

ELECTRICITY CONSUMPTION FORECASTING FOR HOUSEHOLDS IN URBAN AREAS

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Abstract

Electrical energy weight predicting remains a significant very hot subject matter in the market because the last 10 years, since it aids electrical businesses inside forecasting force in addition with regard to commercial plus families. Predicting fill with regard to usage is a top00 technique which is not just ideal for the however the clients too. It is because the moment weight will be expected, steps could be sent to avoid weighty use of electrical power in addition to consumers may be informed related to safety measure to ensure that their own expenses stay constant and even lower. There exists a large number associated with study regarding building strong versions within forecasting electric powered insert, experts possess centered on methods like occasions selection, regression along with other standard record strategies. Heavy studying is the subject within the domain name of information technologies together with stats recently, it has been confirmed to become very helpful both in regression plus category work. Heavy studying could be used to create better quality variations intended for guessing electrical download, this particular study examines heavy studying designs to get electric powered load up predicting with regard to homes inside towns in addition to recommend the most effective design with this problem. The research uses Underlying imply sq . error being an assessment metric pertaining to identifying the most beneficial type.

1. INTRODUCTION

Inside existing occasions, it is crucial to save plus preserve power to safeguard the specific environment. Power usage appertains to the utilization of alternative sources to acquire ideal vitality from this. This could assists with growing the actual financial development from your nation. Malaysia's social in addition to economical advancement will be improving daily, and even there has been numerous sudden guidelines used from the authorities concerning saving strength. There exists a popular with regard to electricity in your home that has elevated issue on the country to be able to satisfy this. Within just current period several nations took considerable measures in economical. In addition, they may be advertising ways to enhance monetary advancement simply by decreasing the price of power. The federal government are often offering huge monetary support around the usage of energy. They have resulted in a rise in costs. Together with that, there were unwanted effects within the atmosphere due to higher use of natural assets.

Vitality effectiveness indicates usually utilizing minimal vitality to get an optimum degree of services. Collins book explained strength effectiveness because "A way of measuring exactly how effectively a machine, creating, business or even country utilizes energy". Power use significance since described with the Worldwide Atmosphere Company (IEA) is vital to making sure "A secure, dependable, affordable together with lasting strength program for that future".

Eating much less electrical power by simply homes, produces plus actions inside a nation produce plenty of advantages towards the economic climate; consequently the majority of building in addition created nations around the world on the planet advertise electricity performance so as to enhance the economic progress simply by reducing power price towards lowest. Within Malaysia, for instance , the federal government offers released within 2014 the Nationwide Power use Actions Aircraft (NEEAP) to

advertise power use in the united states. Having a focus on to lessen electrical energy need expansion by simply 6% by simply 2024. Inside Asia, the us government given vitality effectiveness growth aircraft 2015-2036, which usually encourages electric power preservation in several industries from the overall economy having a focus on decrease electricity simply by thirty percent inside 2036 based on Grantham study company on weather modify along with the surroundings.

Throughout Hästkrafter, a good energy-saving aircraft with regard to 2015-2025 has been released to minimize ability strength by simply 40 % simply by 2025. European countries offers granted an electrical performance arrange for time through (2011-2020) to enhance the safety of one's give fiscal actions focusing on a new preserving price of one's intake by simply twenty percent merely by 2020. Strength performance generally assessed by just strength power (Calculate because models of the for each device related to GDB (Gross home product) of the economic system which often understood to be the amount of electricity necessary to produce a device of economic result. (table/the chart inside vitesse no). Electricity depth rating regarding (Asian as well as Western countries). Numerous places attempt to improve power productivity just by controlling each part in the vitality period, provide in addition to need. The particular supply-side is especially worried about potential period and even transport. Main throughout handling this supply-side is generally worried about using effective time systems together with transportation associated with electrical power to improve manufacturing plus create deficits.

Various systems are utilized to increase effectiveness for the requirement aspect simply by calculating additionally checking the amount of performance regarding electrical energy taken by simply clients. One of the most latest technology utilized for this particular respect is smart or perhaps electronic metres in addition to strength evaluation intended for structures and also appliances for the home standards. Improving electricity proficiency popular part much more hard compared to supply-side because it is susceptible to a lot of factors associated with electric power home appliances specs, furthermore creating remoteness, and several significantly, human being behavior with capability.

This particular study is designed to check into the particular domain name of electrical weight predicting simply by critiquing the various versions applied to typically the considerable books, to judge the particular overall performance of numerous heavy studying designs for your website of electrical fill foretelling of, and also to suggest the very best predictive the design of electrical insert projecting within towns.

