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Energy Consumption Prediction by using Machine Learning for Smart Building

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ABSTRACT: Building Energy Management System (BEMS) has been a substantial content currently due to its significance in reducing energy destruction. still, the performance of one of BEMS operations which is energy consumption vaticination has been stagnant due to problems similar as low vaticination delicacy. therefore, this exploration aims to address the problems by developing a prophetic model for energy consumption in Microsoft Azure cloud- grounded machine literacy platform. Three methodologies which are Support Vector Machine, Artificial Neural Network, and kNearest Neighbour are proposed for the algorithm of the prophetic model. fastening on real- life operation in Malaysia, two tenants from a marketable structure are taken as a case study. The data collected is analysed and pre-processed before it's used for model training and testing. The performance of each of the styles is compared grounded on RMSE, NRMSE, and MAPE criteria. The trial shows that each tenant's energy consumption has different distribution characteristics.

KEYWORDS: MICROSOFT AZURE, ARTIFICIAL NEURAL NETWORK.

I. INTRODUCTION

Lately, smart structure conception has been acclimated more constantly as an action to produce an intelligent space area by taking advantage of the rapid-fire development of computational and communication armature. This conception isn't only limited to Malaysia but other countries as well. General public understanding of smart structure conception rotates on the idea of automated process, which is suitable to automatically control the structure's operation through the operation of instrumentation measures and microcontrollers in two- way communication. Other than automated control, a smart structure also consists of an intelligent system which provides energy consumption vaticinations as an energy effectiveness action. This is due to its advantage of yielding provident savings and as a sustainable approach for energy operation to minimize energy destruction. The growth of population lead to the adding of energy demand in this country and have been estimated to reach 116 million tons of oil painting coequals (mtoe) by this time. Energy handed in Malaysia is told by the main reactionary energy sources which included coal, natural gas and energy oil painting. structures which including marketable, domestic and artificial in our country utilises a aggregate of 48 of the electricity that have been created. The adding of energy consumptions towards structures from day to day produce enforcement to this country in managing and reducing the energy consumption as much as possible in order to ameliorate energy effectiveness. This study is a continuing exploration from our former work where preliminarily statistical analysis and k- nearest neighbour (k- NN) system were proposed as the methodologies and SPSS was used as the platform. In our former study, only k- NN was proposed as the system to prognosticate energy consumption.

II. RELATED WORK

MACHINE LEARNING MODELS

Recently, smart structure generality has been shaped more constantly as an action to produce an intelligent space area by taking advantage of the rapid-fire- fire development of computational and communication architecture. This

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generality is not only limited to Malaysia but other countries as well. General public understanding of smart structure generality rotates on the idea of automated process, which is suitable to automatically control the structure's operation through the operation of instrumentation measures and microcontrollers in two-way communication. Other than automated control, a smart structure also consists of an intelligent system which provides energy consumption vaticinations as an energy effectiveness action. This is due to its advantage of yielding provident savings and as a sustainable approach for energy operation to minimize energy destruction. The growth of population lead to the adding of energy demand in this country and have been estimated to reach 116 million tons of oil painting oil rivals(mtoe) by this time. Energy handed in Malaysia is told by the main archconservative energy sources which included coal, natural gas and energy oil painting oil. structures which including marketable, domestic and artificial in our country utilises a total of 48 of the electricity that have been created. The adding of energy consumptions towards structures from day to day produce enforcement to this country in managing and reducing the energy consumption as much as possible in order to meliorate energy effectiveness. This study is a continuing disquisition from our former work where previously statistical analysis and k- nearest neighbour(k- NN) system were proposed as the methodologies and SPSS was used as the platform. In our former study, only k- NN was proposed as the system to predict energy consumption.

DEEP NEURAL NETWORK LEARNING MODELS

Profitable development depends on the periodic energy consumption in the domestic, artificial and civic sectors. Beforehand machine literacy models play a vital part in the analysis of energy consumption modeling. Still, due to the enormous development and rapid-fire increase of the energy consumption data value, the energy demand is growing consequently. thus, the machine intelligence literacy models don't effectively vaticinating energy retention. As similar, in this script, deep neural networks or deep literacy models effectively work on this large volume of data for analysis. Deep literacy turns out to be better because of its effective strategy for the prosecution of the internal retired layers. also, the deep neural network ways have been used for energy retention analysis and soothsaying by applying the ensuing ways Convolutional Neural Networks(CNN), intermittent Neural Networks(RNN), and Long Short- Term Memory(LSTM). The anticipation approach is dependent on the deep neural network literacy strategy joining inheritable algorithm- grounded computation with the Long Short- Term Memory approach, we represent this model. The inspection set up that transformative deep literacy models have preferred prosecution over traditional and standard vaticination models on the off chance that energy application displays.

