Accepted: 3 June 2008 / Published online: 26 June 2008 Springer Science+Business Media B.V. 2008

(2) Use of Artificial Neural Networks for Prediction of Cell Mass and Ethanol Concentration in Batch Fermentation using Saccharomyces cerevisiae Yeast. This paper was received on September 3, 2003.

(3) Albiol J, Campmajo C, Casas C, Poch M (1995) Biomass estimation in plant cell cultures: a neural network approach. Biotechnol Prog 11:8–92. doi:10.1021/bp00031a012

(4) Ahloowalia, Vienna, Austria, J. Prakash, In Vitro International Pvt. Ltd, Bangalore, India, V.A. Savangikar, C. Savangikar, Nashik, India. Plant Tissue Culture

(5) Ahloowalia, Vienna, Austria, J. Prakash, In Vitro International Pvt. Ltd, Bangalore. Physical Components Of Tissue Culture Technology

(6) Savangikar, C. Savangikar, Nashik, India. Quality Assurance

(7) Neural Network Toolbox™ Release Notes. Copyright 2005–2010 by the MathWorks, Inc.

(8) Dr S V Dudul, Member, Dr A A Ghatol, Fellow. Identification of pH Neutralization Process using the Simplest Neural Network Model. This paper was received on February 2, 2004.

(9) Amit Sharma , Shweta Sharma, Automated Design and Implementation of Artificial Neural Network, Department of Computer Science, Chitkara University Barotiwala, Himachal Pradesh, India, amitsharmapkl@gmail.com, Department of Management, Swami Devi Dayal Institute of Management Studies, Barwala , Haryana, India.

(10) Mohammad E. Amiri. Availability of the P to Banana (Musa acuminate var. Dwarf Cavendish) Explant in vitro, Department of Horticulture, University of Zanjan, Zanjan, Iran. American-Eurasian J. Agric. & Environ. Sci., 4 (3): 280-286, 2008 ISSN 1818-6769.