

Using Machine Learning Models to Evaluate the Performance of Website in Iraqi Universities

Armaneesa Naaman Hasoon

Department of Computer Sciences, College of Computer Science & math, Tikrit University, Iraq

Corresponding Author: armaneesa@tu.edu.iq

Abstract: Academic website played a main role in giving information about academic institutions and view the services that introduced to their users. The purpose of this research evaluates the performance of Iraqi universities websites. A dynamic regression model was built. Created a dataset with 113 university websites then preprocessed executed at first then apply a correlation statistics method for determine the most features that influenced at the prediction of performance. Lastly, eight machine learning regression models was applied. After that compared these models, SGD regressor give the best result of evaluation metrics from other models were applied. For increasing the quality of a websites performance, academic institutions should take the result obtained from this research.

Keywords: website, regression, feature selection, accuracy, performance

Article – Peer Reviewed

Received: 15 Nov 2022

Accepted: 29 Nov 2022

Published: 11 Dec 2022

Copyright: © 2022 RAME Publishers

This is an open access article under the CC BY 4.0 International License.



<https://creativecommons.org/licenses/by/4.0/>

Cite this article: Armaneesa Naaman Hasoon, "Using Machine Learning Models to Evaluate the Performance of Website in Iraqi Universities", *International Journal of Computational and Electronic Aspects in Engineering*, RAME Publishers, vol. 3, issue 4, pp. 63-69, 2022.

<https://doi.org/10.26706/ijceae.3.4.2211496>

1. Introduction

With the increasing development of the Internet and its influences in all aspects on the lives of people who access on the Internet web sites, as it played an important role in education, health, business and others [1]. As a result, attention must be considered when designing the site, as well as the quality of the services that provided by the site, and taking care of its development methods [2]. Every day, a large number of web sites appear. The poorly designed web site gives a bad impression of the organization and the number of users of this site decreases, while attention to achieving quality factors in the design makes the number of users increase because it provides a good and reliable information [3][4].

A university's website is thought of as a virtual entranceway to introduce the essential resources to their users [5] [2]. It is widely used to publish information, provide electronic learning to students, and research declaration and education programs. The users of this academic web site are researchers, professors and students [3].

Universities are recently working on creating their own websites, for the purpose of advertising about the university and providing services to the user community [6]. Evaluating the performance of websites is a necessary problem in improving the quality of website through specialists and many of the methods used in evaluating the performance of websites, they take into consideration many criteria's components include: content quality, design quality, and timeliness, quality of the organization and user-friendliness [3][2][7].

There are many previous studies related to the evaluation of web sites that rely on static models, in this paper a dynamic regression machine learning model were built for evaluating the performance of websites based on feature extracted for Iraqi universities websites then compared between the results obtained from models to choose the most exactness one.

This research contributes in: firstly, collect a real data about Iraqi universities web sites, secondly, compute a weight for each metrics to find the most influenced metrics that investment in performance evaluation, and finally, build a dynamic regression model with extracted metrics to predict the performance of websites.

This research is divided as follows: section two introduces the related work accomplished by many researchers; section three offers the methodology suggested in this research. Section four presents the obtained results from proposed work and in last, in section five, conclusion is submitted.

2. Related works

Many previous studies were conducted by researchers to evaluate the performance of a university websites using different methods, some of these studies showed the metrics that have been affected at the performance of a websites.

This research shows the most important measures that influence on the prediction of the performance for academic website. In this section, we will view some of the previous studies that were presented in evaluating the performance of a universities websites.

The researchers in [2] evaluating the usability hand of Jordanian universities web site. The authors have been used two methods for evaluation: questionnaires and online automated testing tools. Acceptability of the result for universities website verified based on methods of evaluation. However, it should be mentioned that the results from this research must be considered the fact that some designers of websites change periodically.

A frame work designed to evaluate the quality of academic websites introduced in [3]. Achieving quality of product completed by focusing on the “satisfaction of users” and study the models of quality and determined their factors consist from five high level include: content, functionality, reliability and usability, in addition twenty sub quality mesures specified for websites in academic institutions.

In [8] the authors attempt access to all parameters in design a website in Punjab universities. Performance evaluation for a web site by using four tools and determine the different factors which are used in these automated tools include: GTmetrics, Pingdom, Sitespeed checker tools, and Website Grader. To enhance the quality of a website and exploiting time, automatic usability tool for evaluating a performance used with taking into consideration that interest on different factors: request, page size, performance, loading time, mobile, and security.

