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Determination of an Efficient Differentiation Pathway of Stem Cells Employing Predictory Neural Network Model

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***Abstract*—**The stem cells have ability to differentiated themselves through mitotic cell division and various range of specialized cell types. Cellular differentiation is a way by which few specialized cell develops into more specialized.This paper studies the fundamental problem of computational schema for an artificial neural network based on chemical, physical and biological variables of state. By doing this type of study system could be model for a viable propagation of various economically important stem cells differentiation. This paper proposes various differentiation outcomes of artificial neural network into variety of potential specialized cells on implementing MATLAB version 2009. A feed-forward back propagation kind of network was created to input vector (five input elements) with single hidden layer and one output unit in output layer. The efficiency of neural network was done by the assessment of results achieved from this study with that of experimental data input and chosen target data. The propose solution for the efficiency of artificial neural network assessed by the comparatative analysis of "Mean Square Error" at zero epochs. There are different variables of data in order to test the targeted results**.**

***Keywords*—**Computational shcmin, meiosis, mitosis, neural network, Stem cell SOM;

I. Introduction

STEM cells are the unspecialized cells that can be categorized into two different ways:[1] mitosis (They can segregate to generate copies of themselves) and meiosis (Meiosis is the type of cell division by which germ cells (eggs and sperm) are produced. Meiosis involves a reduction in the amount of genetic material) [2] [3]. Stem cells can be classified into embryonic stem cells and adult stem cells. Embryonic stem cells are found in embryos that are just a few days old and can specialize into any of the 200 to 300 different kind of cell that make up a human body. Adult stem cells are found in many parts of the human body. They exist in skin, blood, bone, muscle and nerve cells. Adult stem cells grow or repair adult organs of body. The most well known source of adult stem cell in human body is bone marrow.

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Stem cell division can be mitotic, which means the division of the mother cell into two daughter cells [3]. Biological systems are characterized by no deterministic and non-linear development patterns [4]. The key reasons behind the control of overall developmental process in such systems are genetic and environmental [5]. Exploitation of artificial neural network can be an efficient alternative mean for technology reliable and purposeful for judgment of the biological process [11]. Artificial neural network technology concerns with the estimation of various complex mathematical functions to implement and to interpret it different sets of impulsive data [5]. Self-Organizing Maps (SOM) found to be helpful in pattern reorganization and supervised/unsupervised training [6]. SOM can also provide a better alternate in prediction of stem cells differentiation. For optimization the computational scheming of neural network based on chemical, physical and biological variables of state [5]. The model is tested with supervised training, which is taking different input parameters and network is already trained with targeted output. Values predicted by the network system were further judged against those of experimental values to asses the efficacy of artificial neural network.This will be followed by investigate with the unsupervised network of self-organizing feature maps with the following Kohonen's rule [7] [10].

$$w_i(q) = w_i(q-1) + \alpha(p(q) - w_i(q-1))\ i \in N_{i^*}(d)$$

$$=(1-\alpha)\, w_i(q-1) + \alpha\, p(q),$$

Where the neighborhood $N\,i^*(d)$ contain the indices for all of the neurons that lie within a radius d of the winning neurons i^*. [7] [10]. The learning performance of the map can be increased by making the neighborhood size d dynamic, with the initial large neighborhood size but gradually reducing it until it only includes the winning neuron. The use of self-organizing feature maps with unsupervised learning is predictable to examine and help in isolating the growth factors that are most effective in the differentiation of cells [7] [10].

II. Stem Cells Differentiation

Cellular differentiation is a process which results in the cell separation with the daughter cells being of a different cell type, a specialize type [8]. A cell that has the ability to genetically reprogram into all types of adult cell organism is known as pluripotent stem cell [9]. Pluripotent stem cells undergo further specialization into multipotent cell that then gives rise to functional cells [9].

III. Resource and Methodology

Neural networks are classified on the basis of principle for which they are devised as well as on their basic topology along with the related training method [5]. In computerization of supervised/unsupervised training, judgment making network plays a major important role, which comes under the group of classification and clustering models of neural network. Present study was aimed to judge the efficiency of ANN in stem cell mechanism. Therefore out of various techniques existing with neural network, we have made the use of 'Back propagation' (BPN) technique which comprises the categorization network with supervised learning. During the study, the back propagation learning rule was implied; that deals with the adjustment of connection weights from input to hidden nodes and the errors of the unit in the hidden layers were determined by back propagation type network was created for input vector (five input elements) with single hidden layer and one output unit in output layer. Weight and bias was randomly initialized one thousand epochs have been used for training. In this study dummy data for experiment was taken and tried to prove how we can use neural network in stem cells, network has been trained with supervised training; and used network type "Feed-forward backprop", "TRAINLM" for training function and "LEARNGDM" for adoption learning function so the result has been presented as Target set. This paper was meant to judge the efficiency of ANN in forecasting the appropriate targeted outcome. The effectiveness of neural network was accomplished by the comparison of the result achieved from this study with those of experimental data trained network on targeted data.