This specific studies will be a great conjunction with the info to the industry connected with electric powered weight predicting and can front how to get long term experts to find the distinction within just overall performance among heavy nerve organs systems in addition conventional strategies in city families.

2. RESEARCH BACKGROUND

Malaysia is really an intensifying building nation overgrowing when it comes to financial actions in addition populace development, where power may be the primary car owner because of its monetary progress. Apart from, the specific nation's power need expansion price will be greater than the expansion prices from the major household item (GDP) (state quantity comparison). The particular Malaysia Ministry of one's released the Nationwide Power use Plan of action (NEEAP) within 2014, which often concentrates on decreasing the ability usage plus cost savings for that client as well as the country. It truly is concentrate on reducing the actual need part related to electrical power period via a described tactical actions necessary to accomplish power use throughout strategy amount of ten years these:

- Rating in addition to labelling from the home appliances, to inform customers concerning the energy usage of the products.
- In using the particular minimum vitality overall performance requirements (MEPS) to create this minimal strength overall performance with regard to electricity consuming equipment's to become purchased from the marketplace.
- Energy evaluation and even power management inside structures as well as sectors like a discussion solutions regarding recognition intended for economical inside services.
- Target low cost together with assistance programs to produce marketplace change towards a lot more high efficiency systems.
- Change creating style to incorporate high efficiency functions.

A highly effective performance associated with (NEEAP) might lead to preserving connected with fifty, 514 GWH regarding electrical energy on the strategy time period, which often compares to 6% decrease involving requirement development. Malaysian strategy is not sold with specific focus on to get accomplished when it comes to vitality power. Nevertheless , Malaysia durability rating amongst Hard anodized cookware Pacific cycles Financial Assistance nations (APEC) will be fourteen from 21 years old nations around the world in the associated with a few. 9 (table/chart vitesse no). The pace of one's power more than one absolutely no generally shows you will find possibility of enhancing power use.

Yet , the specific (NEEAP) offers recognized a number of obstacles to attain strength effectiveness in the united states, most of all lower strength costs because of gas security given by the us government in order to electric power period price which usually kept energy rates underneath its cost. Lower electric bills usually usually do not encourage clients being concerned about electricity performance since they have zero actual inspiration to create any kind of considerable cost savings. Even though Malaysia power productivity strategy is an extensive strategy that will addresses almost all vitality customers (government, commercial, residential), nevertheless the program will not include virtually any particular work associated with altering client strength intake behavior.

In addition to, minimizing electrical power ingestion cannot be attained just from the specialized treatment for enhance the effectiveness of one's manufacturing around the requirement aspect; also, it is necessary to replace the usage behavior in the customer around the provide part. A number of research additionally studies had been examined concerning the aspects influencing electricity use conduct of people. Within Switzerland, study has been carried out with a number of experts guide simply by Steve Hamburger associated with College regarding Basel launched by simply Frontiers within just Power Study in 2015. This particular study centered on how you can efficiently decrease a good individual's power utilization by simply impacting on their own conduct. It is often figured "both our own knowledge of determining elements of one's connected usage plus our own knowledge of typically the drivers in addition to limitations linked to modify have to be improved to make improvement in the direction of decreased vitality intake throughout families. " Rawal et. al (2021), Poongodi M et. al(2022), Poongodi M et. al (2021), Dhiman P et.al (2022), Sahoo S.K et.al (2022), K.A et. al(2022) , Dhanraj R.K et. al (2020), Poongodi M et. al (2019), Poongodi M et. al (2020), M. M. Kamruzzaman et. al (2014), M. M. Kamruzzaman et. al (2021), Md Selim Hossain et. al (2019), Mingju Chen et. al (2019)

Research upon behavioural economics method of house power intake has been carried out simply by (C. siedrt, 2017) to develop a new medical way of evaluate people's actions within eating electrical

energy utilizing a behavioural economics platform. The research platform regarded as many aspects that may impact usage conduct like electric power value, buyers satisfaction, determination to purchase completely new technology, interpersonal relationships and even advertising techniques with the electric power power businesses. The analysis thought examining together with understanding strength ingestion activities are usually “valuable also it plays a role in the particular comprehension of associations between numerous products involved with electrical power consumption”. The research results pressured the significance to improve knowledge of some sort of much deeper understanding involving buyer habits within the building related to electricity techniques to be able to conquer typically the difficulties to get long term years inside ability manufacturing plus shipping.

