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Journal on Pattern Recognition

Interpretation of Information Handling and Retrieval Applications

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Journal on Pattern Recognition

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i-manager's Journal on Pattern Recognition provides innovative ideas for the researchers, academics, professionals and high level engineering students to bring together the current developments in the applications of medicine, robotics, and remote sensing by satellites. Pattern recognition is characterized by automated searches over a large number of observations and huge combinatorial spaces and is concerned with the automatic discovery of regularities in data through the use of computer algorithms.

i-manager's Journal on Pattern Recognition is presently in its 5th Year. The first issue was launched in 2014.

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Authors of accepted proposals will be notified about the status of their proposals before the stipulated deadline. All submitted articles in full text are expected to be submitted before the stipulated deadline, along with an acknowledgement stating that it is an original contribution.

Review Procedure

All submissions will undergo an abstract review and a double blind review on the full papers. The abstracts would be reviewed initially and the acceptance and rejection of the abstracts would be notified to the corresponding authors. Once the authors submit the full papers in accordance to the suggestions in the abstract review report, the papers would be forwarded for final review. The final selection of the papers would be based on the report of the review panel members.

Format for Citing Papers

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RESEARCH PAPERS

EDITORIAL

i-manager's Journal on Pattern Recognition was launched in 2014 and is currently in its 5th year of publication. The Journal is listed in ProQuest, EBSCO host, Ulrich's Periodicals Directory, World Cat and Google Scholar. The current issue (Volume 5, Issue 3) of i-manager's Journal on Pattern Recognition presents five interesting articles covering various aspects of Pattern Recognition.

Gabriel Babatunde Iwasokun et al. have presented a design of a fingerprint and iris-based framework for CBE invigilation. The implementation of the framework is ongoing with Python and Java providing the programming terrains while MySQL provides the platform for the creation and management of the examination and authentication databases. The implementation is expected to produce a system for guaranteeing the genuineness of the candidates for CBE and guiding against unlawful acts of looking into another candidate's screen. It will also provide solutions to human invigilation-induced problems, such as connivance, impersonation, external sourcing among others.

John Oloruntoba Awoyemi et al. have presented a comparative evaluation of four techniques on the effect of feature ranking on the detection of credit card fraud. The effect of feature selection technique, filter method, in detecting credit card fraud is investigated using two sets of credit data sourced from Taiwan and European banks. Algorithms of four classifiers are produced and used on feature and raw ranked data. The algorithms of the classifiers are run in Matlab. From the result the feature ranked and raw datasets of the European credit card fraud data recorded highest performance metrics for decision trees.

Taliha A. Folorunso et al. have investigated the effect of different normalization techniques, namely the Min-Max, Decimal Point, Unitary, and the Z-Score on the prediction of the water quality of the Tank Cultured Re-Circulatory Aquaculture System at the WAFT Laboratory, using the Artificial Neural Network (ANN).The performance of the techniques on the ANN was evaluated using the Mean Square Error (MSE), Nash-Sutcliffe Efficiency (NSE) coefficient. The metrics for evaluating the effects of the aforementioned techniques on the ANN was the mean square error and Nash-Sutcliffe Efficiency coefficient. The error measures were used to investigate the predictive capability of the ANN models on the new dataset. The result shows the Min-Max technique has a better model approximation than the other approaches based on the NSE.

Yahaya Mohammed Sani et al. have presented a framework for text-to-speech translation on Android Devices based on Natural Language Processing (NLP) and text-to-speech synthesizer (TTS) to deliver real-time agricultural update to farmers by Agricultural Extension service Workers (AEW) as speech is the most used and natural way for people to communicate with one another. This framework converts agricultural research finding from a source dialect (English) into four identified local target dialects (Hausa, Arabic, Yoruba, Ibo and Arabic) based on selected local language understood by the farmer. The framework also links the key players (agricultural expert, extension workers, and farmers) in agricultural research information generation, processing and broadcasting under one umbrella. This is accomplished by allowing the extension workers to send farmers queries to experts and receive feedback via the mobile application and the web-based system as well. Moreover, farmers take delivery of timely text-to-text and text-to-speech agricultural research communications from the extension via their Android cell phones based on requests, queries forwarded to research for them on their area of interest or preference.