III. METHODOLOGY

By integrating the machine literacy- grounded approach with model optimization, we propose one armature for better energy effectiveness analysis and consumption in smart megacity public sectorbuildings.By integrating the data collection, datapre-processing, data analysis and generation with a deep neural network model, we propose an armature for better energy effectiveness and consumption in civic structures of smartcities.Energy consumption dataset of 300 marketable structures was used to assess the effectiveness of the proposedalgorithm.In this paper we propose a new algorithm for opting and fine- tuning the hyperactive parameters of the energy consumption model and tested it on the illustration of empire of the marketablebuildings.In this paper, we propose a system for estimating the consumption of electric power by large marketable centers and business structures, grounded on the GBM grade boosting algorithm with adaptive tuning of hyperactive parameters using the k-foldcross-validation and randomization procedures

IV. EXPERIMENTAL RESULTS

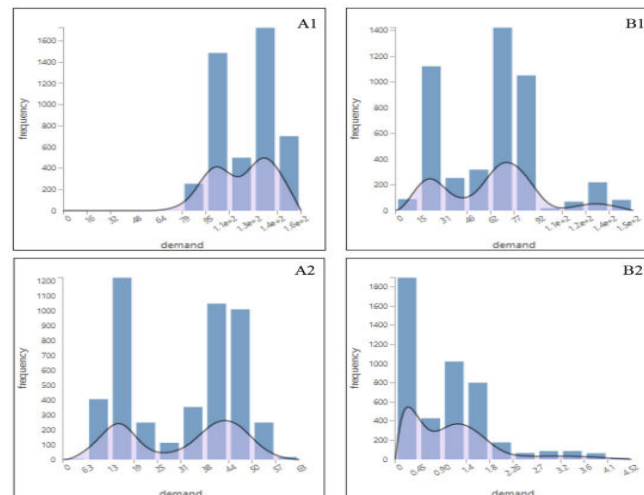


Fig 1 Experimental Result

The results of the trial were banded in sections grounded on the way of the prognostications' frame. The pre-processing system and insinuation of missing data using modules handed by both Microsoft Azure Machine Learning Studio and Caret Package were banded in terms of procedure, goods, and significance. The findings regarding energy consumption vaticination were reviewed for each tenant and performance comparison was handed for the vaticination result of Artificial Neural Network(ANN), Support Vector Machine(SVM) and k- Nearest Neighbour(k- NN). Holistically, utilisation of Azure ML Studio as a soothsaying medium was audited to identify its trustability and comity to prognosticate energy consumption. model training and testing, the prophetic model generated was compared in terms of performance between algorithms for each tenant. originally, the result of the testing was observed by comparing the performance of the styles for individual tenants. The comparison table is as shown in Table 5. From the performance evaluation in Table 5, the SVM system utilising Radial Base Function kernel had the stylish performance for Tenant A1 and A2, in which the RMSE value was 4.7506789 and 3.5898263, independently. Indeed though SVM had the stylish performance, the difference between RMSE value in comparison to k- NN system was minor. The MAPE result also indicates that SVM vaticination had a lower absolute error chance. For Tenant B1, k- NN was the stylish performing system in which the RMSE value was comparably lower than the other system at 14.934312. still, its absolute error was advanced than SVM absolute error. This event happed also to Tenant B2. The stylish performing algorithm was k- NN with 0.5439403 RMSE value, which was lower compared to the RMSE result for SVM and ANN. still, the MAPE result for SVM was lower than the result for k- NN. As the cast stated was in terms of the anticipation of value, the square error system was a much better evaluation system(Tilmann, 2010). therefore, the k- NN system was denoted as the stylish performing algorithm for Tenant B1 and B2. pertaining to the normalised RMSE result, it can be observed how each of the vaticination styles performed else under different datasets. The performance of every system deteriorated from Tenant A1 until Tenant A2, in which Tenant A2 had the worst performance for every system. Under TNB tariff order, the tenants at both departmental lots A and B were categorised as Medium Voltage General Commercial(Tariff C1). This means that the yearly electricity charges were calculated by acquiring the maximum demand of the month and the kWh(Tenaga Nasional Berhad, 2006). For Tariff C1, the off and on- peak period wasn't applied to the billing process. thus, to prognosticate energy billing completely, the maximum energy demand and the kWh need to be determined.