IV. Result and Discussion

The trained network, on basis of 8 sets of training data, for further validation, we can increase the number sets of training data. The efficiency of network for better training initialization can be judged with different training functions. Efficiency of network for training initialization including training function "trainrp", "trainbfg", "trainbr", "traincgb", "traincgf", "traincgp", "traingd", "traingdm", "traingda", "traingdx", "trainnl", "trainoss", "trainr", "trainscg" can be used. The networks were further used for the prediction of target output.

Table I
Training Data Set With Trainlm And Trainrp
("Dummy Data")

PARAMETERS UNIT									
ParamA	I	1	4	3	2	2	1	3	1
ParamB	II	0.3	0.2	0.1	0.2	0.2	0.1	0.3	0.2
ParamC	III	10	10	5	10	10	15	5	10
ParamD	IV	5.82	5.82	4.82	2.47	5.82	4.82	2.74	5.82
ParamE	V	2	2	3	2	2	1	2	3
Target		0.91	5.28	3.9	1.25	2.09	9.2	0.71	0.05

Efficiency of trained network for least deviation from target range was assessed on putting different inputs compare validity between targeted data and results. This observation concludes that output range of network trainlm ("TrainedNWlm") is closest to the targeted data. Therefore, in the current study with the trained and tested datasets, the trained network with trainlm transfer function, include with feed forward back propagation methodology is found to be a competent network which produces an easy and objective way of predicting most favorable values of some the important physical, chemical, biological parameters. By summarizing the above study the current work defines the artificial neural network come up to computational forecasting the various variables of state, which influence the growth and productivity of in stem cell culture. The high learning potential of neural network provides this system the ability to identify and model complex non-linear relationships between the input and output of bioprocesses [12]. ANN can be applied to stem cells for cell differentiation of reprogram cells in order to get specialized cells. After training, the trained network, with input parameters, can be predicting the specialized cell. The different classification and clustering models of neural network are reported to be used in stem cell culture studies, as these models are speedy judgment making network.

