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Judul	Prediction of linear model on stunting prevalence with machine learning approach
URI Jurnal	<a href="https://beei.org/index.php/EEI">https://beei.org/index.php/EEI</a>
Authors	Mambang, Finki Dona Marleny, Muhammad Zulfadhilah

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## #4028 Summary

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### Submission

Authors	Mambang Mambang, Finki Dona Marleny, Muhammad Zulfadhilah
Title	Prediction of linear model on stunting prevalence with machine learning approach
Original file	<a href="#">4028-9215-1-SM.DOCX</a> 2022-05-02
Supp. files	None
Submitter	Mambang M 
Date submitted	May 2, 2022 - 08:37 PM
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Author comments	<p>"I am writing to submit our manuscript entitled, "Prediction of Linear Model on Stunting Prevalence with Machine Learning Approach," for consideration for publication in Bulletin of Electrical Engineering and Informatics."</p> <p>"This manuscript describes original work and is not under consideration by any other journal. All authors approved the manuscript and this submission."</p> <p>"Thank you for receiving our manuscript and considering it for review. We appreciate your time and look forward to your response."</p>
Abstract Views	347

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## Submission Metadata

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### Title and Abstract

Title	Prediction of linear model on stunting prevalence with machine learning approach
Abstract	An increase in the number of residents should be anticipated including in the health sector, especially the problem of stunting. Stunting in children disrupts height and lack of absorption of nutrients. Information and data drive change in many areas such as health, entertainment, economics, business, and other strategic areas. The stages carried out in this study are initiating, developing linear models, and making prediction results on linear machine learning models. The results of testing with the scikit-learn linear model with a minimum variable of 19 get the best test results, namely the polynomial regression with pipeline model with mean absolute percentage error (MAPE) 0.02, root mean square error (RMSE) 3.32, and coefficient of determination (R <sup>2</sup> ) 1,00. Testing with the scikit-learn linear model with a maximum variable of 48 gets the best test results, namely the polynomial regression with pipeline model with MAPE 0.00, RMSE 3.79 and R <sup>2</sup> 1.00. Testing with the scikit-learn linear model with an average variable of 32 gets the best test results, namely the polynomial regression model with MAPE 0.01, RMSE 3.32, and R <sup>2</sup> 1.00. The results of

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testing with the scikit-learn linear model with the minimum, maximum, and average variables get the best test results, namely the polynomial regression with pipeline model.

## Indexing

Academic discipline  
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Computing; Informatics Engineering; Machine Learning

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Linear model; Machine learning; Prevalence; Scikit learn; Stunting

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## Supporting Agencies

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information technology department at Sari Mulia University ; informatics department at the Muhammadiyah University of Banjarmasin



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SUMMARY REVIEW **EDITING**

### Submission

Authors Mambang Mambang, Finki Dona Marleny, Muhammad Zulfadhilah 

Title Prediction of linear model on stunting prevalence with machine learning approach

Section Computer and Informatics Engineering

Editor Hamid Alinejad-Rokny  (Review)  
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3. Final Copyedit — — —  
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## Layout


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## [EEI] Submission Acknowledgement

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3 Mei 2022 pukul 04.37

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Dear Prof/Dr/Mr/Mrs/Ms. Mambang M,

Thank you for submitting the manuscript, "Prediction of Linear Model on Stunting Prevalence with Machine Learning Approach" to Bulletin of Electrical Engineering and Informatics (BEEI), ISSN: 2089-3191, e-ISSN: 2302-9285. The BEEI is open to submission from scholars and experts in the wide areas of electrical, electronics, instrumentation, control, robotics, telecommunication, computer engineering, computer science, information system, information technology and informatics from the global world. This journal is an open access peer-reviewed journal published by Institute of Advanced Engineering and Science (IAES) in collaboration with Intelektual Pustaka Media Utama (IPMU). This journal is indexed by Scopus (Elsevier)/ScimagoJR, SNIP 2020: 0.954, CiteScore 2020: 1.7, SJR 2020: 0.251. Beginning with issue 1 of volume 9 (2020), BEEI is published as a bimonthly journal (6 issues/year).

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Dr. T. Sutikno <bee@iaescore.com>  
Kepada: Mambang M <mmbg1283@gmail.com>

15 Agustus 2022 pukul 03.14

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Dear Prof/Dr/Mr/Mrs: Mambang M,

We have reached a decision regarding your submission entitled "Prediction of Linear Model on Stunting Prevalence with Machine Learning Approach" to Bulletin of Electrical Engineering and Informatics, a Scopus(Elsevier)/ScimagoJR indexed journal, CiteScore: 2.2, SJR: 0.357, and SNIP: 0.730.

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ABSTRACT

An increase in the number of inhabitants should be expected, particularly in the Health sector, due to the problem of stunting. Stunting in children

causes stunting and a lack of nutritional absorption. Change is driven by information and data in many domains, including health, entertainment, economics, business, and other important areas. This study's steps are beginning, constructing linear models, and providing predictions on linear machine learning models. The Polynomial Regression with Pipeline model with MAPE 0.02, RMSE 3.32, and R2 1.00 yields the best test results when tested with the Scikit-Learn Linear Model with a minimum variable of 19. The Polynomial Regression with Pipeline model with MAPE 0.00, RMSE 3.79, and R2 1.00 yields the best test results when tested with The Scikit-Learn Linear Model with a maximum variable of 48. The Polynomial Regression model with MAPE 0.01, RMSE 3.32, and R2 1.00 yields the best test results when tested with the Scikit-Learn Linear Model with an average variable of 32. The Polynomial Regression With Pipeline model produces the best test results when tested with the Scikit-Learn Linear Model with the minimum, maximum, and average variables.

