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An Analysis Using LS-SVM and Artificial Neural Network (ANN) For Crime Forecasting at Johor Bahru

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Abstract

In the recent era of increasing volume crimes, crime prevention is now one of the most important global issues, along with the great concern of strengthening public security. In addition, crime forecasting is rarely used globally by police including in Malaysia. The crime forecasting method is to predict the crime rates that help police officer to prevent the crime rates at Johor Bahru in more effective way. From that, we propose a new forecast method based on least square support vector machine technique and Artificial Neural Network technique that applied in this research project. Least Square Support Vector Machine technique is a nonlinear mapping maps that input data into a higher dimensional feature space and use the performance of Radial Basis Function kernels. While Artificial Neural Network technique uses a three-layer feed-forward ANN which are input layer, hidden layer and output layer with back-propagation multi-layer perceptron to predict the crime rates. The dataset consists of two different type of crimes, i.e. Property Crime and Violent Crime. The two techniques have been constructed using MATLAB and the performances are measured using mean-square error, mean absolute error and mean absolute percentage error. The overall results are compared to the individual models and the performance result shows that the ANN has a better accuracy performance for crime forecasting with low value.

Keywords: Crime Forecasting, Least Square Support Vector Machine, Artificial Neural Network, Radial Basis Function Kernels, Multi-Layer Perceptron, Property Crime, Violent Crime.

1.0 Introduction

In the era of globalization, crime is a subject that is feared and dreaded by the public all around the world. Crime is an integral part of risks that we are facing it in every day. Nowadays, there have been many criminal cases reported by the mass media, such as theft, rape and sex offenses, robbery, murder and kidnappings. High crime rate makes people feel insecure, thus become one of the major problems in society.

However, crime forecasting is rarely used globally by police. Repeated predictions of crime events indexed by geographic area are the technique that military and police leaders regularly rely on to support the forecasting process (Huddleston and Brown, 2013). Accurate forecasting of crime within small geographic areas will significantly benefit the municipal police (Gorr and Harries, 2003; Gorret al., 2003). In this research, we focus and make comparison on the least square support vector machine (LS-SVM) technique and Artificial Neural Network (ANN) technique to solve the short-term load forecasting problem. According to Yusof (2013) and Ismail and Shabri (2014), LS-SVM is a formulation from the original algorithm Support Vector Machine (SVM) and was reported to be much more efficient when dealing with huge scale problems. An ANN or commonly known as "neural network" (NN), is a biological neural network based of mathematical or computational model (Singh & Chauhan, 2009). NN models have been proven successful in improving prediction accuracy through their capabilities in detecting and estimating relationships between nonlinearities, complex interactions and discontinuities (Caulkins et al., 1996). By applying these techniques, crime forecasting can be improved and early crime prevention can be enforced while giving a better assessment of future crime risks.

Therefore, the aim of this research is to study on how LS-SVM technique applied in crime forecasting by analyze the RBF kernel in LS-SVM technique and ANN is applied in crime forecasting research in Johor Bahru and also to make comparison between LS-SVM technique and ANN technique. The objectives of this research are first, to analyze the different type of crimes in Johor Bahru. Second, to forecast the property crime rates and violent crime rates daily data at Contingent Headquarters Police Johor Bahru (IPK) in the future using LS-SVM and ANN techniques. Lastly, to compare the LS-SVM technique and ANN technique with two different types of crimes, property crime and violent crime.

2.0 Methodology

The methodology research of analyzing crime forecasting is using two techniques which are LS-SVM technique and ANN technique. This project is divided into few parts, which are formulating the problem, dataset collection, development of LS-SVM Model, development of ANN, validation and evaluation of the model as well as conclusion and report. The procedure of obtaining the data as well as the data has to be preprocessed. This research project requires Crime Case Indeks Dataset Collection from years 2011 to 2015 as an input to conduct the experiment by using LS-SVM technique and ANN technique. The dataset that applied in the experiment is retrieved from the Bukit Aman Malaysia. This dataset mainly focus in Johor Bahru and consists of two type's crimes which are property crime and violent crime and each of categories has specified daily of attributes follow by year from 2011 to 2015.

