

Comparison of Regression Analysis using Origin, Matlab, and Regression Learner App in Formulating the Linear Equation for Leg Flexibility Index

Nur Safwah Abd Rahaman¹, Nur Anida Jumadi^{1,2*}

¹Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

²AdMedic Focus Group, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

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Abstract: Silat has been practiced at every age stage and it is bringing more popularity worldwide. It focuses on a footwork technique and hand movements for self-defense and attacking the opponent. It is assumed that the greater the kicking angles of an athlete, the greater the leg flexibility index they have. Therefore, to verify this relationship, the aim of the research has been set which is to formulate the equation by using mean kicking angle and leg flexibility index based on regression analysis with the objectives to formulate the linear equation using formula $y = mx + c$ and to evaluate the performance model based on residual plot, R-squared, MSE and RMSE. The leg flexibility index was obtained by calculated using formula of leg flexibility index by dividing the maximum range of kick with the length of leg whereas, the mean kicking angle was used from previous data collection. Both variables were used as input into OriginLab, Matlab and Regression Learner App to study the relationship by performing a straight line regression analysis as a predictive function. From that, the relationship of the graph obtained was moderate positive linear regression. The findings show that the Origin and Regression Learner App resulted the same value of linear equation which is $0.0055x+1.2705$ while in Matlab is $0.0055x+1.3$. It may be stated that the value in Origin and Regression Learner is more exact than in Matlab because it is calculated to 4 decimal places. The main findings show the equation from both OriginLab and Regression Learner App has recognized to be more accurate compared with Matlab as it yields a lower percent of error which has a very close to the accepted value of the leg flexibility index.

Keywords: Regression Analysis, Linear Equation, Leg Flexibility, Origin, Matlab

1. Introduction

*Corresponding author: anida@uthm.edu.my

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The human body consists of biological systems which have many specific functions that are important in daily living. One of the systems that can be viewed is a muscular system that aids in movement maintains the posture and blood flow of the human body. This includes the major body parts such as the head, arms, and legs to have the flexibility of muscle needed and creates voluntary movement [1]. Nowadays, martial arts such as silat have been practiced at every age stage and it is bringing more popularity worldwide. This sport focuses on footwork technique and hand movements for self-defense as well as attacks on pressure points of their opponent. Also, kicks tend to use in silat as it creates a powerful and effective attack towards opponent rather than punch, which engages the leg flexibility to create more muscle strength by involving a higher mass and increase in its velocity [2].

Flexibility is defined as the ability of a joint or series of joints to make unrestricted movement and a range of motion without creating any injuries and pains [3]. The range of motion is influence by the mobility of soft tissues that surround joints such as muscles, ligaments, tendons, and joint capsules. In martial arts silat, flexibility abilities are needed to create movement and offensive, a defensive technique such as front kicking.

The V Sit and Reach test is designed to measure the flexibility of the lower back and length of the hamstring muscles and it can be used as a front kicking test that targets hamstring contraction. The hypothesis of the study is, it is expected that the larger the athlete's kicking angles, the higher the leg flexibility index will be. Previously, a research study had been conducted to establish the relationship between kicking angle and leg flexibility index [4]. Nevertheless, this research was not focusing on residual analysis and was using AutoML Table to produce the predictive model.

A regression analysis has been suggested to accomplish the objectives that quantify the relationship between the independent variable and the outcome of the dependent variables, y . It can be used for predictive analysis of y with a straight line in the graph form. By this linearity, it can interpret easily [5]. The analysis can find a suitable equation that fits into data variables and once it did it, the model can make predictions for future outcomes. If correlation coefficient data shows are likely able to predict future outcomes, a scatter plot can be used to perform a straight line regression analysis as a predictive function. The equation of the regression line can be analyses by $y = mx + c$, where m is the slope of the line, c is y -intercept of the line, x is the values of independent variables and y is the values of dependent variables. Moreover, the performance evaluation of the model using regression metrics residual analysis, R-squared, Root Mean Square Error (RMSE), and Mean Absolute Square (MAE) are also important as they can evaluate the goodness of the fitted model and identify the error percentage.

