Combating the complexity in spatial data: A neuronal approach

S. Chattopadhyay
Calcutta, India
E-mail: binu_2008@yahoo.com

The author wishes to express his indebtedness and regards to Prof. Sutapa Chaudhuri of Calcutta University, who sowed the seed of flexible computing approach in the author's mind.

Introduction

The datasets acquired from various climatological events are non-linear in nature. The non-linearity arises because climatological systems are superpositions of a set of deterministic, multivariate, and non-linear interactions over an enormous range of spatial scales. In order to understand this system, scientists must observe, summarize, make inference, and ultimately predict its behavior at each scale of variability (1). Thus, some flexible techniques are need. Ordinary statistical approaches are less flexible with respect to non-linearity; their application may not always give appropriate results (2). Statistical inference also requires some pre-processing of the data. When the question of prediction of some climatological data arises, the application of simple time-series analysis cannot give an appropriate forecast because of its limitation in handling a highly non-linear data structure. This observation is true for individual parameters as well as for the event itself. The cases, where grided data are employed, may give huge propagation error, if the traditional numerical methods for them are not mingled with some flexible techniques. The word “flexible” is used to mean that the technique should be able to modify itself in order to minimize the output error as much as possible. Various methods, such as, prepositional logic, probabilistic reasoning, neuronal nets can be tried as flexible techniques. In this article, Neuronal Residual Kriging (NRK) is proposed as a flexible

technique to analyze spatial data. NRK can be employed to estimate a non-linear drift and to apply a geo-statistical, predictor (Kriging) to the residuals.

Methodology

The proposed method consists of the following steps:

1. **Data preparation:**

   NRK being a data driven approach, depends highly on quality and quantity of data. That is why the data are prepared by descriptive statistics.

   Attention is given to the data magnitude and variability.

2. **Designing network architecture:**

   A multilayer perception is proposed to be used with proper adjustment of the hidden layers and initial weights.

3. **Training of the data:**

   Method of back propagation is being proposed to be applied with a few essential modifications (if necessary) by some other soft computing techniques. The proposed modifications are:

   (a) Initial weights are selected with the help of genetic algorithm.

   (b) Conjugate gradients are used for the efficient local minimum search or error function.

   (c) Simulated annealing is used in order to escape form local minima.

4. **Evaluating performance the network:**

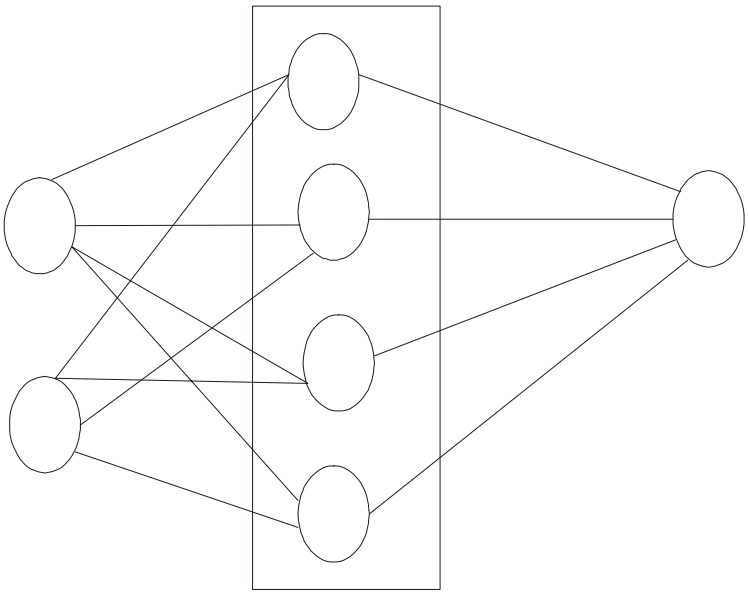
   Different tools can be used for the evaluation, like cross validations accuracy test.

5. **Calculating the final NRK predictions at validation points and comparison**

with the true values are done as final validations.

The basic network architecture for the proposed method can be drawn schematically as:

Inputs



Output layer

Hidden layer

→flow of information ←error propagation

Advantages of NRK

In NRK, several layers can be employed between input and output layers. Thus, like human neurons, the information can be processed very effectively in those hidden layers, where, through proper choice of activation function, the error in the output layer can be optimized.

References

1. Christopher K.Wikle, 2002: *Encyclopedia of Life Support Systems*, EOLSS Publisher Co. Ltd.
2. Yoh-Han Pao, 1989 : *Adaptive Pattern Recognition*, Addison-Wesley, pp113-139.