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## INTRODUCTION

Current and projected population growth continues to be quite important. Economic activity will likewise rise in the future decades [1]. Climate change and environmental damage are occurring all across the planet [2]. An increase in the number of inhabitants should be expected in several sectors, including the health sector, particularly the problem of stunting. Stunting, which is common in children, results in reduced height and nutritional absorption [3]. Stunting is a widespread problem in many nations throughout the world, affecting 161 million children aged 0 to 5 [4]. Stunting affects up to one-third of children in low-to-middle-income (LMIC) countries [5]. Malnutrition is a severe issue in the worldwide society, leading in chronic disease and mortality [6]. Malnutrition impacts muscular function, immunological diseases, and cognitive dysfunction, as well as nerve development [7]. Stunting difficulties continue to arise in many developing nations, making it a severe problem encountered by children under the age of five, and this condition happens in people's lives. Short-term and long-term difficulties in the process of child development, such as the appearance of decrease in cognitive function and other harmful diseases, must be prioritized, particularly in the field of health [8]. The World Health

Organization (WHO) projects that the incidence of stunted toddlers globally will be 22 percent, or 149.2 million by 2020. According to SSGI statistics in 2021, the national stunting rate fell by 1.6% each year, from 27.7% in 2019 to 24.4% in 2021. Only 5 of the 34 provinces increased in comparison to 2019. The primary goal of the Indonesian government is to reduce the frequency of stunting in toddlers. The Vice President's Secretariat oversees efforts to expedite stunting prevention convergence, both in planning and execution, including monitoring and evaluation at all levels of government, including communities. The Vice President's Secretariat invites all parties to participate in accelerating stunting prevention so that its prevalence lowers to 14% by 2024. Currently, the prevalence of stunting in Indonesia is lower than in Myanmar (35%), but greater than in Vietnam (23%), Malaysia (17%), Thailand (16%), and Singapore (4%). The fact that stunting will be less frequent in 2021 may be exploited to improve the quality of life for Indonesia's next generation, which will become the Golden Generation in 2045.

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- <https://doi.org/10.12928/TELKOMNIKA.v19i2.16724>
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Refresentasi

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#### ABSTRACT

An increase in the number of inhabitants should be expected, particularly in the Health sector, due to the problem of stunting. Stunting in children causes stunting and a lack of nutritional absorption. Change is driven by information and data in many domains, including health, entertainment, economics, business, and other important areas. This study's steps are beginning, constructing linear models, and providing predictions on linear machine learning models. The Polynomial Regression with Pipeline model with MAPE 0.02, RMSE 3.32, and R2 1.00 yields the best test results when tested with the Scikit-Learn Linear Model with a minimum variable of 19. The Polynomial Regression with Pipeline model with MAPE 0.00, RMSE 3.79, and R2 1.00 yields the best test results when tested with The Scikit-Learn Linear Model with a maximum variable of 48. The Polynomial Regression model with MAPE 0.01, RMSE 3.32, and R2 1.00 yields the best test results when tested with the Scikit-Learn Linear Model with an average variable of 32. The Polynomial Regression With Pipeline model produces the best test results when tested with the Scikit-Learn Linear Model with the minimum, maximum, and average variables.

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Figure 1 --> Inisiasi??

Figure 2 --> Prediksi ??

## INTRODUCTION

Current and projected population growth continues to be quite important. Economic activity will likewise rise in the future decades [1]. Climate change and environmental damage are occurring all across the planet [2]. An increase in the number of inhabitants should be expected in several sectors, including the health sector, particularly the problem of stunting. Stunting, which is common in children, results in reduced height and nutritional absorption [3]. Stunting is a widespread problem in many nations throughout the world, affecting 161 million children aged 0 to 5 [4]. Stunting affects up to one-third of children in low-to-middle-income (LMIC) countries [5]. Malnutrition is a severe issue in the worldwide society, leading in chronic disease and mortality [6]. Malnutrition impacts muscular function, immunological diseases, and cognitive dysfunction, as well as nerve development [7]. Stunting difficulties continue to arise in many developing nations, making it a severe problem encountered by children under the age of five, and this condition happens in people's lives. Short-term and long-term difficulties in the process of child development, such as the appearance of decrease in cognitive function and other harmful diseases, must be prioritized, particularly in the field of health [8]. The World Health Organization (WHO) projects that the incidence of stunted toddlers globally will be 22 percent, or 149.2 million by 2020. According to SSGI statistics in 2021, the national stunting rate fell by 1.6% each year, from 27.7% in 2019 to 24.4% in 2021. Only 5 of the 34 provinces increased in comparison to 2019. The primary goal of the Indonesian government is to reduce the frequency of stunting in toddlers. The Vice President's Secretariat oversees efforts to expedite stunting prevention convergence, both in planning and execution, including monitoring and evaluation at all levels of government, including communities. The Vice President's Secretariat invites all parties to participate in accelerating stunting prevention so that its prevalence lowers to 14% by 2024. Currently, the prevalence of stunting in Indonesia is lower than in Myanmar (35%), but greater than in Vietnam (23%), Malaysia (17%), Thailand (16%), and Singapore (4%). The fact that stunting will be less frequent in 2021 may be exploited to improve the quality of life for Indonesia's next generation, which will become the Golden Generation in 2045.

