Chapter 19
An Artificial Neural Network Model as the Decision Support System of Ports

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ABSTRACT

The new feasibility analysis model proposed in this study for coastal projects consists of three interrelated decision support models: 1) Artificial Neural Network (ANN) to determine the rates and capacity of cargo by considering the economical development of hinterland 2) Queuing model to determine the waiting to service time and the berth occupancy ratios by waiting time modeling of ships using discrete queuing simulation 3) Importance Sampling Monte Carlo (ISMC) to simulate ship arrivals/departures from the quays and to estimate income/expenditure parameters of the coastal project. As a case study, the proposed model was applied to the Iskenderun Pier in Turkey and the future loading/unloading cargo rates of pier were predicted by ANN's. The superiorities of this proposed simulation-ANN model to other classical investment planning methods were the inclusion of uncertainties in the investment parameters like the change of cargo and costs variables in time, and the determination of project benefit/cost with an improved accuracy when compared to classical decision support models.

INTRODUCTION

As 85% of the world and Turkish trade is carried by maritime transportation, new commercial piers and harbors are constructed in Turkey. Iskenderun Pier that is under construction in the organized industry zone of Hatay, will serve for internal and foreign trade of Turkey. The main problem that has been faced in coastal engineering projects of Turkey is to perform a realistic investment planning in order to include uncertainties and risk parameters, which decrease the reliability of cost and income predictions (Balas & Ergin, 2002). In this study for the solution of the problem, ISMC (Melchers, 1999; Balas et al., 2001) was applied and interrelated with ANN's for the investment planning of coastal projects.

Time to reach the simulation capacity of the pier was estimated by considering ANN predictions of cargo increase in the bay. The net present values of the investment were determined by modeling income/expenditures of pier activities in ISMC simulations by probability distributions that consider the cargo predictions of the artificial intelligence technique for various economic scenarios. As a result, the annual capacity changes of cargo were determined by neuronets and the annual incomes of quays were computed by simulation considering the occurrence frequency distribution of predicted values.

DECISION SUPPORT MODEL

The ANN sub-model predicted the annual shipment rates in the Iskenderun Bay between the years of 2015 and 2030. This model was interrelated with ISMC simulations, since the maritime trade in the bay was mainly affected in the last decades by the successive wars of Syria and Iraq; therefore, a large extent of uncertainty was inherent in its future predictions. The neural network is a multivariate, nonlinear, nonparametric artificial intelligence system, which consists of a large number of interrelated processing units (neurons) to simulate the human brain learning. ANN's are non-linear prediction models of natural systems, which can be used as alternatives to regressive models in coastal projects (Balas & Koc, 2002; Balas & Balas, 2002; Balas et al., 2004). In recent years, neuronets have been successfully used for analysis of coastal environments, such as for time series processing (Deo & Kumar, 2000), tidal level forecasting (Tsai & Lee, 1999), pattern classification (Deo & Naidu, 1999), wave data assessment (Tsai et al., 1999; Balas et al., 2004) and structural failure predictions (Mase et al., 1995).

The artificial neural network (ANN) is a non-linear robust prediction method that can satisfactorily handle the randomness and uncertainty inherent in data sets and complex natural systems. Neuronets exhibit the characteristics of "biological" networks to simulate the human brain learning and they have been successfully used for the prediction of environmental processes. In summary, artificial neural networks can demonstrate the learning and adaptation capabilities of biological neural systems by predicting stability numbers from experimental data sets considering the change in environmental conditions. On the other hand, fuzzy systems can effectively utilize the uncertainties inherent in human knowledge, but they do not have the capability of learning. Therefore, neural networks have more "generalization ability" (functional approximation capability) than the fuzzy systems in using a database. However if the database is limited and contains qualitative information, fuzzy systems can be alternatively used as design models. The advantage of fuzzy systems is that, they can handle human based information such as experience and judgment, and can consider qualitative data described by language.

Neural networks are simplified models of the human brain. Connections between neurons are axons and dendrites, connection weights represent synapses, and the threshold approximates the activity in the soma. The response of network:

$$y_j = f(\sum_{i=1}^{n} w_i x_i - t_j),$$

where y_j is the output of the jth neuron, x_i is the ith input signal, w_i is the connection weight from the ith input neuron to j^{th} neuron, t_j is the threshold or bias value of the jth neuron and $f(x)$, is a non-linear function.

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