In [5] the researchers introduced a study for analyzing and evaluation of the website of Bangladesh universities. A Dynamic model based on a web tool has been built. Score computed for each website, and based on that value a ranked list of the universities websites have been obtained. Our model also offers a comparative study for all the chosen websites based on each attribute. In addition to that, the authors make a questionnaire- based survey to know the opinions of users on the universities websites including: updated information should be satisfied, loading time and performance for virous activities in a websites should be improved.

In [9] the researchers have been analyzed different websites that include text and make various experiments by using some techniques for evaluate websites performance: SEOptimizer, Websites Grader, and Qualidator, which are used consequently for introduce a report about performance evaluation, usability and social part and explain the developer view about evaluation of performance. Using the cloud and a variety of attribute selection methods, and an accurate evaluation of those websites is completed and the obtained results encouraging to introduce help and future advise.

3. Methodology

This paper aimed to achieve three purposes: first, it was determined the most features that effects on the prediction of website performance. Second, to identify the most appropriate predictor, eight regression models are built then we compared the obtained accuracy to select the best result from them. A dynamic prediction model was proposed with many stages described in this section in order to accomplish these goals. Fig. 1 shows the work flow for evaluating the performance of Iraqi universities web site. It consists of six steps: data collecting, dataset creation, preprocessing, apply methods for selecting a metric, using a regression machine learning models to predict the performance of proposed model, then evaluate the models.

3.1 Data collecting

The data in this research related to the websites of Iraqi universities, where these universities are classified into governmental which includes 35 university, private universities recognized by the Iraqi Ministry of Higher Education and Scientific Research numbering 68 university, and 13 university in the Kurdistan, located in the Kurdistan region.

The dataset collected in this research by entering a URL of Iraqi universities website in to automated testing tools include: Gtmetrix, Pingdom and website grader, to give the values for all metrics used in the proposed work.

3.2 Creation of a dataset

The dataset obtained from the previous step saved in a csv file, it contains 27 metrics the main 10 metrics shown in Table. 1 that introduce a description of the main metrics and the units that are used to measure them.

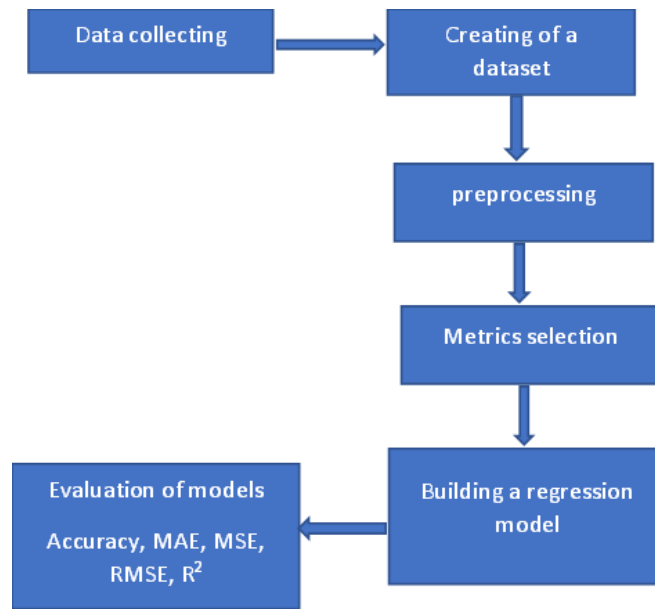


Figure 1. Methodology work flow

Table.1 The main metrics in dataset

Metrics	Definition	Unit
First_Contentful _Paint	How rapidly text or images are painted onto your website while adding content.	Second
Speed Index	The speed at which your page's contents are shown.	Second
Largest_Contentful _Paint	length of time required to paint your page's largest piece of content, such as a hero image.	Second
Time_to_Interactive	The page take this time to become completely interactive	Second
Total_Blocking_ Time	How much of the time used to load your page is blocked by scripts.	Second
Cumulative_Layout Shift	How much your page's design changes as it loads.	Second
Redirect Duration	This is the amount of time before the last HTML page loads that URLs are redirected.	Second
No_of_request	Overall HTTP response code count.	Number
Structure	It illustrates how well your page is designed for efficient performance.	Number
Onload Time	This period happens when all of the page's resources have finished downloading and the page has finished processing.	Second

Dataset contains 113 instances because not all universities have been completed website.