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# Mambang\_Prediction of Linear Model on Stunting Prevalence with Machine Learning Approach

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# Prediction of Linear Model on Stunting Prevalence with Machine Learning Approach

Mambang<sup>1</sup>, Finki Dona Marleny<sup>2</sup>, Muhammad Zulfadhilah<sup>1</sup>

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## ABSTRACT

An increase in the number of residents should be anticipated including in the Health sector, especially the problem of stunting. Stunting in children disrupts height and lack of absorption of nutrients. Information and data drive change in many areas such as Health, entertainment, economics, business and other strategic areas. The stages carried out in this study are initiating, developing linear models, and making prediction results on linear machine learning models. The results of testing with the Scikit-Learn Linear Model with a minimum variable of 19 get the best test results, namely the Polynomial Regression with Pipeline model with MAPE 0.02, RMSE 3.32 and R2 1.00. Testing with The Scikit-Learn Linear Model with a maximum variable of 48 gets the best test results, namely the Polynomial Regression with Pipeline model with MAPE 0.00, RMSE 3.79 and R2 1.00. Testing with the Scikit-Learn Linear Model with an average variable of 32 gets the best test results, namely the Polynomial Regression model with MAPE 0.01, RMSE 3.32 and R2 1.00. The results of testing with the Scikit-Learn Linear Model with the minimum, maximum, and average variable get the best test results, namely the Polynomial Regression With Pipeline model.

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## 1. INTRODUCTION

Current and future population growth continues to experience a very significant increase. Economic growth activity will also increase in the coming decades [1]. Climate change and ecosystems are happening all over the world [2]. An increase in the number of residents should be anticipated in many areas, including the Health sector, especially the problem of stunting. Stunting that often occurs in children causes impaired height and lack of absorption of nutrients [3]. Stunting is a common problem in many countries globally and occurs in 161 million children between 0 and 5 [4]. Stunting affects up to a third of children in low- to middle-income countries (LMICs) [5].

Stunting problems continue to occur in many developing countries, making it a serious problem experienced by children less than five years old, and this condition occurs in people's lives. Stunting problems in the short and long term in the process of child development, such as the occurrence of decline in cognitive function and other dangerous diseases, stunting problems need to be a priority, especially in the field of Health [6]. Malnutrition is a serious problem in the global community resulting in chronic disease and death [7]. Malnutrition affects decreased muscle function, immune disorders, and brain dysfunction and can cause disorders: nerve development [8].

The World Health Organization (WHO) estimates the prevalence of stunted toddlers worldwide at 22 per cent or as many as 149.2 million by 2020. Based on the results of the Indonesian Nutrition Status Survey (SSGI) in 2021, the national stunting rate decreased by 1.6 per cent per year from 27.7 per cent in 2019 to 24.4

per cent in 2021. 36 of the 34 provinces showed a decrease compared to 2019, and only 5 provinces showed an increase. The decrease in the prevalence of stunting in toddlers is the main agenda of the Government of Indonesia. The Secretariat of the Vice President coordinates efforts to accelerate stunting prevention to converge, both on planning, and implementation, including monitoring and evaluation at various levels of government, including villages. The Secretariat of the Vice President encourages the involvement of all parties in the acceleration of stunting prevention so that its prevalence drops to 14% by 2024. Currently, the prevalence of stunting in Indonesia is better than in Myanmar (35%) but still higher than in Vietnam (23%), Malay (17%), Thailand (16%) and Singapore (4%). The decrease in the prevalence of stunting in 2021 can be used to improve the quality of life of the younger generation towards the Indonesian Golden Generation 2045.

The stunting data used in this study came from secondary data and open access obtained on <https://data.kalselprov.go.id/dataset/data>. The presence of data in all sectors provides a very big change in the order of life [9]. The advent of the big data era has had a huge impact on traditional management methods, and companies have also begun to make changes. The huge impact of data growth makes data play a very important role in changing lives, from traditional to more modern and dynamic [10]. Artificial intelligence technology is very important to use to automatically detect and diagnose various types of diseases [11]. Building the model used in this study uses open data trained using machine learning to get the results of predictions and new information [12]. Information and data have driven change in many areas such as Health, entertainment, economics and business and other strategic areas [13].