Kavyashree and her co-author Rajesh have addressed the problems of text detection and extraction systems. This work is to give a comparison analysis on the various techniques and methods that were used and applied to detect and extract the text from complex background images. First, the summarized study of text detection and extraction is presented. Secondly, the major contributions and loopholes achieved in this research area are listed and finally, further research direction based on the work is also discussed. Various methods for extracting the text from the images have been analyzed vigorously and this comparison analysis work helps the researchers to ease out the time complexity they find in searching for the different combinational works.

EDITORIAL

Four papers of this issue, papers 1 to 4 were submitted from the 2nd International Conference on Information and Communication Technology and Its Applications (ICTA 2018), conducted on 5 -6th September 2018 at Federal University of Technology, Minna, Nigeria. We express our gratitude to the Conveners Dr. Shafii Abdulhamid & Dr. Oluwafemi Osho for their support in ensuring the papers were submitted on time.

We extend our sincere thanks to the authors for their contributions towards this issue and we are grateful to the reviewers for spending their quality time in reviewing these papers. Our special thanks to the Editor-in-Chief, Dr. G.R. Sinha for his continuous support and efforts in improving further the quality of the Journal.

Hope this issue imparts an enlightening reading experience. Enjoy reading!

Warm regards,

Asha T.
Associate Editor
i-manager Publications

EFFECTS OF DATA NORMALIZATION ON WATER QUALITY MODEL IN A RECIRCULATORY AQUACULTURE SYSTEM USING ARTIFICIAL NEURAL NETWORK

By

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ABSTRACT

Water Quality remains as one of the most important factors that influence the aquaculture system as its effects can make or mar the state of organisms as well as the environment. Furthermore, the use of Artificial intelligence especially the Artificial Neural Network (ANN) has greatly improved the forecasting capability of water quality due to better solutions produced as compared to other approaches. The performance of these AI techniques lies in the quality of dataset used for its implementation, which is in turn a function of the preprocessing (Normalization) techniques performed on them. In this paper, the effect of different normalization techniques, namely the Min-Max, Decimal Point, Unitary, and the Z-Score were investigated on the prediction of the water quality of the Tank Cultured Re-circulatory Aquaculture System at the WAFT Laboratory, using the ANN. The Water Quality Index was based on the prediction of the Dissolved Oxygen (DO) as a function of the Temperature, Alkalinity, PH, and conductivity. The performance of the techniques on the ANN was evaluated using the Mean Square Error (MSE), Nash-Sutcliffe Efficiency (NSE) coefficient. The comparison of the evaluation of the various techniques depicts that all the approaches are applicable in the prediction of the DO. The Decimal point technique has the least MSE as compared to others, while the Min-Max technique has better performance with respect to the NSE.

Keywords: Aquaculture System, Artificial Neural Network, Dissolved Oxygen, Prediction, Water Quality Index.

INTRODUCTION

The processes involved in the cultivation and rearing of aquatic animals in controlled environment and conditions is referred to as Aquaculture (Garcia, Sendra, Lloret, & Lloret, 2011; Folorunso, Aibinu, Kolo, Sadiku, & Orire, 2017). In attaining a sustainable aquaculture system, the role and importance of water quality cannot be over emphasized as its effects can make or mar the entire cultivation process (Folorunso et al., 2017; Chuang & Lin, 2010; Badiola, Mendiola, & Bostock, 2012). The amount of Dissolved Oxygen (DO) in the aquatic environment reflects the balance in the rate of production of oxygen and consummation of oxygen therein (Olyaie, Abyaneh, & Mehr, 2017). The amount of DO is used in estimating and quantifying the quality of the water in the environment (Olyaie et al., 2017).

Though, 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 (Folorunso et al., 2017; Africa, Aguilar, Lim, Pacheco, & Rodrin, 2017).

Over the years, there exist different approaches for the estimation and prediction of the water quality index in the aquaculture systems with respect to the DO level. One of such approach is the use of artificial intelligence based prediction algorithms (Folorunso et al., 2017; Olyaie et al., 2017; Schmid & Koskiaho, 2006; Antanasijević, Pocajt, Perić-Grujić, & Ristić, 2014). The successes of prediction algorithms, such as Artificial Neural Network (ANN), Support Vector Machine (SVM) often lie in the quality of the dataset used and as such the fidelity of the dataset used for prediction task must be guaranteed (Yusof & Mustaffa, 2011; Han, Kamber, & Pei, 2011, 2012). In real world applications, data acquisition processes are most often characterized by noise, inliners, outliners, missing data, and inconsistent data that are needed to be removed before such dataset is used (Han et al., 2011, 2012; Alasadi & Bhaya, 2017). Thus, data preprocessing techniques, which include data cleaning, data integration, data transformation, and data reduction is required to improve the quality of data (Alasadi & Bhaya, 2017). Furthermore, the application of data normalization techniques have proven to improve the accuracy and efficiency of algorithms, such as ANN, K-nearest neighbor, and clustering classifiers (Olyaie et al., 2017; Antanasijević et al., 2014; Al Shalabi, Shaaban, & Kasasbeh, 2006).

