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Iterative Parameter Selection Based Artificial Neural Network for Water Quality Prediction in Tank-Cultured Aquaculture System

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ABSTRACT
Water Quality plays an important role in attaining a sustainable aquaculture system, its cumulative effect can be detrimental to the aquatic organisms as well as the environment, which in turn leads to poor growth, increased diseases and production losses. The amount of dissolved oxygen alongside other parameters such as Temperature, pH, Alkalinity and Conductivity are used to estimate the water quality index in aquaculture. There exist different approaches for the estimation of the quality index of the water in the aquatic environment. One of such approaches is the use of the Artificial Neural Network (ANN) in the prediction of this Index, however, its efficacy lies in the ability to select and use optimal parameters for the network. Thus, this work proposes the development of an Iterative Parameter Selection (IPS) algorithm for the selection optimal network parameters for the ANN such as the number of neurons in the hidden neurons. The performance of the proposed algorithm on a typical BP-ANN was evaluated using the Mean Square Error (MSE), and the Nash-Sutcliffe Efficiency (NSE) metrics. Furthermore, a comparison of the proposed algorithm with two other known algorithm shows the proposed IPS has having a better performance. Thus, this demonstrates the capability of the IPS algorithm in obtaining optimal ANN parameters for effectively determining water quality index in Aquaculture system.
Keywords: *Aquaculture System; ANN; Dissolved Oxygen; Prediction; Water Quality Index.*

1 INTRODUCTION

Aquaculture deals with all activities aimed at rearing and cultivating of fishes and other aquatic animals and plants under controlled conditions and environment(Garcia, Sendra, Lloret, & Lloret, 2011; Oyakhilomen & Zibah, 2013). This production method is fast growing and forecasted to be on the increase for the nearest future to come (Kristofersson & Anderson, 2006). According to the Food and Agriculture Organization of the United Nation (FAO) report in 2011, there is a global substantial growth in the aquaculture production up to the tune of 52.5 Million tonnes in 2008 as compared to the 32.4 million tonnes in 2000 (FAO, 2011). This sector of agriculture continues to dominate other sectors as the fastest growing animal food producing sector which accounts for over 45.6% of the total world's food fish consumption in 2012 as compared to the 33.8% in 2000 (Atoum, Srivastava, & Liu, 2015; FAO, 2011).

The importance of water in aquaculture cannot be over emphasized as it forms the basis of any aquatic ecosystem and its quality index can make or mar wellbeing of the entire aquatic environment (Wei & Huang, 2010). The level of dissolved oxygen (DO) in the aquatic environment is the default factor used in estimating and characterizing of the water quality index. The concentration of the DO reflects a balance in the oxygen producing and oxygen consuming processes and activities in the system (Olyaie, Abyaneh, and Mehr, 2016).

Furthermore, other environmental parameters such as temperature, salinity, turbidity, pH as well as water level in the system also plays significant roles in the estimation of the DO and consequently the water quality in the system. The water quality is also influenced by the inefficiency of feeding systems which counts for considerable amount of waste from the unconsumed feeds dispensed (Garcia et al., 2011). Aside these factors, the excreta of the aquatic organisms also add to the effect on the water quality.

There exist different approaches for the estimation of the water quality index in the aquatic environment with respect to the DO level in it. One of such approaches is the application of the Artificial Neural Network (ANN) in developing reliable DO model for the prediction of this Index (Olyaie, et al., 2016).

The ANN mimics the information processing capability of the human nervous system in solve complex problems such as the prediction and modeling of DO with respect to other parameters. However, its efficacy lies in the ability to select and use optimal network parameters in developing the associated model (Schmid and Koskiaho, 2006; Antanasijevic et al. 2014; Olyaie, et al., 2016). Based on this, the paper proposes the development of an iterative algorithm for the selection of optimal network parameters for the ANN in the quest to develop an optimal DO prediction model.