Data computing using machine learning can provide optimal performance in data processing to be meaningful and have added value for its users [14]. Today and in the future, humans need strategies to manage information and data with various media and networks [15]. Various data management approaches increase innovative value and profitability in business and other strategic areas [16]. Data with various categories can be integrated to explore knowledge and support the latest research on a small scale and a large scale [17]. The prediction process then carried out with a linear model in the Scikit Learn Machine Learning library from the available data. The use of machine learning and creating artificial intelligence models and methods is very important in classifying, clustering and performing other prediction models [18]. The use of Machine Learning in many cases and datasets in the field of Health has contributed a lot of knowledge [19]. Today and in the future, algorithms in processing datasets are becoming increasingly necessary knowledge in many fields [20]. In Machine learning, we can perform multistage classifiers such as Logistic Regression (LR), k-Nearest Neighbors (kNN), Gaussian Naive Bayes (GNB), Support Vector Machine (SVM), and linear discriminant analysis (LDA) [21]. Group classification problems can be solved using classification algorithms such as supporting vector machines (SVM) [22]. Machine learning models are very important in solving large and complex problems and can reach many disciplines [23]. Machine learning algorithms in classifying disease datasets can be done with various methods [24]. The method used to predict this dataset is the Linear Model, the Linear Regression algorithm on Machine Learning. Previous research has also used machine learning to solve dataset problems in Health. The dataset used in this paper is very precise if it is processed with a linear model [25]. The linear output of the model can later provide conclusions to the data process carried out so that the results can be a measure of the strategy that will be carried out in managing stunting problems in the community.

From this condition, we compiled this paper with a linear methodology model on machine learning [26]. Some previous studies on stunting and machine learning approaches in conducting research related to stunting are the basis of theoretical and scientific studies. Hundstad *et al* [3] We have been reviewing stunting among children for the past 20 years in Sub-Saharan Africa (SSA), where stunting is highly affecting and has high consequences for children's current and future physical and mental development. The method is used by identifying as many as 13 articles from 2000 to 2020 with established criteria. This study stated that children in Sub-Saharan Africa (SSA) were severely affected by stunting, with an average prevalence of 41%. Elizabeth *et al*. [5] use machine learning models in determining stunting at birth and systemic inflammatory biomarkers as predictors of the next baby's growth. Machine learning with a random forest model is used in performing descriptive analysis. This study showed that of 107 children who were followed up to 48 months of age, 51% experienced stunting (HAZ < -2) at birth which increased to 54% at 48 months of age. Fikrewold *et al* [7] use algorithms on machine learning to predict toddlers' malnutrition in Ethiopia. Descriptive results show that the XGBoost algorithm has better predictive capabilities than common linear mixed algorithms. Hui Shi *et al* [8] use machine learning models to predict the occurrence of postoperative malnutrition in children. Their study used the machine learning model used five Machine Learning algorithms to build predictive models and performance models from Machine Learning measured with AUC. Using five predictive algorithms to predict the occurrence of postoperative malnutrition in children, the XGBoost model achieved the largest AUC in all outcomes. Research with machine learning methods is very important to predict the prevalence of stunting in the future by taking dataset samples from the minimum, average and maximum number of each dataset table so that the results of this study can be a reference in predicting stunting prevalence.



## 2. METHOD

This study has several stages in predicting datasets using machine learning. The stages carried out are the initiation process, developing linear models, and making prediction results that have been processed on linear machine learning models.

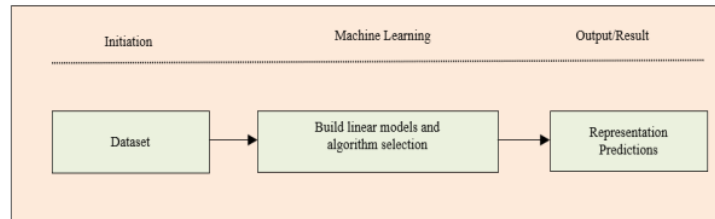


Figure 1. Research Method

The initiation stage is carried out by identifying the prevalence population of stunting from the dataset used. The second stage is to develop models and machine learning algorithm selection using dataset samples from the minimum, average and maximum number of all dataset variables, in the end, making predictions from the dataset to get information and value from the data owned.

### 2.1 Dataset

The data used in this study used datasets from the website database "one data banua", which can be accessed openly to all circles with a URL address: <https://data.kalselprov.go.id/dataset/data/1012>. From this dataset will be carried out the process of sampling data will be carried out the process to the prediction stage with linear models in machine learning. The minimum, maximum and average values in each variable will be summed up and made as an average of each variable's sums. This average value will be used in the prediction process with a linear model. The dataset used in the study has 6 columns and 13 rows.

Table 1. Dataset Prevalence Stunting

Location/Year	2013	2015	2016	2017	2018	2020
1	39.8	38.49	26.97	40.7	29.3	9.4
2	74.8	32.82	36.39	46.7	27.2	15.9
3	48.2	30.09	26.89	26.1	29.1	20.2
4	47.6	39.03	35.91	36.3	28.9	15.2
5	45.3	37.78	35.84	45.7	32.7	13.6
6	49.9	48.08	28.76	39.9	20.7	7.1
7	51.7	37.65	35.94	39.1	29	10
8	56.1	53.54	48	39.4	38.8	21.3
9	44.6	44.64	32.71	36.2	35.3	11.5
10	44.9	31.5	25.41	17.9	26.1	6.4
11	42.7	40.32	15.77	35.3	34.6	26.2
12	35.8	32.13	33.64	31.5	24.9	5.8
13	34.1	21.48	20.99	29	23.5	17.3
Total	615.5	487.55	403.22	463.8	380.1	179.9