Furthermore, this paper proposed the objectives; to adjust the equation using regression analysis that meets the relationship between mean kicking angle and leg flexibility, and to evaluate the performance model based on residual plot, R-squared, Mean Square Error (MSE) and RMSE. Due to Coronavirus (COVID-19) restriction, only ten subjects of silat athletes were managed to be recruited to perform the measurement of true leg length at their home because it is important to stay at home as to avoid this infectious disease.

2. Materials and Methods

The functional block diagram in Figure 1 shows the overall proposed project of formulation of equation. It used ten subjects of silat athletes to perform the measurement of true leg length which will be used to calculate data of leg flexibility index. The leg flexibility index can be obtained by dividing the maximum range of kick with the length of the leg whereas, the mean kicking angle was used from previous data collection. Therefore, the equation can be formulated using a regression graph of leg flexibility index against the mean kicking angle and the relation between both variables can be interpreted, as well as the performance evaluation of the model based on regression metrics residual analysis, R-squared, RMSE, and MAE.

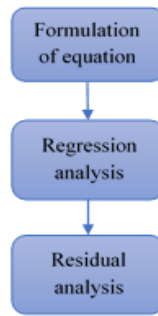


Figure 1: Block diagram of the overall proposed project

2.1 Formulation of the Equation

Linear regression is commonly used to describe data and to evaluate the relationship of variables [6]. In this project, a regression graph was used to analyze both variable mean kicking angle and leg flexibility which helps to identify the strength of the relationship between them and predict the data trends. As for residual analysis, it was analyzed to show the appropriateness of a linear regression model. There are 6 types of residual plots supported in Origin that are residual vs independent, residual vs predicted value, residual vs order of the data, histogram of the residual, residual lag plot, and lastly is normal probability plot of residuals.

Figure 2 illustrates the process to perform a linear fitting regression to obtain a slope-intercept equation from the graph. The variables mean kicking angle were set as x and leg flexibility index as y and they were used to import from Microsoft Excel into Origin software to examine the data in a graph form. Then, a scatter plot was created based on data and hence it results in a linear regression graph. The analysis of residuals and statistics were observed from results obtained in Origin.

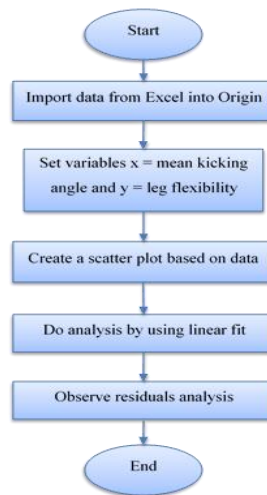


Figure 2: The process of regression analysis using Origin

2.1.1 Regression Analysis using Matlab

Figure 3 illustrates the process to perform linear fitting regression in Matlab to obtain an equation from the regression graph. Mean kicking angle and leg flexibility index were used as data in this analysis. The data was accessed and imported from Microsoft Excel using output type Column vectors into Matlab workspace to solve and examine the data into a graph. Mean kicking angle was an independent variable, x while leg flexibility index was the dependent variable, y . Based on data using a scatter graph was plotted and resulted in a linear regression graph. Therefore, the results were obtained and the residuals analysis was observed.

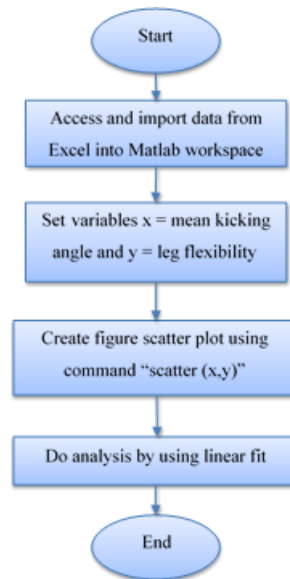


Figure 3: The process of regression analysis using Matlab

2.1.2 Regression Learner App

Based on Figure 4, shows a flow chart process of regression analysis by using Regression Learner App in Matlab machine learning. It is a part of supervised learning. There are few steps to follow to carry out this process. Firstly, the data were access from Excel and loaded into Matlab software. Then, Regression Learner App was used to make regression analysis to generate predictions for the response to the the new data train. Suitable type of regression model was chosen to be trained by click on “All Quick-To-Train” for fast train models. After that, the models were compared and improved by inspecting the results in residual analysis, R-squared, RMSE, and MSE to find the best models prediction. The best-trained model was exported to the workspace to make predictions with new data [7].