Past works depict the suitability of various normalization techniques in predicting water quality. He and Che (2010) used Min-Max normalization technique in the development of a water quality prediction model based on wavelet transform and support vector machine for a water monitoring station. Furthermore, (Xu, Hu, & Liu, 2011) adopted the use of Min-Max normalization technique in the developing a particle swarm optimization algorithm for predicting water quality of Changjiang river.

In addition, (Olyaie et al., 2017) adopted the use of log-sigmoidal activation for the normalization of the dataset used in the comparative analysis of the different computational intelligence algorithm. The algorithms; the Multi-Layer Perceptron (MLP) ANN, Radian Basis Function (RBF) ANN, Linear Genetic Programming (LGP), and Support Vector Machine (SVM) were used for the prediction of dissolved oxygen level as a function of water quality in Delaware River. Antanasijevic et al. (2014) have investigated the effect of three different normalization techniques, namely the Min-Max, Median, and Z-score on various ANN models for the determination of Dissolved Oxygen in Danube River. The result showed the Min-Max approach as having a better performance as compared to others. Folorunso et al. (2017) applied the Min-Max technique in developing an iterative parameter selection algorithm ANN for predicting water quality index as a function of DO in a Tank cultured re-circulatory aquaculture system.

In view of the ongoing research, this paper proposes to investigate the effects of four different normalization techniques, namely the Min-Max, Decimal Point, Unitary, and Z-Score techniques on Artificial Neural Network (ANN) in predicting the water quality index in a tank cultured re-circulatory aquaculture system. The novelty of the work lies in the nature of the dataset adopted which any researcher has not used before. Hence, it is in this view the research considers to investigate the effect of normalization techniques on the dataset for prediction of water quality using ANN.

1. Methodology

The methodology is divided into three subsections. In the first subsection, a detailed description of the dataset used is presented, while the second subsection presents an overview of the ANN and the third subsection presents the normalization techniques adopted.

1.1 Dataset Description

The dataset used in this study was obtained from the Water Resources, Aquaculture and Fisheries Technology (WAFT) Laboratory of the Federal University of Technology, Minna through a continuous monitoring of the water quality parameters of the Tank-Cultured Re-Circulatory Aquaculture System therein for eight weeks. The parameters contained in the dataset include the Temperature, Dissolved Oxygen, Alkalinity, Conductivity, and pH.

The temperature is a measure of degree of hotness or coldness of the water environment of the aquatic species. The temperature also has an inverse relationship with the dissolved oxygen, as the temperature increases, there is a resultant decrease in the value of the dissolved oxygen (Anyachebelu et al., 2014). While the Dissolved Oxygen is a measure of the available oxygen in water for the healthy survival of the fishes (Anyachebelu et al., 2014). The pH is an indication of how acidic or basic the water environment is. It is the measure of the hydrogen ion concentration in water (Africa et al., 2017; Anyachebelu et al., 2014).

The Alkalinity refers to the ability to resist sudden changes in the values of the pH in the aquatic environment. It is also the true measure of acid neutralizing capacity of the water. The conductivity is a measure of the available dissolved salts and minerals present in the water. It also refers to the ability to allow electrons through water. Furthermore, there is a relationship between temperature and conductivity. The warmer the water, the higher the conductivity (Anyachebelu et al., 2014).

1.2 Artificial Neural Network Model

Characteristically, the Artificial Neural Networks (ANN) are inspired by the information processing capability of the biological Nervous system (Chaturvedi, 2010). The ANN is a useful tool that finds application in many ecological modeling and prediction problems (Malek, Salleh, & Baba, 2010; Basheer & Hajmeer, 2000). In this paper, the authors have applied a multiple layered feedforward type of ANN with a back-propagation algorithm for predicting the water quality index with the view of investigating the effect of different normalization techniques on the input dataset. The structure adopted ANN is as depicted in Figure 1, where the ANN consists of one Input node and two layers namely the Hidden and Output layers.