Table 2. Sample Dataset, Minimum, Maximum, Average

Variable						Average	
Min	34.1	21.48	15.77	17.9	20.7	5.8	<b>19.3</b>
Max	74.8	53.54	48	46.7	38.8	26.2	<b>48.0</b>
Average	47.3	37.5	31.0	35.7	29.2	13.8	<b>32.4</b>

From table 1 of the stunting prevalence dataset used as a population, table 2 is a sample of the dataset that will be processed on a linear machine learning model. The use of samples by creating an average of the values of all tables, such as a minimum every table value every column year, is further made the average of the entire table. The next step is also done simultaneously at maximum and average values. These three variables will be X inputs in the model's linear process.

### 2.2 Linear Model with Scikit Learn

Scikit-learn or commonly known as Sklearn is a python programming language module that is built based on NumPy, Scipy, and Matplotlib. Sklearn modules assist in processing data and performing data training for machine learning and data science purposes. Scikit-learn provides many features, such as classification models, clustering, regression-based machine learning models, and processes used in the feature engineering stage, such as dimensionality reduction using PCA. Various data scientists use Scikit-learn a lot because of the

*Paper's should be the fewest possible that accurately describe ... (First Author)*



many machine learning models that can be used with this module. Some of the algorithms that are often used in the Linear Model with Scikit Learn are MinMaxScaler, Linear Regression, Ridge regression, Lasso, ElasticNet, Orthogonal Matching Pursuit, Generalized Linear Models (GLM), and Stochastic Gradient Descent.

### 2.3 Design Linear Model with Scikit Learn

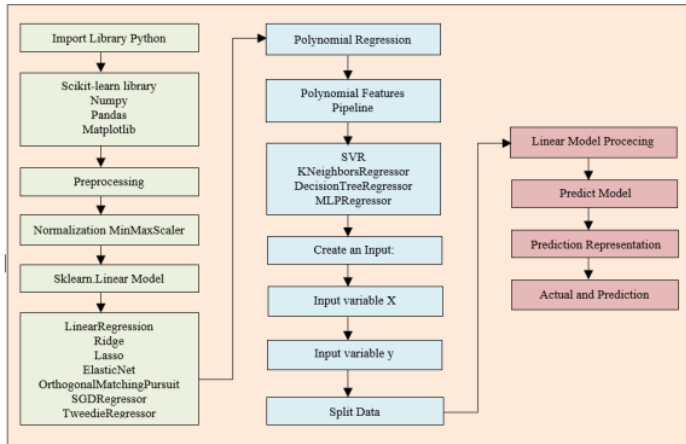


Figure 2. Proposed model linear method design

Figure 2 shows the stages of the design method made in this study. Method design is used in this phase to describe conceptually and comprehensively and identify processes and stages in the research process [27]. Research design is a collection of techniques and strategies used to analyze and collect data in order to determine the research variables. Research design is also a strategy carried out by researchers to systematically connect each element of research to analyze and determine the focus of research that becomes more effective and efficient.

Table 3. Variable input X

Input variable X		Script input variable X
Minimal	19	X = np.random.randint (19,3, size =(1000,6))
Maximal	48	X = np.random.randint (48,3, size =(1000,6))
Average	32	X = np.random.randint (32,3, size =(1000,6))

In creating an input variable X using parameters random.randint(low, high=None, size=None, dtype=int). Programming scripts created as below:

```
X = np.random.rand(19, size=(1000,6))
X = pd.DataFrame(X)
X.columns = ['x1', 'x2', 'x3', 'x4', 'x5', 'x6,']
X
```

Input X = np.random.randint (19) is the minimum value of the dataset sample used, where the random range to be generated from 0 to the largest value is 19. Input value X will have 3 inputs, namely (19,48, and 32). Size (1000) indicates the number of rows of data to be created. Value (6) indicates the feature we use in variable X. As for the input y that serves as the output later made with the equation  $y = 5 * X['x1'] + 0.1 * (X['x2'] ** 2) + 30 * (X['x3'] ** 0.5) + X['x4'] * X['x5'] + X['x6'] + 10$ . The input process of variables X and y generate new data, where this data will be the weight value or (w), and subsequently, the prediction process will be carried out with linear models on sklearn. Below is a table of the results of X and y inputs.

Table 4. Input Results variables X and y

	Variable X						Variable y	
	x1	x2	x3	x4	x5	x6		
0	6	18	5	4	6	1	0	164.482039
1	0	2	3	6	5	12	1	104.361524
2	17	1	9	2	15	5	2	220.100000
3	9	4	14	1	7	7	3	182.849722

4	14	6	4	3	10	0	4	173.600000
...	...	...	...	...	...	...	...	...
995	9	3	8	15	1	14	995	169.752814
996	7	9	17	7	15	3	996	284.793169
997	3	2	0	6	12	17	997	114.400000
998	0	9	2	11	17	4	998	251.526407
999	0	10	17	7	9	11	999	217.693169

1000 rows x 6 columns Length: 1000, dtype: float64

42

Once the X data input and y output are created, the next step is to divide the data used for the training and testing process to create the model and validate the data used. The table below is the training and testing data used.

