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Deep Learning Web Based Prediction System for Zakat Collection

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Abstract : Zakat is a religious obligation that aims for charitable contribution by the Muslims. It is an annual payment made under Islamic law on certain kinds of property by a group of Muslim and is based on certain criteria. The collected zakat is distributed to certain group people based on pre-defined criteria with the aim to improve their life well-being. The payment and distribution of zakat have played a major role in the history of Islam. To date, various studies have been reported on utilizing ICT, in particular deep learning models, to facilitate either the zakat collection or distribution. However, unlike artificial neural network, deep learning consists of more hidden layers. One of the issues in the deployment of deep learning models is the determination of number of hidden layers and hidden neurons. This study demonstrates the use of Long Short Term Memory (LSTM), to forecast zakat collection for one of the states in Malaysia. The model is realized through four phases: data collection and preparation, algorithm design, model implementation and model evaluation. The focus was put in investigating the effects of LSTM parameters (window size, number of hidden layers and number of hidden nodes) on the zakat forecasting performance. Experimental results showed that LSTM produces the least error rate (i.e 5.29) when it uses two hidden layers, three hidden nodes and seven time step (i.e window size). With an error rate below than 8%, the produced forecasting model can be considered as a competitive prediction model. Putting the prediction model into practice, zakat institution will be able to better design appropriate strategies to collect and distribute zakat for the well-being of the ummah.

Keywords: Zakat Management, Deep Learning, Long Short Term Memory

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1. Introduction

Zakat is an annual payment made under Islamic law on certain kinds of property by a group of Muslim and is based on certain criteria. The collected zakat is distributed to certain group people based on pre-defined criteria with the aim to improve their life well-being. In Malaysia, zakat is managed by the state government where each state has its own institution that is responsible to manage zakat. Even though the scope of the zakat management has been limited to state level, zakat institutions are still facing problem with zakat collection and distribution. One of the difficulties is in forecasting the amount of zakat collection, which is performed manually. When such an approach is deployed, it limits the planning for an optimal zakat distribution and relevant programs to increase zakat collection. Therefore, a systematic prediction tool is required to facilitate zakat management for a better strategic planning. To date, various attempts have been made to forecast zakat collection using statistical and machine learning approaches. This includes the multiplicative decomposition [1] and Holt's exponential smoothing [2] which is an example of the machine learning approach that focuses on artificial neural network.

Deep learning which is a form of machine learning was inspired by artificial neural network. Like artificial neural network, it also uses existing data to train a model to make predictions from new data [3]. However, unlike artificial neural network, deep learning consists of more hidden layers. Although it is not clear the number of hidden layers that separate shallow from deep learning, it is noted that more hidden layers result to more abstract processes. The increase in the number of layers in a network requires a high computational processing power, which is why deep learning only gains popularity recently with the introduction of GPU. Moreover, the digitization of processes which increases the data available for training also contributes to the rising popularity of deep learning since its performance relies heavily on the amount of training data. Considering the success of artificial neural network in forecasting zakat collection [4] and the performance of deep learning in other forecasting tasks [5-6], the deployment of deep learning in zakat management needs to be investigated.

Among the models in deep learning is the Recurrent Neural Network (RNN) where connections between nodes form a directed graph along a sequence. This allows it to exhibit dynamic temporal behaviour for a time sequence. Unlike feedforward neural networks, RNNs can model sequential data because the hidden state is affected by the input and the previous hidden state. A popular solution to RNN drawbacks is an augmentation to RNN called Long Short-Term Memory (LSTM). Long Short-Term Memory [7] prevents the vanishing and exploding gradient problem. Instead, errors can flow backwards through unlimited numbers of virtual layers unfolded in time. This ability results in LSTM being able to remember long term dependencies even given with long delays between significant events.

2. Material and Methods

In LSTM, errors can flow backwards through unlimited number of virtual layers unfolded in time. This is made possible with the implementation of LSTM cell which comprises of cell state, input gate, forget gate and output gate. Cell state is an element that runs across the entire iteration with minimal linear interactions. Meanwhile, input, forget, and output gate are the elements that control cell state by deciding which information to be written, read, or erased, respectively. Among all the tasks that LSTM perform, this study is interested in time series prediction. Even so, prior to obtaining an efficient LSTM model, several parameters need to be defined. This includes the number of hidden layers and number of hidden nodes. In addition, due to utilizing LSTM as a predicting model, there is also a need to define the window size of the time series prediction. In this case, window size refers to the time step required to predict the future time step. This is useful when we need to transform time series data into supervised learning. We use previous time steps as input variables and use the next time step as the output variable.

This study undergoes four phases: data collection and preparation, algorithm design, model development and model evaluation. Among the four phases, the second phase is the focus as it includes the determination of window size, number of hidden layers and number of hidden nodes to be used by the LSTM. Each time the combination is determined, the model is implemented and evaluated.

3. Result and Discussion

In realizing LSTM to predict zakat collection, various combination of number of hidden layers, hidden nodes and time window have been experimented. A web-based system was then developed on top of the LSTM model. This is to ease end users in predicting zakat collection for the identified district. Figure 1 illustrates the steps in utilizing the developed web-based system. Experimental results showed that LSTM produces the least error rate (i.e 5.29) when it uses two hidden layers, three hidden nodes and seven time step (i.e window size). The performance of the proposed models was compared with linear regression (LINREG) as illustrated in Table 1. The evaluation metric of Root Mean Squared Error (RMSE) of LSTM for every district are smaller than RMSEs of linear regression (LINREG) model. The high RMSEs of LINREG is due to the volatile nature of the zakat collection which LINREG could not model. On contrary, the RMSEs of LSTM are far less than RMSEs of LINREG which proves the ability of LSTM to model the movement of the zakat collection better than LINREG.

Figure 1: Steps to use deep learning web based prediction system for zakat collection

Table 1: Root Mean Squared Error: LSTM vs LINREG

District	LSTM	LINREG
BB	2,719.73	138,228.37
BL	5,895.79	571,010.42
KL	16,471.54	818,878.26
KM	16,967.86	1,256,518.13
KP	6,192.46	1,050,280.88
KS	24,316.78	1,205,789.68
LW	3,435.97	658,787.14
PD	1,626.90	361,391.97
PS	2,712.11	148,255.97
PT	1,684.12	143,502.99
SK	2,938.26	123,097.80
YN	4,036.39	553,275.18

4. Conclusion

Time series analysis is the collection of data at specific intervals over a time period, with the purpose of identifying trends to ease the process of predicting a future occurrence. Deploying time series forecasting contributes to the decision making of many organizations. It helps the management to make correct and appropriate decision for the benefit of the organization. This study demonstrates the use of a deep learning model in zakat management. Particularly, the discussion is made on the use of Long Short Term Memory, which is architecture of a deep learning model, to forecast zakat collection in one of the state in Malaysia. In order to benefit from the model, there is a need to determine the parameter values (i.e window size, number of hidden layers and hidden nodes). Upon completion of the experiments on data in-hand, it is learned that LSTM works best when window size is set to be 7 and the hidden layer and hidden nodes are 2 and 3, respectively.

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