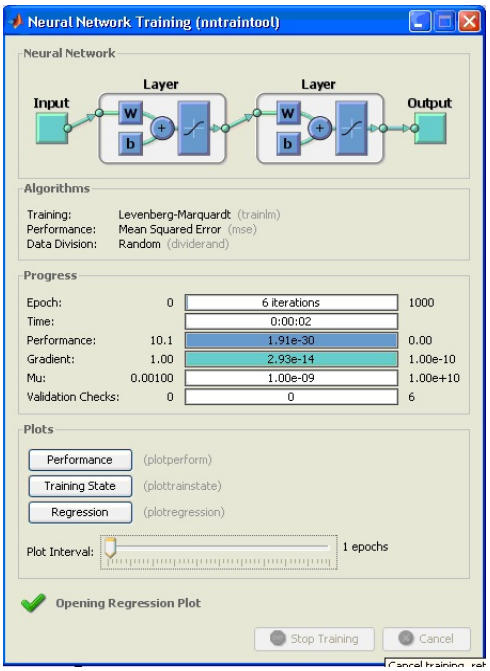

Fig. 1 TrainedNWlm

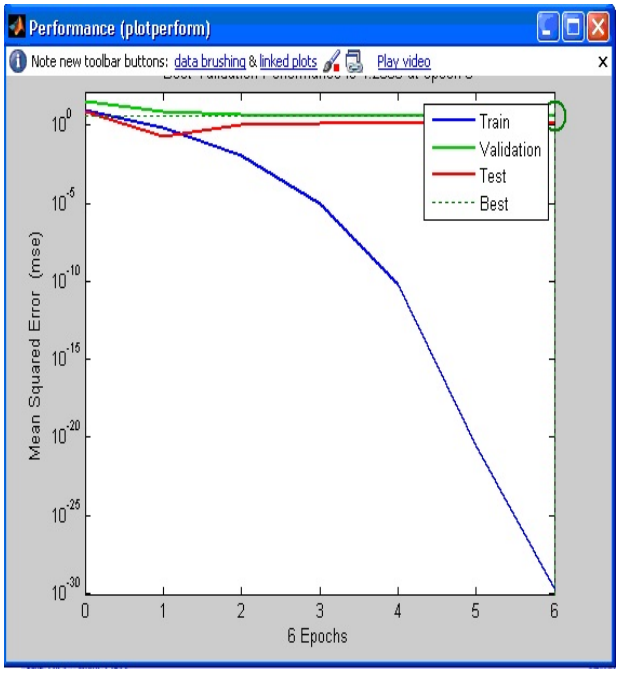

Fig. 2 Mean Square Errors (MSE) in TrainedNWlm

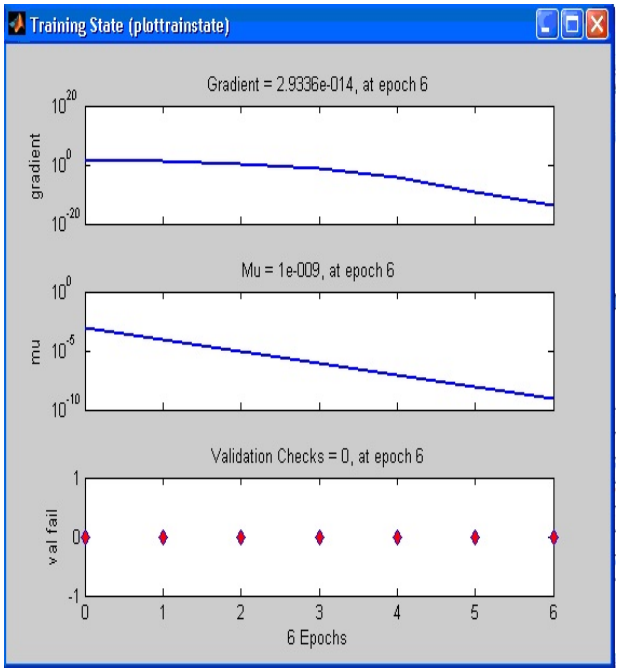

Fig. 3 TrainedNWlm, Training State

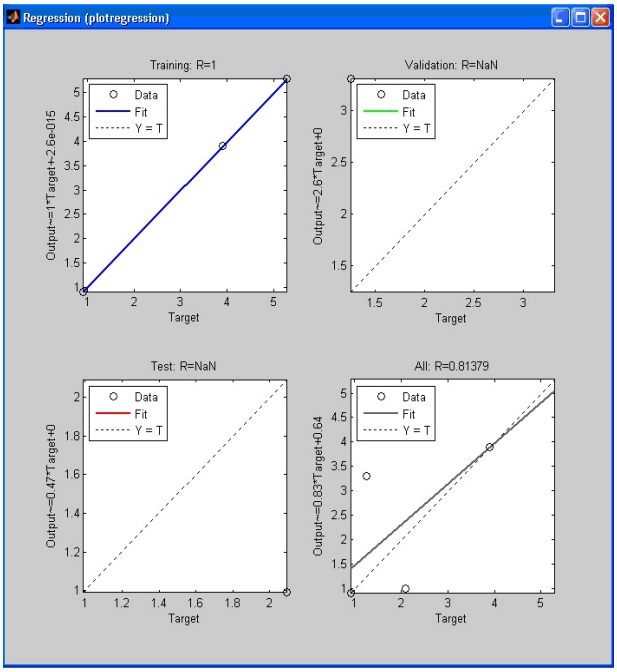

Fig. 4 TrainedNWlm Regression

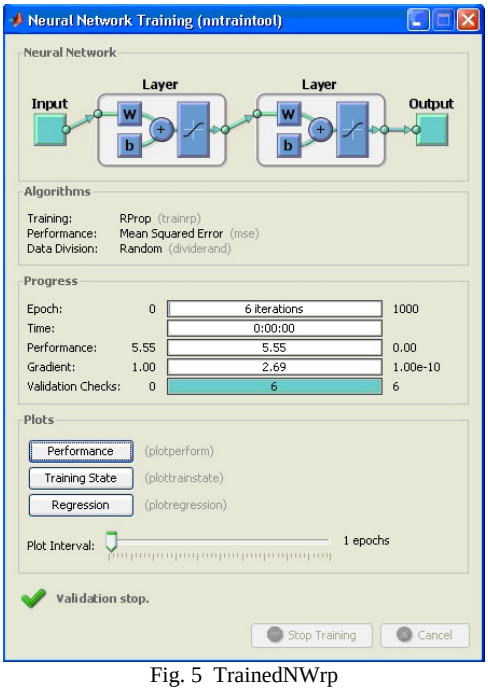