Table 5. X\_train, X\_valid, y\_train, y\_valid

28	X_train						X_valid						y_train		y_valid		
	x1	x2	x3	x4	x5	x6	x1	x2	x3	x4	x5	x6					
0	6	18	5	4	6	1	0	7	10	10	2	5	16	0	164.482039	0	175.868330
1	0	2	3	6	5	12	1	1	15	11	8	7	2	1	104.361524	1	194.998744
2	17	1	9	2	15	5	2	12	9	17	4	11	15	2	220.100000	2	260.793169
3	9	4	14	1	7	7	3	0	11	17	16	6	2	3	182.849722	3	243.793169
4	14	6	4	3	10	0	4	10	6	15	9	11	5	4	173.600000	4	283.789500
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
795	18	2	6	4	3	5	795	9	3	8	15	1	14	795	190.884692	195	169.752814
796	3	3	5	2	5	13	796	7	9	17	7	15	3	796	115.982039	196	284.793169
797	5	10	17	2	16	13	797	3	2	0	6	12	17	797	213.693169	197	114.400000
798	6	14	15	2	14	8	798	0	9	2	11	17	4	798	211.789500	198	251.526407
799	1	1	16	2	6	17	799	0	10	17	7	9	11	799	164.100000	199	217.693169

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3. RESULTS AND DISCUSSION

After all the previous processes are done, this section describes the results with a linear model on Scikit-learn. The Linear Regression model is based on inputs from "from sklearn.linear\_model import LinearRegression". Form a model or run the training process using the "model.fit(X\_train, y\_train)". From the command model.fit(X\_train, y\_train) Will form an input of X\_train and output y\_train. After the model for input and output is created, then the continuation of the model is used for prediction with commands y\_valid\_pred = model.predict(X\_valid). Predicted results y\_valid and It will then be compared to y\_valid = y[800:1000]. To compare the results of these predictions by using Mean Absolute Percentage Error (MAPE), Root mean squared error (RMSE), and Coefficient of determination (R2).

6

3.1. Mean Absolute Percentage Error (MAPE)

The mean absolute percentage error (MAPE) measures a forecast system's accuracy. It measures this accuracy as a percentage and can be calculated as the average absolute per cent error for each time minus actual values divided by actual values. The formula for Mean Absolute Percentage Error is:

$$M = \frac{1}{n} \sum_{t=1}^n \left| \frac{A_t - F_t}{A_t} \right| \tag{11}$$

Where:

n = is the number of fitted points,

At = is the actual value,

Ft = is the forecast value.

Σ = is summation notation (the absolute value is summed for every forecasted point in time).

The average absolute percentage error (MAPE) is the most common measure used to estimate errors and works best if there are no extremes on the data (and no 0).

27

3.2. Root Mean Square Error (RMSE)

Root Mean Square Error (RMSE) is the residuals' standard deviation (prediction errors). Residuals measure how far data points are off the regression line; RMSE measures how these residuals are dispersed. In other words, it indicates the degree of data concentration around the line of best fit. In climatology, forecasting, and regression analysis, root mean square error is frequently used to verify experimental results. The formula for Root Mean Square Error (RMSE) are:

$$MRSE = \sqrt{\frac{1}{n} \sum (f - o)^2} \tag{12}$$

Where:

f = forecasts (expected values or unknown results).

o = observed values (known results).

10

### 3.3. Coefficient of Determination (R2)

The coefficient of determination, often known as the R-squared method, is the proportion of the variation in the dependent variable that can be predicted based on the independent variable. 11 presents the level of dispersion in the provided data set. The formula for Coefficient of determination (R2) is:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (13)$$

5 Where:

n = Total number of observations

$\sum x$  = Total of the First Variable Value

$\sum y$  = Total of the Second Variable Value

$\sum xy$  = Sum of the Product of first & Second Value

$\sum x^2$  = Sum of the Squares of the First Value

$\sum y^2$  = Sum of the Squares of the Second Value

11 The table below shows the results of these predictions by using Mean absolute percentage error (MAPE), Root mean squared error (RMSE), and Coefficient of determination (R2).

Table 6. Predicted Results MAPE, RMSE, R2 with minimum variables

Linear Model Scikit-Learn	MAPE	RMSE	R2
LinearRegression	0.13	31.33	0.88
Ridge	0.15	40.19	0.80
Lasso	0.20	50.42	0.69
OrthogonalMatchingPursuit	0.14	32.65	0.87
TweedieRegressor	0.11	26.32	0.92
Polynomial Regression with Pipeline	0.02	3.32	1.00
No Pipeline (Manual)	0.02	4.61	1.00
SVR	0.09	21.96	0.94
KNeighborsRegressor	0.10	23.93	0.93
MLPRegressor	0.03	8.25	0.99

The result of table 6 is the input variable  $X = np.random.randint(19, size=(1000,6))$ , while to get the output of variable y by using equations  $y = 5 * X[x1] + 0.1 * (X[x2]**2) + 30 * (X[x3]**0.5) + X[x4] * X[x5] + X[x6] + 10$ . From this test we did, polynomial Regression with Pipeline is the best method to predict stunting prevalence using minimum variables.