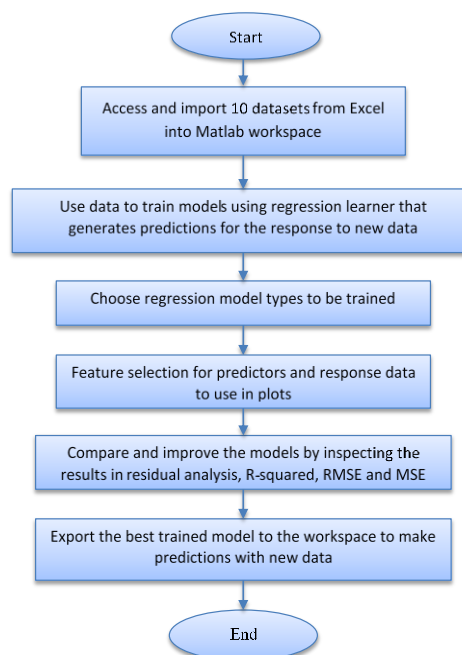


Figure 4: The process of regression analysis using Matlab

3. Results and Discussion

The main finding is presented in this section cover in the formulation of equation based on mean kicking angle and leg flexibility index using Origin, Matlab and Regression Learner App.

3.1 Formulation of Equation using Origin and Matlab

3.1.1 Regression Line Comparison using Origin, Matlab, and Regression Learner App

Figure 5 (a), (b), (c) shows a regression line obtained from Origin, Matlab, and Regression Learner App respectively which indicates the graph has a positive correlation. However, the graph in Figure (c) is unable to be scale down as there is no options provided for axes setting. The figures were observed the changes in the mean kicking angle that relate to the leg flexibility index. Hence, the higher the mean kicking angle, the higher the leg flexibility index can achieve.

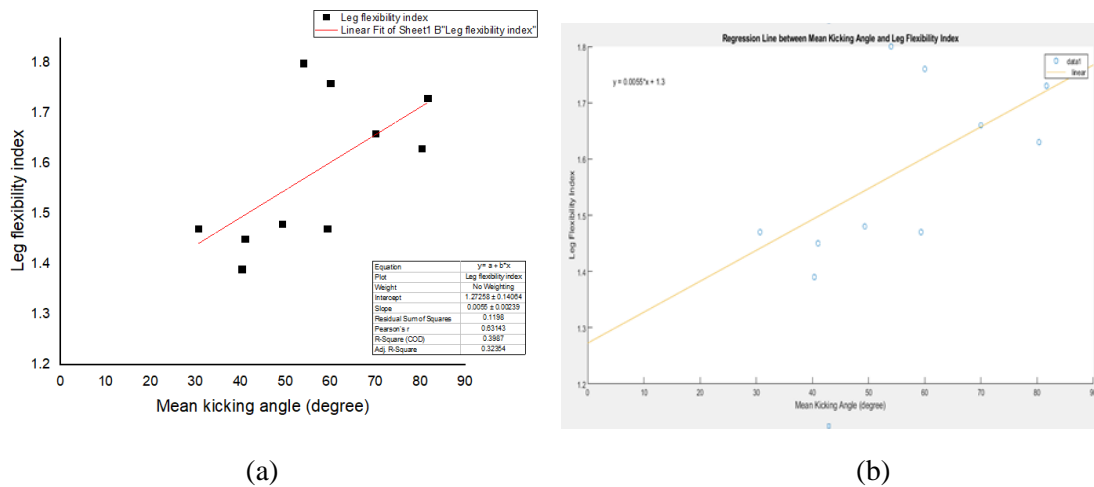


Figure 5: Regression line for leg flexibility index against mean kicking angle for (a) Origin (b) Matlab (c) Regression Learner App