3.3 Preprocessing

Here, prepared a dataset before entered to a machine learning model. Pre-processing executed through search about a missing value for all metrics in each instance to replace them with a random value, and also there are some metrics that are measure during collecting a dataset over automated testing tools, once in a small unit and other in a large unit such as time metric in a milliseconds and seconds, as well as page weight measured by a megabytes and bytes, so we work to unify these units.

3.4 Metric (features) selection

Correlation statistics method has been applied for select a numerical input metrics with a numerical target variable (performance). Used method returned ten important metrics mentioned in Table.1 and selected from 23 metrics on a dataset. The result from this step was sent to a machine learning models.

3.5 Building a regression model

A regression models used to predict a numerical value, in this research many of a regression models applied on a created dataset to compute the performance of Iraqi universities web site. To precisely prediction eight models were executed with 10-fold cross validation, Bayesian Ridge regression, Gradient Boosting regressor, Elastic Net Regression, Random Forest regressor, Decision Tree regressor, multi-layer perceptron, XG Regressor, and SGDR regressor.

3.6 Evaluation of models

After running machine learning models evaluate the models executed, there are four methods for evaluating the regression model: RSquared, mean absolute Error(MAE), mean squared Error(MSE), root Mean squared Error(RMSE), in order computed from the following equations [10]:

$$RSquared = 1 - \frac{\sum_i (y_i - \hat{y}_i)^2}{\sum_i (y_i - \bar{y})^2} \quad \dots (1)$$

$$MAE = \frac{1}{N} \sum |Y - \hat{Y}| \quad \dots (2)$$

$$MSE = \frac{1}{N} \sum (y - \hat{y})^2 \quad \dots (3)$$

$$RMSE = \sqrt{MSE} \quad \dots (4)$$

Where:

y_i = actual value

\hat{y}_i = predicted value

\bar{y}_i = the mean of the actual value

N= size of dataset

4. Result and discussion

This paper aimed to evaluate the performance of a universities websites to enhance the quality of these sites. Eight supervised machine learning algorithms were used in evaluation. Correlation statistics method used to find ten metrics that have relevant with the target variable performance, forwarded these values to a regression models. The result in Table. 2 explains the percentage of RSquared that implemented by depend on the correlation between the actual value of performance and the predicted value of performance as shown in eq. 1, we notice SGD regressor achieved a highest value of Correlation 95.2%, while the lowest value of correlation 86.6% obtained from Decision Tree Regressor.

Table 2. The percentage of RSquared from applied models

Machine learning model	Value of RSquared
Bayesian Ridge	89.8%
Gradient Boosting Regressor	94.9%
Elastic Net	94.8%
SGD Regressor	95.2%
Random Forest Regressor	87.2%
Decision Tree Regressor	86.6%
MLP Regressor	88.9%
XGB Regressor	90.1%

Absolute error represents the absolute value of subtract the predicted value from the actual value as mentioned in eq. 2, after determined absolute error which contribute in measured the performance of a regression models [11]. Fig. 2 explains the values of MAE for eight machine learning models, SGD regressor achieved better result with lowest value of MAE.

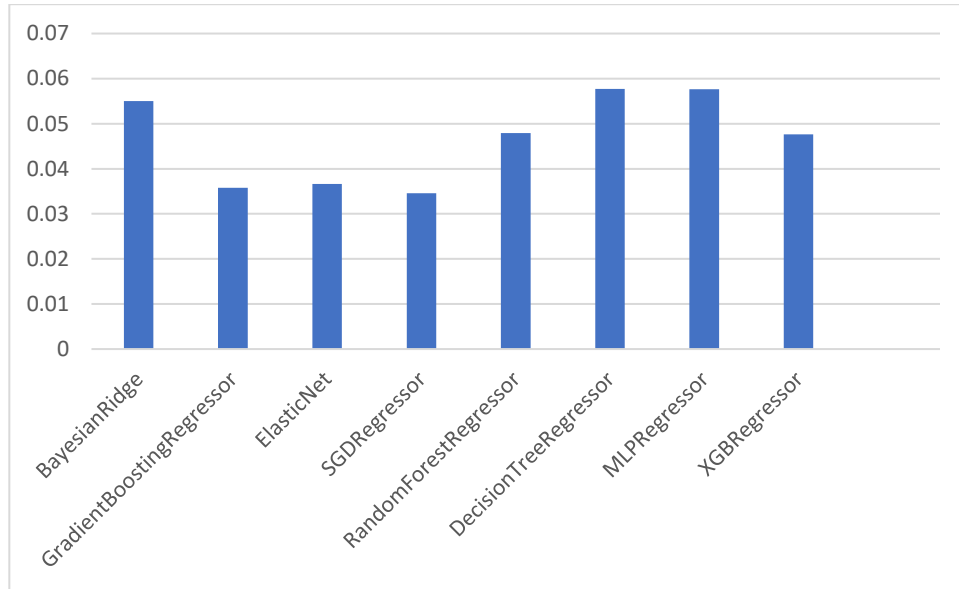


Figure 2. Values of MAE for applied models

MSE it is a general metric for evaluating a regression model, it is calculated from eq. 3 represent the mean of the squared differences between the predicted values and actual values. Whenever the value of MSE may be little that means the less errors between predicted and actual [10]. Fig. 3 shows the values of MSE for eight machine learning models.