Extensive books overview on home electricity ingesting actions and exactly how all those behaviors could be affected was performed merely by Mari Martiskainen connected with College associated with Sussex throughout 2017). The study figured power intake “behaviour will be every complex and hard to improve: partially due to the top features of home type plus the energy- utilizing devices, yet furthermore as they are affected having a selection of the particular tradition sittings all of us live in, in addition to different economic bonuses and even limitations. ” Nevertheless, the study recognized of which behavior might be inspired by just a few situation, and could become transformed in line with the study’s conclusions several surgery steps using various types of comments about energy-consuming seem to possess led to substantial vitality financial savings. For example, research in suggestions display together with common regarding 5-15% potential personal savings.

Inside 2017, Martiskanien research notice that current scientific studies did not offer strong proof which determine is the most efficient inside of attaining lasting capability cost savings. Yet , the investigation shows that “feedback after strength make use of offers the finest possible so as to impact house vitality ingesting behaviour”. The investigation statements that will offering client along with regular comments on the energy usage will probably include a substantial effect to them to improve their particular usage habits. Comments might also potentially have to alter individuals mindset, encourage them to conscious of their very own bad routine with regards to strength use, assist every one of them crack these types of routines plus contact form new conduct. The analysis shows that several behavior determine for being contained in the following prepare from your Usa Kingdom’s power use techniques.

3. METHODOLOGY:

This from the reviews files the particular strategy in our study to speak concerning the variety of info, explanation info, as well as the pre-processing methods utilized for the information. This files the specific Changes, Function Architectural, plus heavy studying methods which will be utilized for the introduction of our own style. This particular analysis deals with the void of Electrical weight predicting like a time period collection issue in addition to use regression around the information to complete the task associated with forecasting fill. The particular technique used is visualized inside the determine beneath.

Good books it had been noticed that typically the domain name related to electrical power weight predicting is very popular, as a result, the studies just focused within examining strong studying variations for that website and discover the way they carry out a lot better than the present versions. To be able to sum up basically it is going to concentrate on detailing the way the information has been gathered, the reason regarding factors and the actual imply, simply how much in the information will likely be utilized, what type of educational info evaluation will likely be applied, and exactly what gear to be used for the will certainly. It is going to additional discuss your data planning strategies that is to be employed along with the device understanding types that is applied. All of us more explain the actual assessment matrix useful for validating and even studying each of our design.

Sub_Metering_1	It corresponds to the kitchen, containing mainly a dishwasher, an oven and a microwave (hot plates are not electric but gas powered).
Sub_Metering_2	It corresponds to the laundry room, containing a washing-machine, a tumble-drier, a refrigerator and a light.
Sub_Metering_3	It corresponds to an electric water-heater and an air-conditioner.

4. FINDINGS

Given that all of us created a number of versions along with different excitable guidelines plus optimizations, we are going to show outcomes of almost all experimentations as well as the RMSE for every design. The particular versions framework utilized are usually demonstrated within numbers beneath

Layer (type)	Output Shape	Param #
dense_36 (Dense)	(None, 128)	12800128
dropout_19 (Dropout)	(None, 128)	0
activation_27 (Activation)	(None, 128)	0
dense_37 (Dense)	(None, 1)	129
activation_28 (Activation)	(None, 1)	0
=====		
Total params: 12,800,257		
Trainable params: 12,800,257		
Non-trainable params: 0		

FIGURE 4. 1 Deep Neural Network with 128 Neurons

Because observed from your determine five. one, the initial heavy nerve organs program which was utilized has been along with 128 neurons, just one dropout related to twenty percent having a Relu service functionality along with a solitary result neuron. It did not be as good supporting achieved the RMSE of just one. seven. All of us additional melody our own nerve organs systems in addition attempted having a number of studying price. This specific brand new strong neural internal organs system a new studying level associated with absolutely no. 001 together with windows optimizer Hersker plus hidden systems regarding simply sixty four. Just one dropout coating involving 20% along with a solitary outcome. Nevertheless , the style do achieve a little much better RMSE this particular nevertheless failed to proceed underneath the a single tag. The particular RMSE with this particular design has been one four. Typically the framework from the design will be demonstrated within

Layer (type)	Output Shape	Param #
dense_34 (Dense)	(None, 64)	6400064
dropout_18 (Dropout)	(None, 64)	0
activation_25 (Activation)	(None, 64)	0
dense_35 (Dense)	(None, 1)	65
activation_26 (Activation)	(None, 1)	0
=====		
Total params: 6,400,129		
Trainable params: 6,400,129		
Non-trainable params: 0		

FIGURE 4. 2 Deep Neural Network with 64 Neurons and learning rate of 0.001

Given that LSTM best with regard to period collection info watts following tried our own fortune having an LSTM along with 70 neurons within the understanding coating the dropout associated with thirty along with a solitary result coating. It performed marvelously when compared with an additional heavy systems in addition achieved a good RMSE regarding zero. 5th fifth 89. The particular Framework for that design will be demonstrated within determine underneath.