Temperature, pH, Conductivity, and Alkalinity are fed through the Input nodes as input to the ANN to predict the DO, which is presented at the Output layer. The ANN structure has one Hidden Layer that is an intermediate layer and connected to the input node and output layer through the synaptic weights. Thus, the DO is used as a basis of the water quality index and is represented by equation (1) as a function of Temperature (T); pH (p); Conductivity (C); and Alkalinity (A).

$$DO = f(T, p, C, A) \quad (1)$$

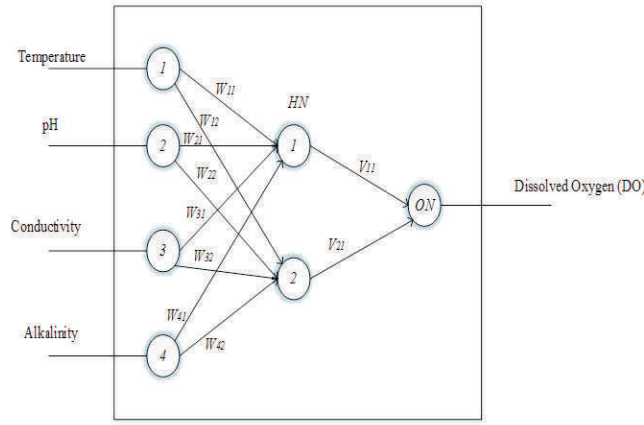

Figure 1. The Structure of the ANN Model

Each node of the ANN takes in multiple inputs and processes them to produce an output, which is passed onto another node. The output produced is a function of the input, weight, and bias associated with each nodes and defined as:

$$w_{ji}x_i + b_1 \quad (2)$$

where,

w is the interconnecting weight;

x is the input to the neuron;

b is the connecting bias.

Furthermore, the output is also a function of the type of activation function used on the node. For instance, the equivalent output of the Hidden layer is defined by the activation function and the summation of equation (2) is given as:

$$y_{hidden} = \varphi\left(\sum_{i=1}^{n} w_{ji}\, x_i + b_1\right) \quad (3)$$

where,

w is the interconnecting weight;

x is the input to the neuron;

b is the connecting bias;

i is the number of inputs;

j is the number of neurons in the layer;

φ is the activation function of the layer.

y_{hidden} is fed into the output layer as its input, and been acted on it by the activation function and the weight as well as the bias associated to produce the final output of the ANN defined as:

$$y_{Output} = \alpha\left(\sum_{i=1}^{n} w_{ji}\, y_{hidden(i)} + b_2\right) \tag{4}$$

where,

w is the interconnecting weight;

x is the input to the neuron;

b is the connecting bias;

i is the number of inputs;

j is the number of neurons in the layer;

α is the activation function of the layer.

Substituting equation (3) into equation (4) the output of the ANN, which is the target of equation (1) the DO is given as:

$$y_{Output} = \alpha\left(\sum_{i=1}^{n} w_{ji}\, \varphi\left(\sum_{i=1}^{n} w_{ji}\, x_i + b_1\right) + b_2\right) \tag{5}$$

Thus, the y_{output} is dependent of the activation functions α and φ of the Output and Hidden Layers, respectively as well as the weights, biases and more important the input.

The input has a significant effect on the output of the ANN and has earlier aforementioned the type of data preprocessing performed on the input also affects the output of the ANN.

1.3 Normalization Techniques

Based on the earlier, the input of the ANN has effect on the output and consequently the type of preprocessing adopted for input. Thus, the authors investigate four different data normalization techniques namely The Min-Max; Decimal Point; Unitary, and Z-Score techniques.

The Min-Max normalization technique performs a linear transformation on the original data based on the maximum and minimum values of the dataset. This approach helps preserve the relationship among the original data values (Yusof & Mustaffa, 2011; Han et al., 2011; Mustaffa & Yusof, 2011). The Min-max is defined by:

$$Minmax = \frac{x - x_{min}}{x_{max} - x_{min}} \tag{6}$$

where,

x is the values of the T, C, p, A and DO in the dataset;

x_{min} is the lower bound of attribute values of the T, C, p, A, and DO

x_{max} is the upper bound of attribute values of the T, C, p, A, and DO

In the Decimal point technique, the data attributes are transformed by moving the decimal points of the original data. The number of points moved is dependent on the maximum absolute value of the attribute data (Yusof & Mustaffa, 2011; Han et al., 2011; Mustaffa & Yusof, 2011). The technique is defined by:

$$Decimal\ Point\ (DP) = \frac{x}{10^j} \tag{7}$$

where, x is the attributed values of the T, C, p, A, and DO,

k is the smallest integer such that (max(|DP|)<1).