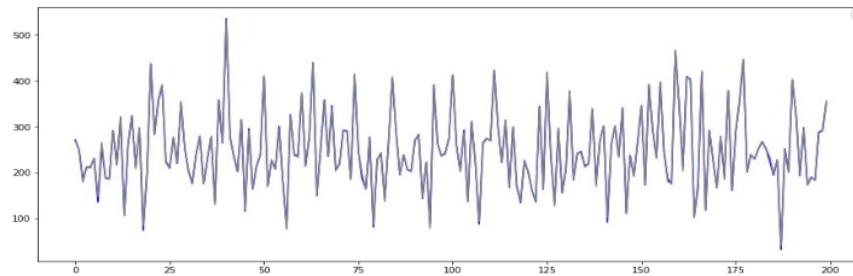


Figure 3. Variable X Minimum with Polynomial Regression

14 Figure 3 shows the representation of y variation with actual label and y validation prediction with prediction label. From the visualization in figure 3, the predicted value is close to the actual value. The results of testing with the Scikit-Learn Linear Model with a minimum variable of 19 get the best test results, namely the Polynomial Regression with Pipeline model with MAPE 0.02, RMSE 3.32 and R2 1.00.

Table 7. Predicted Results MAPE, RMSE, R2 with maximum variables

Linear Model Scikit-Learn	MAPE	RMSE	R2
LinearRegression	0.22	194.92	0.86
Ridge	0.21	199.98	0.86
Lasso	0.22	197.40	0.86

OrthogonalMatchingPursuit	0.23	201.87	0.85
TweedieRegressor	0.15	127.04	0.94
Polynomial Regression with Pipeline	0.00	3.79	1.00
No Pipeline (Manual)	0.01	5.63	1.00
SVR	0.09	86.77	0.97
KNeighborsRegressor	0.11	133.39	0.94
MLPRegressor	0.04	61.61	0.99

The result of table 7 is variable input  $X = \text{np.random.randint}(48, \text{size}=(1000,6))$ , while to get the output of variable  $y$  by using equations  $y = 5 * X['x1'] + 0.1 * (X['x2'] ** 2) + 30 * (X['x3'] ** 0.5) + X['x4'] * X['x5'] + X['x6'] + 10$ . From this test we did, polynomial Regression with Pipeline is the best method to predict stunting prevalence using maximum variables.

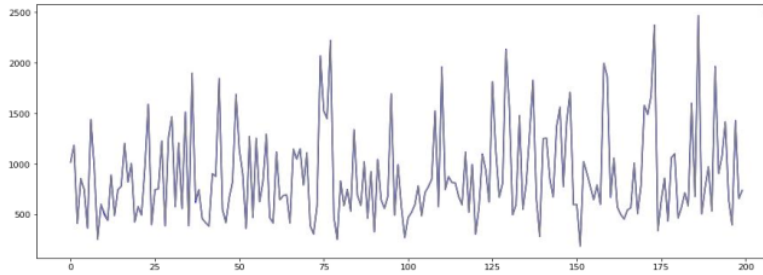


Figure 4. Variable X Maximum with Polynomial Regression

Figure 4 shows the representation of  $y$  validation with actual label and validation prediction with prediction label. From the visualization contained in figure 4, get the result that the predicted value is close to the actual value or actual value. The results of testing with the Scikit-Learn Linear Model with a maximum variable of 48 get the best test results, namely the Polynomial Regression with Pipeline model with MAPE 0.00, RMSE 3.79 and R2 1.00.

Table 8. Predicted Results MAPE, RMSE, R2 with average variable

Linear Model Scikit-Learn	MAPE	RMSE	R2
LinearRegression	0.17	83.62	0.86
Ridge	0.16	87.75	0.85
Lasso	0.17	87.31	0.85
OrthogonalMatchingPursuit	0.17	85.88	0.85
TweedieRegressor	0.12	59.95	0.93
Polynomial Regression with Pipeline	0.01	3.32	1.00
No Pipeline (Manual)	0.01	5.24	1.00
SVR	0.07	36.77	0.97
KNeighborsRegressor	0.10	58.98	0.93
MLPRegressor	0.03	16.61	0.99

The result of table 8 is variable input  $X = \text{np.random.randint}(32, \text{size}=(1000,6))$ , while to get the output of variable  $y$  by using equations  $y = 5 * X['x1'] + 0.1 * (X['x2'] ** 2) + 30 * (X['x3'] ** 0.5) + X['x4'] * X['x5'] + X['x6'] + 10$ . From the results of this test that we do, polynomial regression with Pipeline is the best method to predict stunting prevalence using the average variable.