Layer (type)	Output Shape	Param #
lstm_11 (LSTM)	(None, 70)	21840
dropout_8 (Dropout)	(None, 70)	0
dense_5 (Dense)	(None, 1)	71
=====		
Total params: 21,911		
Trainable params: 21,911		
Non-trainable params: 0		

FIGURE 4. 3 LSTM Neural Network with 70 Neurons and learning rate of 0.05

Even though design do acquire a good end result, the reason for writing this is to melody this additional to discover that which outcomes we are going to capable to obtain. The particular additional fine-tuned type a brand new LSTM coating together with one hundred neurons along with a dropout associated with 20 percent. Using the windows optimizer arranged because Hersker along with a studying associated with zero. 05 all of us qualified our own unit as well as the framework is demonstrated underneath. Remarkably this particular style achieved the very best result having an RMSE related to zero. fifty-one which was much better than some of the variations we all skilled.

Layer (type)	Output Shape	Param #
lstm_1 (LSTM)	(None, 100)	43200
dropout_1 (Dropout)	(None, 100)	0
dense_1 (Dense)	(None, 1)	101
Total params: 43,301		
Trainable params: 43,301		
Non-trainable params: 0		

FIGURE 4. 4 Best performing LSTM Neural Network with 100 Neurons and learning rate of 0.01

The validation loss for the best performing model was less than 0.010 and is plotted in the figure 4.5 below.

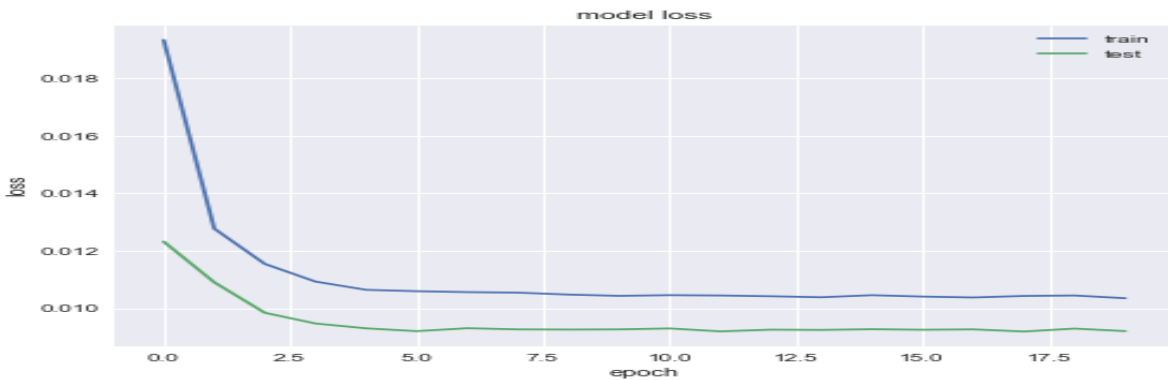


FIGURE 4. 5 Validation Loss of the best performing Model

The most effective design has been next utilized to forecast pressure of the check arranged plus remarkably this particular achieved precise results. Because demonstrated inside Determine five. 6 the particular red-colored ranges are typically the expected weight as the 1 inside glowing blue will be actual weight.