For the developing of LS-SVM techniques, RBF kernels are used because RBF has superior efficiency compare to other kernels (Suykens et., . 2001). Besides that, Radial basis kernels have proved to be useful in a wide variety of applications but for regression, there can be a better choice. Besides that, ANN technique is used in this research which consists of three layers: the first is the input layer where the data are introduced to the network, the second layer is the hidden layer where the data are processed, and the final layer is the output layer where the results of the given input are produced. The network is trained using the backpropagation algorithm. Backpropagation has been the most popular and most widely implemented learning algorithm for all neural network paradigms (Zou et al., 2007). In a backpropagation network, the weighted connections only feed activations is the forward direction from an input layer to

the output layer. Lastly, to measure the the performances of each model for both training and testing data and to measures of forecast accuracy are evaluated by using the mean-square error (MSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) which is widely used for evaluating results of time series forecasting.

3.0 Result

Based on the results, each model was tested using the same data sets, and the results were compared using MAE, MSE and MAPE in order to measure their predictive capabilities and to evaluate the performances of LS-SVM and ANN model on crime forecasting. The programs for the development of each model were written using MATLAB language. Before that, the data of property crimes and violent crimes will arrange with first lagged data until twelve lagged data. The lagged of data will be written as X is raw of data, Xt-1 is first input lagged of data and Xt-12 is twelve input lagged of data. Below is an example of a table by generating lagged observations as shown in Table 1.

Table 1: Example of Lagged Observations in Property Crimes Data

X	**Xt-1**	**Xt-2**	**Xt-3**	**Xt-4**	**Xt-5**	**Xt-6**	**Xt-7**	**Xt-8**	**Xt-9**	**Xt-10**	**Xt-11**	**Xt-12**
50	46	42	63	47	56	37	60	36	44	44	38	57
46	42	63	47	56	37	60	36	44	44	38	57	66
42	63	47	56	37	60	36	44	44	38	57	66	58
63	47	56	37	60	36	44	44	38	57	66	58	48
47	56	37	60	36	44	44	38	57	66	58	48	55
56	37	60	36	44	44	38	57	66	58	48	55	42
37	60	36	44	44	38	57	66	58	48	55	42	47
60	36	44	44	38	57	66	58	48	55	42	47	39
36	44	44	38	57	66	58	48	55	42	47	39	56
44	44	38	57	66	58	48	55	42	47	39	56	61
44	38	57	66	58	48	55	42	47	39	56	61	45
38	57	66	58	48	55	42	47	39	56	61	45	48
57	66	58	48	55	42	47	39	56	61	45	48	52
66	58	48	55	42	47	39	56	61	45	48	52	45
58	48	55	42	47	39	56	61	45	48	52	45	46
48	55	42	47	39	56	61	45	48	52	45	46	46

Since the number of input nodes for each model corresponds to the number of lagged observations, two types of input structures are produced, meaning that each model will forecast four, six, eight, ten and twelve input data as shown in Table 2. These structures are essential in finding out which number of input nodes is favorable for the models.

Table 2: Input Structures for Forecasting Models

Model	**Input Structure**
M1	xt = f (xt-1,xt-2,xt-3,xt-4)
M2	xt = f (xt-1, xt-2, xt-3, xt-4, xt-5, xt-6)
M3	xt = f (xt-1, xt-2, xt-3, xt-4, xt-5, xt-6, xt-7, xt-8)
M4	xt = f (xt-1, xt-2, xt-3, xt-4, xt-5, xt-6, xt-7, xt-8, xt-9, xt-10)
M5	xt = f (xt-1, xt-2, xt-3, xt-4, xt-5, xt-6, xt-7, xt-8, xt-9, xt-10, xt-11, xt-12)