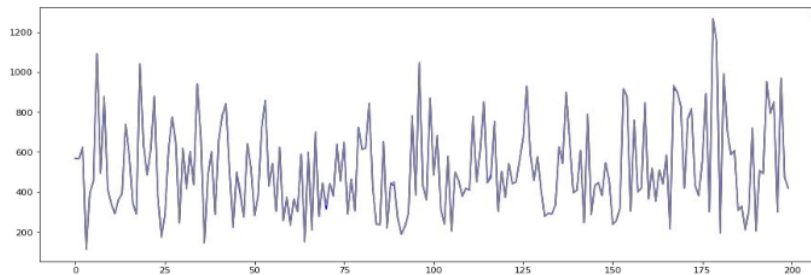


Figure 5. Variable X Average with Polynomial Regression



Figure 5 shows the representation of  $y$  validation with actual label and  $y$  validation prediction with prediction label. From the visualization in figure 5, the predicted value is close to the actual value. The results of testing with the Scikit-Learn Linear Model with an average variable of 32 get the best test result, namely the Polynomial Regression With Pipeline model with MAPE 0.01, RMSE 3.32 and R2 1.00. Testing the results of this study is also compared with previous studies such as Elizabeth *et al.* [5]. It uses machine learning models in determining stunting at birth and systemic inflammatory biomarkers as predictors of the next baby's growth. The random forest model identified HAZ at birth as the most important feature in predicting HAZ at 18 months. Of the biomarkers, AGP (Alpha-1-acid Glycoprotein), CRP (C-Reactive Protein), and IL1 (interleukin-1) were identified as strong predictors of subsequent growth in both classification and regression models. Fikrewold *et al.* [25-27] use algorithms on machine learning to predict the malnutrition of toddlers in Ethiopia. Descriptive results show that the xgboost algorithm has better predictive capabilities than common linear mixed algorithms. Hui Shi *et al.* [8] use machine learning models to predict the occurrence of postoperative malnutrition in children. Using five predictive algorithms to predict the occurrence of postoperative malnutrition in children, the XGBoost model achieved the largest AUC in all outcomes. Haile *et al.* [28] Testing machine learning to identify determinants of childhood malnutrition. The results obtained by machine learning testing are determined from several algorithms used and show rf algorithms selected as the best ML model.

Polynomial Regression is a special case of linear Regression. We adjust the polynomial equation on the data to the curved relationship between the target and independent variables. Machine learning pipelines are a way to codify and automate the workflows needed to generate machine learning models. The machine learning pipeline consists of several sequential steps, from data extraction and preprocessing to training and implementing models. Polynomial Regression is a statistical analysis method used to look at the influence of two or more variables. Variable relationships are functions that are manifested in a mathematical model. A pipeline is a Python scikit-learn utility for organizing machine learning operations. Pipelines function by allowing a series of linear data transformations to be linked together, resulting in a scalable modelling process. The goal is to ensure that all phases in the pipeline, such as training datasets or any parts involved in cross-validation techniques, are limited to the data available for assessment. The Mean Absolute Percentage Error (MAPE) method provides information on how many forecasting errors compare to the actual value of the series. The smaller the value of the error presentation (percentage error) in MAPE, the more accurate the forecasting results. MAPE values close to zero indicate that the forecasting results follow actual data and can be used for forecasting calculations in future periods. A low RMSE value indicates that the variation in value generated by a forecast model is close to the variation in its observant value. RMSE calculates how different a set of values is. The smaller the RMSE value, the closer the predicted and observed value and the smaller the RMSE value, the better. Coefficient of determination or commonly symbolized by "R2", which means as a contribution of influence given by free variables or independent variables (X) to bound variables or dependent variables (Y), or in other words, the value of the Coefficient of determination or R Square is useful for predicting and seeing how much influence contribution that variable X gives simultaneously (together) to variable y. The smaller the value of the Coefficient of determination (R square) then the means that the influence of the free variable (X) on the bound variable (y) is weaker. Conversely, if the value of R Square is getting closer to the number 1, then the influence is getting stronger.

#### 4. CONCLUSION

An increase in the number of residents should be anticipated in many fields, including the Health sector, especially the problem of stunting. Stunting that often occurs in children disrupts height and lack of absorption of nutrients. Stunting affects up to a third of children in low- to middle-income countries (LMICs). The presence of data in all sectors provides a very large change in the order of life. Data with various types of categories can be integrated to explore knowledge and support the latest research both on a small scale and on a large scale. Machine learning algorithms in classifying disease datasets can be done with a wide variety of methods. The method used in predicting this dataset is the Linear Model, which is used to perform the Linear Regression algorithm process in Machine Learning. In this study, there are several stages in predicting datasets using machine learning. The stages carried out are the initiation process, developing linear models, and making prediction results that have been processed on linear machine learning models. The results of testing with the Scikit-Learn Linear Model with minimum, maximum and average variables get the best test results, namely the Polynomial Regression with Pipeline model. From the test of 3 variables that have been done with the Polynomial Regression with Pipeline model the Mean Absolute Percentage Error value in variable X maximum has a very accurate value of 0.00. The Mean Absolute Percentage Error (MAPE) method provides information on how many forecasting errors compare to the actual value of the series. The smaller the value of the error presentation (percentage error) in MAPE, the more accurate the forecasting results. MAPE values close to zero indicate that the forecasting results follow actual data and can be used for forecasting calculations

in future periods. This prediction method can help stakeholders make predictions following the data testing results conducted by machine learning methods using the Scikit-Learn linear model.

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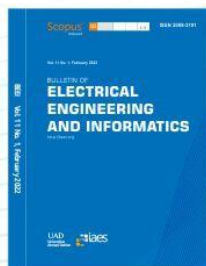
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