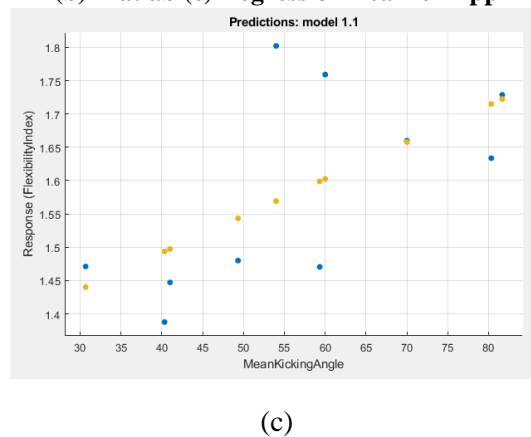


Figure 5 (continued): Regression line for leg flexibility index against mean kicking angle for (a) Origin (b) Matlab (c) Regression Learner App

Table 1 shows the summary of the equation obtained from Origin, Matlab, and Regression Learner App. The value from Origin and Regression Learner App has the same value of y-intercept of the line, c which is 1.2705 while from Matlab is 1.3. It can be said value in Origin and Regression Learner is much precise as it resulted in 4 decimal places than in Matlab. Therefore, the equation from Origin and Regression Learner App can be applied to obtain the value of leg flexibility index, y by inserting the value of mean kicking angle, x so it can create more data of leg flexibility index future studies. The

performance of these models can be evaluated through residual analysis, R-squared and Root Mean Square Error (RMSE) so a better prediction can achieve in machine learning.

Table 1: Equation formula obtained using three methods; Origin, Matlab and Regression Learner App

Method	Equation
Origin	$y = 0.0055x + 1.2705$
Matlab	$y = 0.0055x + 1.3$
Regression Learner App	$y = 0.0055x + 1.2705$

3.1.2 Performance Evaluation

Residuals analyses were presented in Figure 6 (a) Origin, (b) Matlab and (c) Regression Learner App. The residuals give insight into the model performance against the actual value. The figure show the appropriateness of a linear regression model created which is not scattered symmetrically around 0, changes significantly in size from left to right, outliers occur and a pattern of nonlinear appears in this residuals analysis in all methods shown. Hence, the analysis shows it is a good model as it has meets the pattern criteria in residuals.

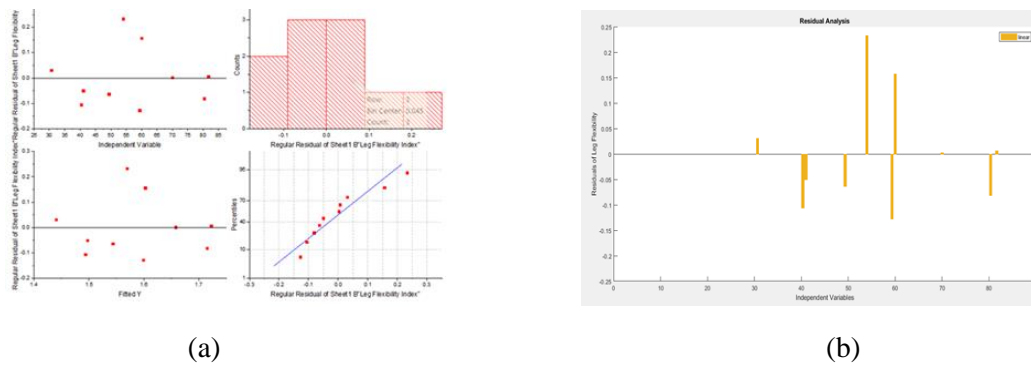
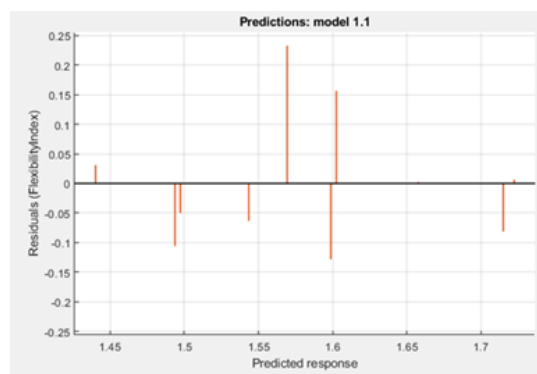


Figure 6: Residual Analysis from (a) Origin (b) Matlab (c) Regression Learner App