Once the input structures are prepared, the data are then divided into two sets; training and testing data. In this research, the data will be divided into 70% and 30% respectively. It should be noted that the train data is used to train the network into modeling whereas the test data will be used to develop and evaluate the performance of the model. The overall performance of the three models in forecasting the two sets of data will be tabulated by Table 3, Table 4 and Table 5 to give a clearer picture on the forecasting capability of each model. The results are based on the MSE, MAE and MAPE of the testing set. Based on Table 2, 3 and 4, it can be seen that the ANN model gives out the lowest number of MAE, MSE and MAPE for all the data sets. The lower the value of MAE, MSE and MAPE, the more accurate the predictions. Hence, since ANN model outperforms the other models in forecasting all the crimes data, it can be said that the ANN has a higher predictive power compared to LS-SVM models. Concluded that ANN model is better technique for crime forecasting than LS-SVM model

Table 3: Comparison of Forecasting Models Based on MSE

Type of Crimes	**LS-SVM**	**ANN**
Property Crimes	57.43503	**38.858**
Violent Crimes	9.590057	**6.3322**

Table 4: Comparison of Forecasting Models Based on MAE

Type of Crimes	**LS-SVM**	**ANN**
Property Crimes	6.105565	**5.1713**
Violent Crimes	2.55228	**2.1028**

Table 5: Comparison of Forecasting Models Based on MAPE

Type of Crimes	**LS-SVM**	**ANN**
Property Crimes	0.229383	**17.818**
Violent Crimes	0.565412	**0.25824**

4.0 Conclusion

In this research, ANN and LS-SVM model for forecasting is developed in order to improve the existing forecasting models and to do the comparison between two models which are gives a best result. The model is designed so that ANN and LS-SVM would take the data inputs and process the inputs thoroughly using MATLAB2013a is implemented using two types of crime data, mainly Property Crimes and Violent Crimes. In order to measure the performance of the ANN and LS-SVM model, three types of well-known performances measures are used;

MAE, MSE and MAPE. Additionally, the performances measured are compared to the individual of ANN and LS-SVM models. Based on the analyzed results, it is proven that the ANN model managed to achieve the highest accuracy by producing the lowest value training data of MAE, MSE and MAPE.

References

Caulkins, J., Cohen, J., Gorr, W., & Wei, J. (1996). Predicting criminal recidivism: A comparison of neural network models with statistical methods. Journal of Criminal Justice, 24(3), 227-240.

Gorr, W., Olligschlaeger, A., & Thompson, Y. (2003). Short-term forecasting of crime. International Journal of Forecasting, 19(4), 579-594.

Gorr, W., & Harries, R. (2003). Introduction to crime forecasting. International Journal of Forecasting, 19(4), 551-555.

Hart, T., & Zandbergen, P. (2014). Policing. An International Journal of Police Strategies & Management, 37(2), 305-323.

Huddleston, S. H., & Brown, D. E. (2013, December). Using discrete event simulation to evaluate time series forecasting methods for security applications. In 2013 Winter Simulations Conference (WSC) (pp. 2772-2783). IEEE..

Ismail, S., & Shabri, A. (2014). Stream Flow Forecasting using Principal Component Analysis and Least Square Support Vector Machine. Journal of Applied Science and Agriculture, 9(11), 170-180.

Mustaffa, Z., & Yusof, Y. (2014). LSSVM parameters tuning with enhanced artificial bee colony. International Arab Journal of Information Technology, 11(3), 236-242.

Singh, Y., & Chauhan, A. S. (2009). Neural networks in data mining. Journal of Theoretical and Applied Information Technology, 5(6), 36-42.

Suykens JA, Vandewalle J, De Moor B. (2001). Optimal control by least squares support vector machines. Neural Netw 14(1):23–35.

Yusof, Y., Kamaruddin, S. S., Husni, H., Ku-Mahamud, K. R., & Mustaffa, Z. (2013). Forecasting model based on LSSVM and ABC for natural resource commodity. International Journal of computer theory and Engineering, 5(6), 906.

Zou, H.F., Xia, G.P., Yang, F.T., & Wang, H.Y. (2007). An investigation and comparison of artificial neural network and time series models for Chinese food grain price forecasting. Neurocomputing, 70: 2913-2923.