LITERATURE SURVEY

A. WATER QUALITY PREDICTION USING MACHINE LEARNING METHODS

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Abstract:

This study investigates the performance of artificial intelligence techniques including artificial neural network (ANN), group method of data handling (GMDH) and support vector machine (SVM) for predicting water quality components of Tireh River located in the southwest of Iran. To develop the ANN and SVM, different types of transfer and kernel functions were tested, respectively. Reviewing the results of ANN and SVM indicated that both models have suitable performance for predicting water quality components. During the process of development of ANN and SVM, it was found that tansig and RBF as transfer and kernel functions have the best performance among the tested functions. Comparison of outcomes of GMDH model with each other applied models according to the error indexes declared that SVM was the most accurate model. Examining the results of the models showed that all of them had some over-estimation properties. By evaluating the results of the models based on the DDR index, it was found that the lowest DDR value was related to the performance of the SVM model.

Introduction:

Water quality has a direct impact on public health and the environment. Water is used for various practices, such as drinking, agriculture, and industry. Recently, development of water sports and entertainment has greatly helped to attract tourists (Jennings 2007). Among various sources of water supply, due to easy access, rivers have been used more frequently for the development of human societies. Using other water resources such as groundwater and seawater sometimes assisted with problems. For example, using groundwater without suitable recharge will lead to land subsidence (Motagh *et al.* 2017) and using seawater is usually associated with pollution transmission (El-Kowrany *et al.* 2016). Therefore, the use of rivers has attracted attention.

Several investigations related to rivers around the world have been conducted and a field of engineering named river engineering has been proposed. In river engineering, studies on morphological changes, sediment transport, water quality, and pollution transmission mechanisms are very important (Julien 2002; Dey 2014). Flow structure, sediment transport and morphology of rivers are investigated in the hydraulics of rivers in river engineering (Wu 2007). The study of water quality of rivers is a common theme in earth sciences. To evaluate the quality of rivers two approaches are considered, including measuring the water quality components and defining the mechanism of pollution transmission (Kashefipour 2002; Kashefipour & Falconer 2002; Naseri Maleki & Kashefipour 2012; Qishlaqi *et al.* 2016). Among water quality components, measuring the dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), electrical conductivity (EC), pH, temperature, K, Na, Mg, etc. have been proposed (Şener *et al.* 2017). To this end, governments have constructed hydrometry stations along rivers that cross from urban areas, agro-industrial projects, industrial estates, and rivers that join dams' reservoirs (Herschy 1993; Kejiang 1993). In hydrometry stations, the water quality components are measured and the stage-discharge relation is defined. Obtained values from hydrometry stations contain basic information for feasibility studies and development of water conservation projects. Evaluation of water quality is a basic stage for development of agriculture projects in terms of determination of cropping pattern, type of irrigation system, and systems of water purification for industries (Chen *et al.* 2017). To investigate the mechanism of pollution transmission, in addition to field and laboratory experiments, advanced numerical methods such as computational hydraulic, image processing and GIS methods have been utilized (Parsaie & Haghiabi 2015, 2017a, 2017b). By reviewing the time history of water quality components, investigators have attempted to estimate future values. Nowadays, by advancing soft computing techniques in most areas of water and environmental engineering, researchers have attempted to accurately analyse time series of water quality components and their internal relation (May *et al.* 2008; Palani *et al.* 2008; Haghiabi 2016a, 2016b; Jaddi & Abdullah 2017). In this regard, Emamgholizadeh *et al.* (2013) used multilayer perceptron (MLP), radial basis network (RBF) and an adaptive neuro-fuzzy inference system (ANFIS) for water quality components of Karoon River. They stated that all applied models have suitable performance

for prediction of water quality components; however, the MLP model was slightly more accurate. Shokoohi *et al.* (2017) managed the water quality of a water supply system. They considered this an optimization problem and used modern optimization methods to solve it. Zhang *et al.* (2010) introduced a new approach for water allocation. They considered water quality as one of the main factors in their approach. Nikoo & Mahjouri (2013) developed a Probabilistic Support Vector Machines (PSVMs) model associated with GIS technique for planning the classification and distribution of surface and groundwater water in Iran. They stated that the use of these two methods would provide accurate information for feasibility studies of water conservation projects. Heddam (2016a; 2016b; 2016c; 2016d; 2016e) utilized artificial neural networks for predicting the water quality components in several case studies. He stated that artificial intelligence techniques have suitable performance for modeling and predicting the internal relation between the water quality components and modeling their time series. Reviewing the literature shows that water quality assessment and prediction is an important factor for developing water conservation projects and, to this end, artificial intelligence techniques have been proposed. Hence, in this study the water quality components of Tireh River, one of the main rivers of Dez catchment (one of the major catchments in Iran), were predicted using a support vector machine, article neural network and group method of data handling.

Methodology:

The aim of this study is the prediction of water quality components using Artificial Intelligence (AI) technique including MLP, SVM, and group method of data handling (GMDH). Therefore, in the first part of this section, the studied area is introduced and then ranges of measured water quality components are presented. Overviews on applied AI models are then presented.

B. EFFICIENT WATER QUALITY ANALYSIS PREDICTION USING SUPERVISED LEARNING

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Abstract:

Water makes up about 70% of the earth's surface and is one of the most important sources vital to sustaining life. Rapid urbanisation and industrialization have led to a deterioration of water quality at an alarming rate, resulting in harrowing diseases. Water quality has been conventionally estimated through expensive and time-consuming lab and statistical analyses, which render the contemporary notion of real-time monitoring moot. The alarming consequences of poor water quality necessitate an alternative method, which is quicker and inexpensive. With this motivation, this research explores a series of supervised learning algorithms to estimate the water quality index (WQI), which is a singular index to describe the general quality of water, and the water quality class (WQC), which is a distinctive class defined on the basis of WQI.

Introduction:

Water is the most important of sources, vital for sustaining all kinds of life; however, it is an constant threat of pollution by life itself. Water is one of the most communicable mediums with a far reach. Rapid industrialization consequently led to deterioration of water quality at an alarming rate. Poor water quality results have been known to be one of the major factories of escalation of harrowing diseases. As reported, in developing countries, 80% the diseases are water brown diseases which have led to 5 million dead and 2.5 billion illnesses. The most common of these diseases in Pakistan are diarrhoea, typhoid, gastroenteritis, cryptosporidium infections, some form of hepatitis and giardiasis intestinal worms.

Water quality is estimated through expensive and time-consuming lab and statistical analyses, which require sample collection, transport to labs, and a considerable amount of time and calculation which is quite ineffective given water is quite a communicable medium and time is of the essence if water is pulled with disease inducing waste. The horrific consequences of water pollution necessitate a quicker and cheaper alternative.

Methodology:

This research explores the methodologies that have been employed to help solve the problem related to water quality. Typically, conventional lab analysis and statistical analysis are used in research to aid in determining water quality, while some analyses employ machine learning methodologies to assist in finding an optimized solution for the water quality problem.