(c)

Figure 6 (continued): Residual Analysis from (a) Origin (b) Matlab (c) Regression Learner App

Table 2: Statistics analysis from Origin, Matlab, and Regression Learner App

	Origin	Matlab	Regression Learner App
Adjusted R-squared	0.3254	0.325	0.3254
R-squared	0.400	0.400	0.400
MSE	0.0151	0.0151	0.0151
RMSE	0.1228	0.123	0.1228

In regression analysis, R-squared or denoted by R^2 is a coefficient of determination that helps to measure the strength of the relationship of the model and dependent variable in the regression model. It recognizes the percentage of variation of a dependent variable between the percentage of 0 to 100%. Based on Table 2, the value of R^2 obtained in this analysis using Origin, Matlab, and Regression Learner App were the same which 0.40 or 40% that was relatively low. However, the lower R^2 does not consider as a negative indicator because some factors have affected the results such as the inaccuracy measurement taken in V Sit and Reach by silat athletes and the units use on variables measured in a project. Thus, this lower value of R^2 can be considered as a good predictive model based on mean kicking angle and leg flexibility index.

Furthermore, the value of RMSE obtained was 0.1228 which a low range of prediction errors. The RMSE is a square root of Mean Square Error (MSE) that shows the value of MSE obtained is 0.0151. It helps to measure the trained model's accuracy and evaluate the performance of the regression model made. With this lower value of RMSE, it generally means that the model can be good in predicting the observed data for mean kicking angle and leg flexibility index. Thus, it can create a prediction analysis in identifies the influence between variables and their relationship.

$$\text{Percentage Error (\%)} = \frac{|\text{accepted value} - \text{measured value}|}{\text{accepted value}} \times (100\%) \quad \text{Eq. 1}$$

Where accepted value is the leg flexibility index (formula) and measured value is the leg flexibility (experiment)

Moreover, the percentage error was calculated using Eq. 1 by finding the difference between actual value (formula) and experimental value in percentage form. This helps to evaluate how big the error occurs and the accuracy value in the leg flexibility index obtained. Table 3 tabulates the calculated percentage error in the leg flexibility index. The resulted measurement can take in absolute value sign without regard to its sign. It was observed that the percentage of error in the Origin and Regression Learner App had the same value because the formula obtained from both methods was the same. In addition to that, both yielded a lower percent of error compared to Matlab and this means the accuracy in both methods much better as they were very close to the accepted value of the leg flexibility index.

Table 3: Percentage error of leg flexibility index

Subject	Mean Kicking Angle	Leg flexibility (experiment)	Leg flexibility index (formula)		Percentage error (%)	
			Origin/Regression Learner App	Matlab	Origin/Regression Learner App	Matlab
S1	41	1.45	1.50	1.53	3%	5%
S2	49.33	1.48	1.54	1.57	4%	6%
S3	60.00	1.76	1.60	1.63	-10%	-8%
S4	80.33	1.63	1.71	1.74	5%	6%
S5	81.67	1.73	1.72	1.75	-1%	1%
S6	54.00	1.80	1.57	1.60	-15%	-13%
S7	40.33	1.39	1.49	1.52	7%	9%
S8	59.33	1.47	1.60	1.63	8%	10%
S9	70.00	1.66	1.66	1.69	0%	1%
S10	30.67	1.47	1.44	1.47	-2%	0%

4. Conclusion

In conclusion, all objectives that were set at the beginning of the research were successfully achieved. The formulation of equation based on regression analysis using data mean kicking angle and

leg flexibility index had been successfully obtained and observed in this study. The analysis was able to measure the relationship between mean kicking angle and leg flexibility index by silat athletes which resulted in moderate positive linear regression and give a prediction of leg flexibility index, which means the higher the mean kicking angle, the higher the leg flexibility index. Additionally, findings showed that the performance regression model in Origin and Regression Learner had higher accuracy as it yielded a lower error percentage compared with Matlab although they have the same value of R^2 of 0.4. In the future, more data of subjects can be used to assure that model prediction are more effective when analyzing the relationship. Other than that, the regression analysis can approach the prediction of the leg flexibility index for future output.

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