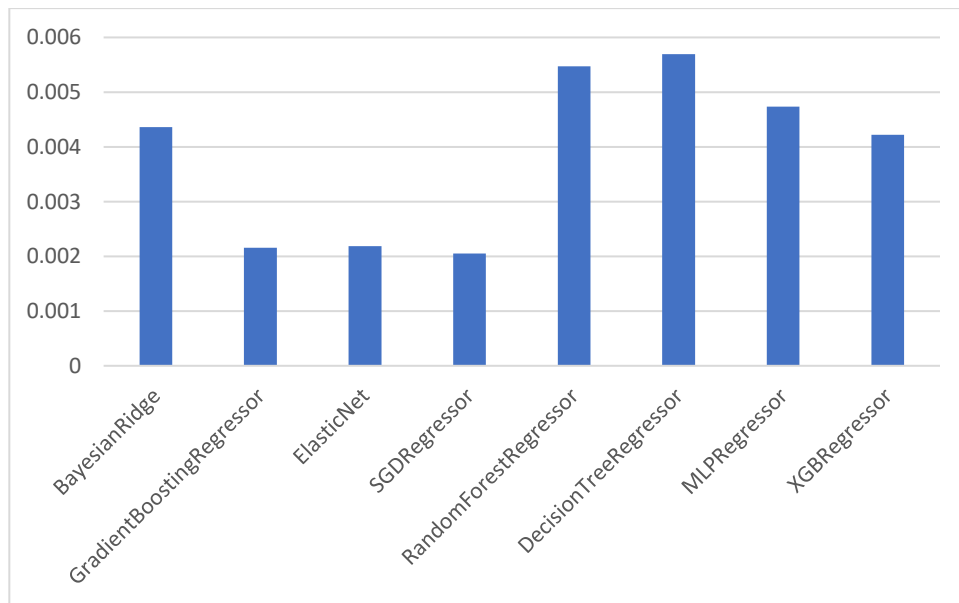


Figure 3. Values of MSE for all models

RMSE implement the square root of MSE computed from eq. 4, it is frequently employed as a public purpose error metric for forecasting a numerical value [12]. Fig. 4 explains the values of RMSE for all regression models.

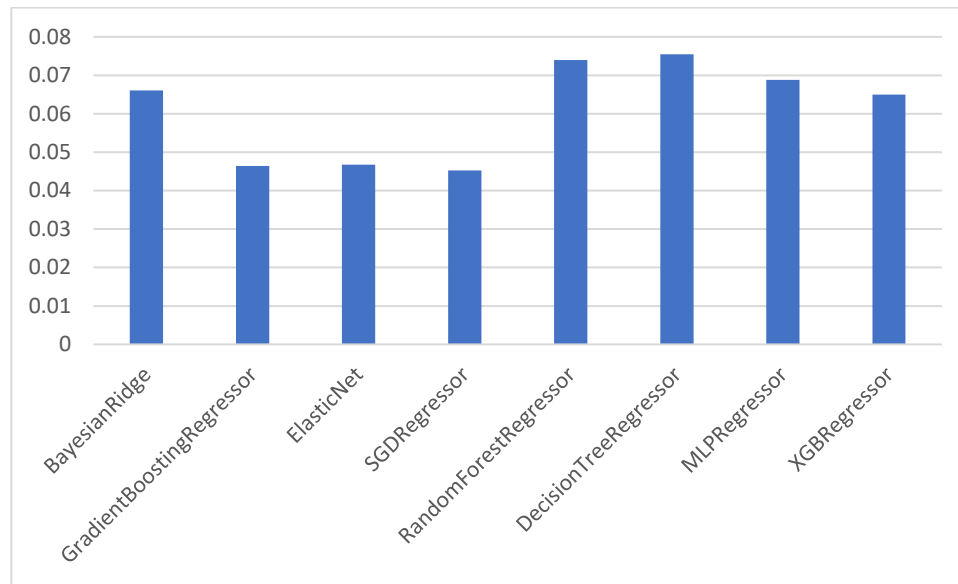


Figure 4. Values of RMSE for all models

After comparison the result of all models applied to evaluate the performance of website, we notice the SGD regressor give the best value of Rsequared, MAE, MSE and RMSE as compared with other used models.