The Unitary normalization technique uses the maximum value of the attribute data to transform the original data (Yusof & Mustaffa, 2011; Han et al., 2011). The unitary is defined as:

$$Unitary = \frac{x}{max(x)} \tag{8}$$

Where, x attributed values of the T, C, p, A, and DO

In the z score normalization technique, the transformation is based on the mean and the standard deviation of the attributed values of the data (Yusof & Mustaffa, 2011; Han et al., 2011; Mustaffa & Yusof, 2011). The z score is defined by:

$$z\ score = \frac{x - \bar{x}}{\delta} \tag{9}$$

where,

x is the attributed values of the T, C, p, A, and DO

$\bar{x}$ is the mean of attributed values of the T, C, p, A, and DO

δ is the standard deviation of attributed values of the T, C, p, A, and DO

2. Result and Discussions

The performance evaluation metric adopted in this work helps in providing varying details on the predictive capability of the developed network with respect to the normalization approach. The Mean Squared Error (MSE) and the Nash-Sutcliffe Efficiency Coefficient (NSE) was adopted and they are defined as follows;

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(DO_p(i) - DO_A(i))^2 \quad (10)$$

$$NSE = 1 - \frac{\sum_{i=1}^{n}(DO_p(i) - DO_A(i))^2}{\sum_{i=1}^{n}(DO_p(i) - \overline{DO_A})^2} \quad (11)$$

where,

$DO_p(i)$ is the predicted value of the DO;

DO_A (i) is the actual value of the DOA;

$\overline{DO_A}$ is the mean value of the DO;

n is the size of sample.

The dataset for the study was obtained after eight weeks of monitoring of the tank re-circulatory aquaculture system at the WAFT Laboratory. Thereafter, divided on the bases of 60:20:20 percentage for Training, Testing, and Validation, respectively for the ANN model development.

The result of the performance effect of the adopted four normalization techniques with respect to the earlier defined metrics of evaluation are as depicted in Table 1. Furthermore, the results depict the Decimal point technique as having a MSE value of $3.2617e^{-05}$, the least of all techniques. This indicates that it has the least error margin between the predicted and the actual values of the DO. The MSE of the unitary technique is 0.0084, a better performance as compared to the Min-max and Z score techniques with a value of 0.0280 and 0.3622, respectively. The MSE is a measure of the error margin between the actual and the predicted model. It also depicts the deviation of the predicted model from the actual model. Thus, smaller the MSE, smaller the error margin and the better the model. Based on this, the Decimal point with the least value of MSE has a better and improved performance as compared to other techniques.

Furthermore, with the Nash-Sutcliffe Efficiency (NSE), whose values ranges from –∞ to 1 is a measure of the goodness of fit of a predicted model as compared to the actual model. If the value is 1 there is a perfect match of the predicted model to the actual model, thus closer the efficiency value is to 1, better the model. Thus, the Decimal Point technique has a least performance with respect to the closeness of the predicted model to the actual model while the Min-Max technique has the best performance of the other techniques. Thereby placing Min-Max techniques as a better solution as compared to other techniques considered. Figure 2 depicts the normalized actual data in comparison with the ANN forecasted using the Min-Max technique. The comparison of the normalized actual data and that of the ANN using Decimal point technique is presented in Figure 3. Figure 4 presents the output of the ANN using the unitary technique as compared with the normalized actual data,

	MSE	NSE
Min Max Technique	0.0280	0.6508
Decimal Technique	$3.2617e^{-05}$	0.5670
Unitary Technique	0.0084	0.6010
Z-Score Technique	0.3622	0.6342

Table 1. Performance Comparison of Techniques

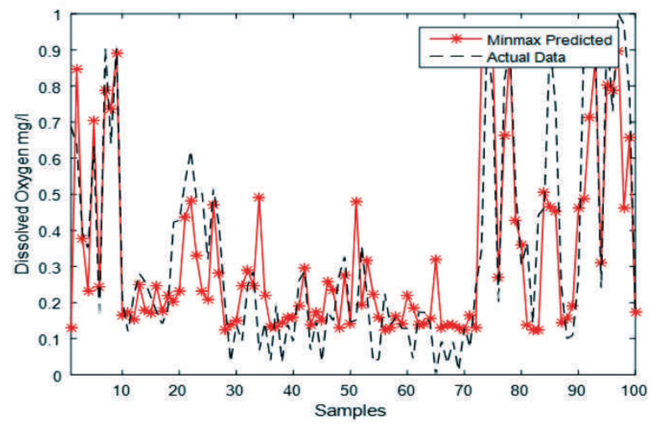

Figure 2. Actual vs. Predicted (MinMax)