Fig. 5 TrainedNWrp

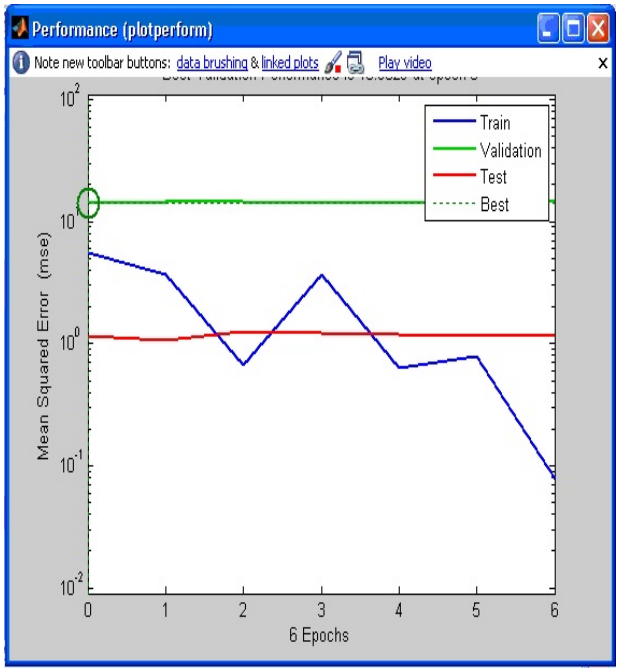

Fig. 6 Mean Square Errors (MSE) in TrainedNWrp

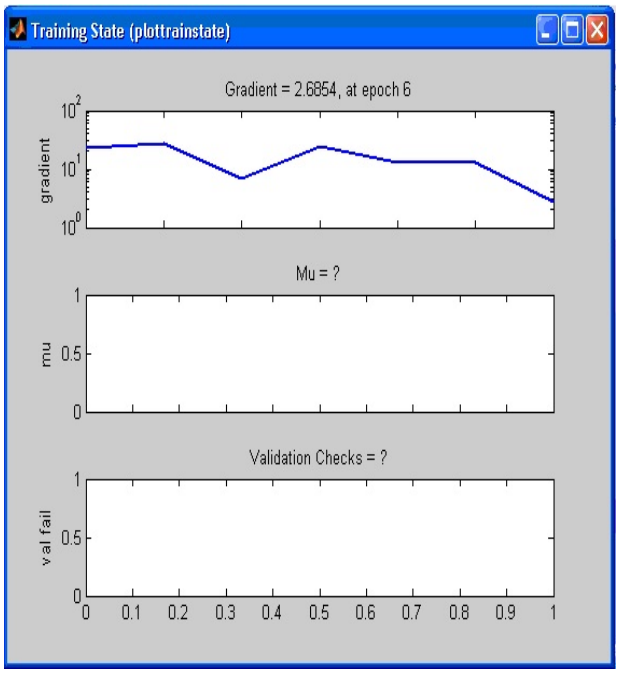

Fig. 7 TrainedNWrp, Training State

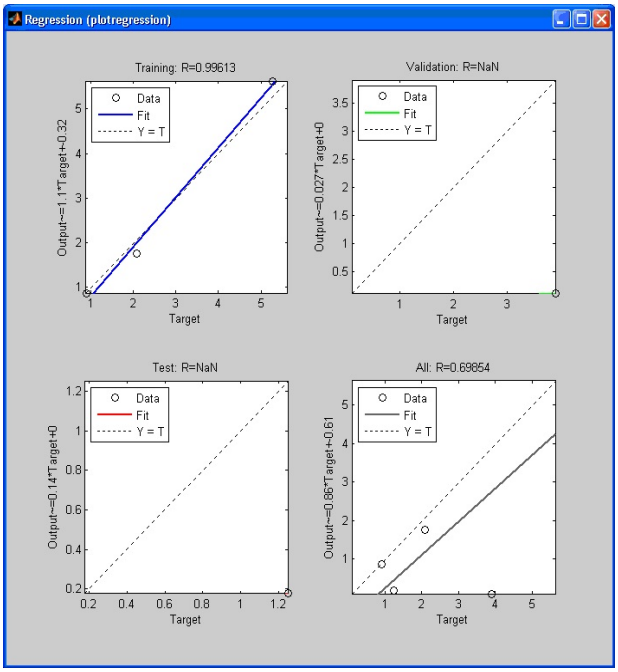

Fig. 8 TrainedNWrp Regression

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