The result obtained from this paper finding the most metrics that influence on a performance of academic website, which requires from academic institution forwarded their interesting on these metrics.

5. Conclusion

This article was accomplished based on a collected information about Iraqi universities web sites. Machine learning regression algorithms have been applied to evaluate the performance of a web sites with Correlation statistics method used for selecting the influenced metrics that investment in increase the correlation's of the machine learning models. SGD regressor has been achieved the best result of RSquared 95.2%. Academic institutions should be taken in consideration the relevant metrics about websites specified in this research for increasing the quality of a website performance. Future works is to use our work for expanded dataset and using a various methods of features selection.

References

- [1] M.Bilal, Z. Song, and C. Wang, "Evaluate Accessibility and Usability Issues of Particular China and Pakistan Government Websites", in *2019 2nd International Conference on Artificial Intelligence and Big Data*, IEEE, 2019, pp.316-322. <https://doi.org/10.1109/ICAIBD.2019.8836990>
- [2] S. H. Mustafa, L. F. Al-Zoua'bi, "Usability of the Academic Websites of Jordan's Universities An Evaluation Study", in *2008 9th International Arab Conference for Information Technology(ACIT'2008)*, 2008. https://www.researchgate.net/publication/275519174_Usability_of_the_Academic_Websites_of_Jordan's_Universities_An_Evaluati_on_Study
- [3] K. Devi, A. Sharma, "Framework for Evaluation of Academic Website", *International Journal of Computer Techniques*, Vol.3, Issue 2, pp. 234-239, 2016. <http://www.ijctjournal.org/Volume3/Issue2/IJCT-V3I2P35.pdf>
- [4] L.Peng , Y. Lu, and D. Wang, " Brief analysis on web site performance evaluation", in *2015 3rd International Conference on Cyberspace Technology (CCT)*, IEEE, 2015. <https://doi.org/10.1049/cp.2015.0858>
- [5] M. Rashida and et al, " Towards Developing a Framework to Analyze the Qualities of the University Websites", *Computers*, Vol 10,57, pp.1-16, 2021. <https://doi.org/10.3390/computers10050057>
- [6] A. Islam, K. Tsuji, "Evaluation of Usage of University Websites in Bangladesh", *DESIDOC Journal of Library & Information Technology*, Vol. 31, No. 6, pp. 469-479, 2011. <https://doi.org/10.14429/djlit.31.6.1322>
- [7] L. Hasan, E. Abuelrub, "Assessing the quality of web sites", *Applied Computing and Informatics*, Vol 9, pp.11-29, 2011. <https://doi.org/10.1016/j.aci.2009.03.001>
- [8] S. Kaur, K. Kaur, P.Kaur, "An Empirical Performance Evaluation of Universities Website", *International Journal of Computer Applications*, Vol 146 , No.15, pp.10-16, 2016. <http://dx.doi.org/10.5120/ijca2016910922>
- [9] N. Kumar, S. Kumar, R. Rajak, "Website Performance Analysis and Evaluation using Automated Tools", in *2021 5th International Conference on Electrical, Electronics, Communication, Computer Technologies and Optimization Techniques (ICEECCOT)* , IEEE, pp. 210-214, 2021. <https://doi.org/10.1109/ICEECCOT52851.2021.9707922>

- [10] A. Botchkarev, "Performance Metrics (Error Measures) in Machine Learning Regression, Forecasting and Prognostics: Properties and Typology", *arXiv preprint arXiv:1809.03006*, 2018. <https://doi.org/10.28945/4184>
- [11] D. Chicco, M. J. Warrens, and G. Jurman, "The coefficient of determination R-squared is more informative than SMAPE, MAE, MAPE, MSE and RMSE in regression analysis evaluation", *PeerJ Comput. Sci.*, Vol:7, 2021. <https://doi.org/10.7717/peerj-cs.623>
- [12] D. Christie, S. P. Neil, "Measuring and Observing the Ocean Renewable Energy Resource", *Comprehensive Renewable Energy*, Elsevier, Vol:2, pp. 149-175, 2022. <https://doi.org/10.1016/B978-0-12-819727-1.00083-2>