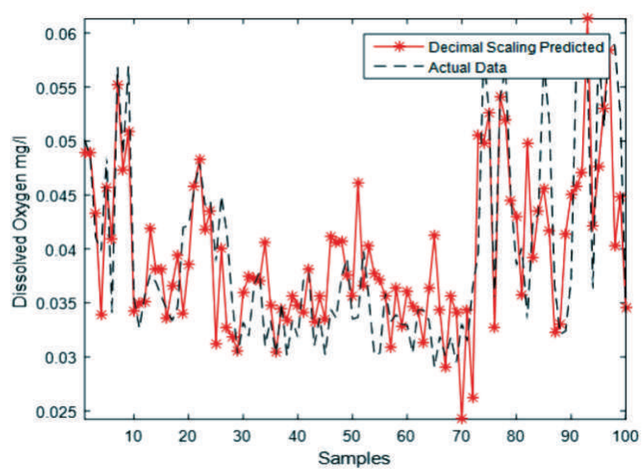

Figure 3. Actual vs. Predicted (Decimal Point)

while Figure 5 depicts the comparison of the normalized actual data and that of the ANN using the Z-score technique.

Conclusion

In this study, the effect of various normalization techniques namely the Min-Max, Decimal Point, Unitary, and Z Score techniques were investigated on the prediction of water quality based on the prediction of DO re-circulatory aquaculture system. The comparative effects of these techniques was investigated using the multiple layered Artificial Neural Network. The metrics for evaluating the effects of the aforementioned techniques on the ANN was the mean square error and Nash-Sutcliffe Efficiency coefficient. The error measures were used to investigate the predictive capability of the ANN models on the new dataset. The results showed that the type of normalization techniques used on the dataset has effect on the ANN predictive capability and consequently, the water quality model of the aquaculture system. Furthermore, Decimal point technique produces the least MSE on implementation with the ANN, while the Min-Max technique has a better model approximation than the other approaches based on the NSE. Conclusively, the result obtained shows that the type of normalization technique adopted in the pre-processing operation has effect on the predictive capability of the ANN model.

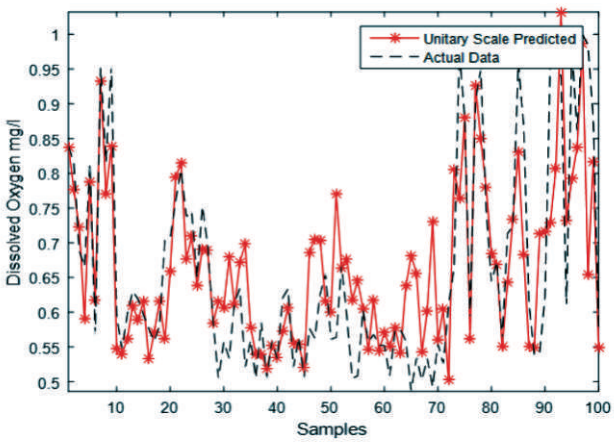

Figure 4. Actual vs. Predicted (Unitary Scale)

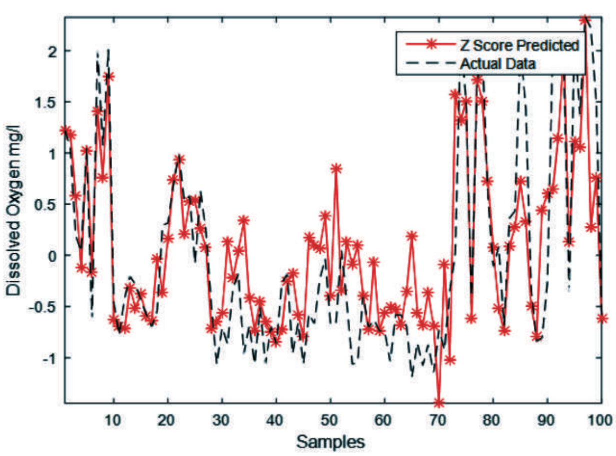

Figure 5. Actual vs. Predicted (Z-Score)

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