V. CONCLUSION

The course of this exploration has concentrated on developing an energy consumption prophetic model for two marketable departments that have espoused the smart structure ecosystem. The energy demand data collected from June 2018 until December 2018 has been analysed and pre-processed for training and testing of the prophetic models. Utilising the Microsoft Azure Machine Learning plant (AzureML), statistical analysis of the data collected was made to determine the normalcy of the dataset. From this analysis, skewness and kurtosis values were acquired and established that all collected data was different in distribution characteristics. Continuing with the process of prophetic model development, the data collected was pre-processed through the insinuation of missing data using PPCA system and standardisation metamorphosis. The pre-processing was successfully executed inside AzureML terrain, in which the attendant reused data had a mean valued at 0 and a standard divagation of 1. An trial process was also made to determine the capability of the missing data insinuation system. A tried data with missing value was generated to estimate the PPCA system, in which it produced a promising result with low raw bias and content rate of further than 90 of the factual value. fastening on the ideal of this exploration, three supervised machine literacy vaticination styles videlicet k- Nearest Neighbour, Support Vector Machine with Radial Base Function kernel, and Artificial Neural Network with Multilayer Perceptron model, were chosen as the algorithm for the prophetic model. These styles were successfully compared in terms of their attendant structure and vaticination performance. The consequence of the model training and testing shows that each system performed else for every tenant. SVM system shows the most promising result, whereby it managed to be the stylish system for 2 tenants which were Tenant A1 and Tenant A2, with RMSE valued at 4.7506789 and 3.5898263, independently. likewise, SVM result also shows a lower mean absolute error for Tenant B1 and Tenant B2 at 12.09 and 43.97, independently, although k- NN had lower RMSE affect for these two tenants. SVM prognosticated demand also had better delicacy when average consumption was calculated from the demand, in which it achieved a lower MAPE than the rest of the styles for all tenants. All by each, this SVM auspicious result comes with a price, whereby the model developed with the algorithm took 13 – 18 h to train. In discrepancy with kNN system that performed slightly worse than SVM, it only took maximum 40 s to train. For this exploration, Azure ML was employed for all processes and R programming was used considerably for data standardising, model training and testing and eventually performance evaluation

REFERENCES

- [1] Abadi, Martín, et al., 2016. TensorFlow: Large-Scale Machine Learning on Heterogeneous Distributed Systems. ArXiv abs/1603.04467.
- [2] Abdul Karim, S.A., Alwi, S., 2013. Electricity load forecasting in UTP using moving averages and exponential smoothing techniques. Appl. Math. Sci. 7, 4003–4014.
- [3] Ahmad, M.W., Mourshed, M., Mundow, D., Sisinni, M., Rezgui, Y., 2016. Building Energy Metering and Environmental Monitoring - a State-of-the-art Review and Directions for Future Research, 120, pp. 85–102.
- [4] Attewel, P., Monaghan, D., 2015. Data Mining for the Social Sciences: an Introduction. University of California Press, Oakland.
- [5] Azur, M.J., Stuart, E.A., Frangakis, C., Leaf, P.J., 2011. Multiple imputation by chained equation: what is it and how does it work? Int. J. Methods Psychiatr. Res. 49, 40–49.
- [6] Gnecco, G., Sanguineti, M., 2009. The weight-decay technique in learning from data: an optimization point of view. Comput. Manag. Sci. 6, 53–79. <https://doi.org/10.1007/s10287-008-0072-5>.
- [7] Gonzalez-Briones, A., Hernandez, G., Corchado, J.M., Omatu, S., Mohamad, M.S., 2019. Machine learning models for electricity consumption forecasting: a review. In: IEEE Virtual-Ledgers-Tecnologías DLT/Blockchain y Cripto-IOT.
- [8] Hassan, J.S., Zin, R.M., Majid, M.Z.A., Balubaid, S., Hainin, M.R., 2014. Building energy consumption in Malaysia: an overview. Jurnal Teknologi 707 (7), 2180–3722.
- [9] Hegde, H., Shimpi, N., Panny, A., Glurich, I., Christie, P., Acharya, A., 2019. MICE vs PPCA: missing data imputation in healthcare. Inf. Med. Unlocked 17. <https://doi.org/10.1016/j.imu.2019.100275>.
- [10] Kang, H., 2013. The prevention and handling of the missing data. Kor. J. Anesthesiol. 64 (5), 402–406.
- [11] Karunathilake, S.L., Nagahamulla, H.R.K., 2017. Artificial neural networks for daily electricity demand predictions of Sri Lanka. In: International Conference on Advances in ICT for Emerging Regions (ICTer).
- [12] Kumar, Y., Sahoo, G., 2012. Analysis of parametric & non parametric classifiers for classification technique using

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