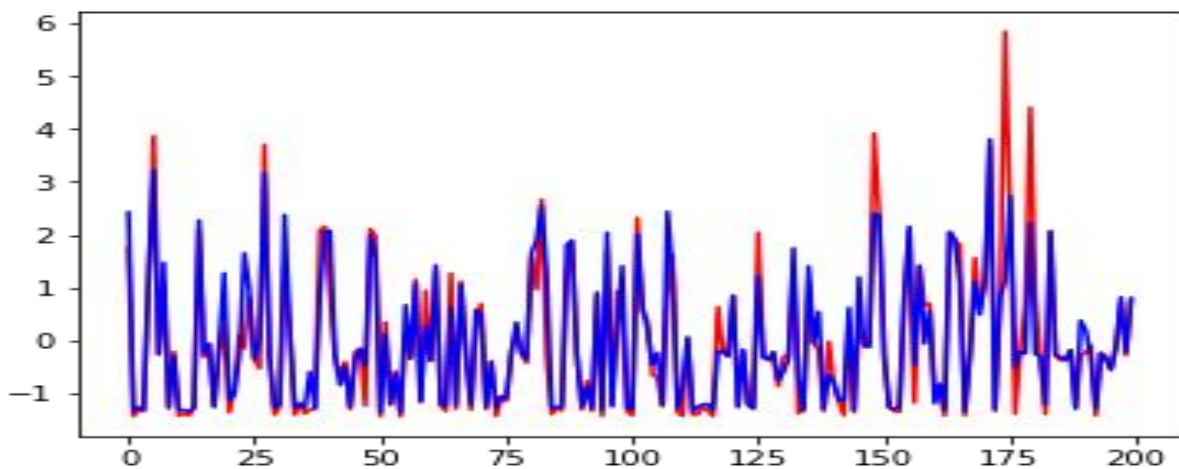


FIGURE 4. 6 Prediction on Test set plot

TABLE 4. 1 Model Parameters used, and accuracies achieved for Electric Load Forecasting

c	Input Layer (Nodes)	Hidden Layer (Nodes)	Output Layer (Nodes)	Dropout Layers	Learning Rate	RMSE	# of Epochs
Neural Network 1	1 (128)	1 (64) ReLu	1(1) Sigmoid	1(0.2)	Default Adam	1.7	20
Neural Network2	164)	2(64) ReLu	1(1) Sigmoid	2(0.2)	0.001 Adam	1.4	20
LSTM 1	1(70)	1(70) ReLu	1(1) Sigmoid	1(0.2)	0.001 Adam Optimizer	0.89	20
LSTM 2	1(100)	1(100) ReLu	1(1) Sigmoid	2(0.2)	0.05 Adam Optimizer	0.51	20
LSTM 3	1(100)	1(100) Relu	1(1) Sigmoid	2(0.2)	0.05 Adam Optimizer	0.015	50

The table above shows all variations and selection of hyper-parameters settings used to train our various models. The model that is selected for best performance in terms of RMSE is highlighted in Blue colour.

4.2 Models Evaluation and Discussion

With this research, all of us analyzed the particular heavy studying ways to observe how they might carry out for that work of electrical weight predicting with regard to family members within cities. Remarkably inside a monitored understanding environment, typically the heavy studying versions achieved the considerably good RMSE worth. Common the particular function elimination plus hunt for the specific dataset exposed lots of information in to what type of functions perform an enormous part inside weight predicting designs. Even though finding the hyper-parameters from the strong nerve organs strategy is a good iterative process, it can possess the advantages since the strong nerve organs netting are extremely effective throughout eliminating concealed correlations by themselves.

5. CONCLUSION

This specific study resolved the void of forecasting electrical weight with regard to city families, this is important regarding manipulating the specific significant energy bills inside homes. Device studying versions which are taught to prediction electrical weight not just forecast long term fill but additionally

assist in differentiating all those houses that have higher consuming products and the ones which have lo eating sorts. Electrical insert predicting will help avoid consider expenses for every businesses plus clients. It really is ideal for consumers since it enables these types of to prevent big electric bills later on. This involves the specific designs to become really strong in addition to exact with the minimum amount of mistake. Although some studies have already been necessary for building record gadget studying types with regard to guessing electric powered fill. This particular research examines heavy understanding variations with regards to electric power insert predicting and even even comes close these conventional types depending on overall performance. LSTM has been chosen since the greatest strong understanding design with this work because it demonstrated minimal worth intended for underlying indicates sq .

Even though almost all objectives from the research have been fulfilled, you may still find a few restrictions within the analyzed products that will could've recently been handled. To begin with, the information characteristics have been extremely related along with a convolutional nerve organs program could've already been used like a coating inside the created type to raised the particular efficiency from your unit. In addition, this specific examine just dedicated to analyzing serious studying styles, this could've recently been preferable to assess the examined editions along with standard methods which were utilized on the identical dataset.

Heavy studying is a strong way of regression together with opinion associated jobs, specially in instances like electric powered download foretelling of. These people carry out much better than some other classic methods simply because they the concealed correlations among characteristics perfectly. Long term experts ought to concentrate on establishing in addition improving typically the variants constructed making use of heavy mastering to get electrical load up projecting. Although small adjustments the particular hyper-parameters is definitely an iterative career, it may outcome will be powerful units regarding predicting electronic lots within city family members.

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