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PE-M: Prediction of malnutrition of Barangay 35 Tondo Manila using random

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Abstract

Malnutrition is still an ongoing problem in the Philippines as it poses a threat especially to children. There are multiple considerations for malnutrition in order to help find the root cause of malnutrition for each child, it is quite a tedious task to perform. According to the classification of undernutrition rates, the prevalence in the Philippines is of "extremely high" public health relevance. It was stated that in 2019, the prevalence of underweight and wasting was 19% and 6%, respectively. Poverty amplifies the risk of, and risks from, malnutrition. People who are poor are more likely to be affected by different forms of malnutrition. Also, malnutrition increases health care costs, reduces productivity, and slows economic growth, which can perpetuate a cycle of poverty and ill-health. The application Pe-M, is a web application which is aimed to predict the malnutrition rate within Barangay 35 in Tondo Manila City and also give food recommendations based on the classification the children are categorized. The application uses Random Forest Algorithm in calculating the prediction from the data provided in order to calculate the percentage of malnutrition present in Barangay 35 Tondo Manila City. To ensure that the web application performs as per its specified requirements, a comprehensive specification and evaluation of software product quality was conducted using the ISO 25010 software quality model. This study specifically seeks to evaluate the web application in terms of performance efficiency and usability. The following results show that there are kids that fall in the classification of malnutrition showing that there is malnutrition in the barangay. The confusion matrix shows that RFA gives 87.80% accuracy based on the risk factors given and the trained data in the system. The RFA predicted that 21.95% of the data is said to be the malnutrition rate in the barangay based on the given data and the highest risk factor in the data with 3.6% is mineral water consumption of the citizens. The model identified the risk factors which helped predict malnutrition rate making the model more reliable and transparent.

CCS CONCEPTS • Random Forest Algorithm • Classification • Malnutrition• Percentage Calculation

1. Introduction

According to the World Bank, the Philippines is among the 10 nations with the most stunted children worldwide and ranks sixth among nations in East Asia and the Pacific with the highest frequency of stunting. Malnutrition is still an ongoing problem that is happening in this country whether we accept it or not. According to the classification of undernutrition rates, the prevalence in the Philippines is of "extremely high" public health relevance. It was stated that in 2019, the prevalence of underweight and wasting was 19% and 6%, respectively. Poverty amplifies the risk of, and risks from, malnutrition. People who are poor are more likely to be affected by different forms of malnutrition. Also, malnutrition increases health care costs, reduces productivity, and slows economic growth, which can perpetuate a cycle of poverty and ill-health. According to The World Bank study of Undernutrition in the Philippines (2021)

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municipalities, particularly those with a high prevalence of childhood undernutrition, face several problems in the effort to implement nutrition interventions. Chief among them are the limited budgets allocated for nutrition programs, the lack of a full-time provincial, city or municipal nutrition action officer, and the scarcity of health personnel. As stated by Islam, et al. (2021) Late or lack of prominent risk factors identification enhances the risk of developing any difficulties. Early identification of women malnutrition is an important task for preventing malnutrition-related numerous difficulties in Bangladesh. Henceforth, there is a growing need for early identification of prominent risk factors and predicting a woman with malnutrition using an automated standard system.

According to the World Health Organization, there are many forms of malnutrition namely: undernutrition, micronutrient-related malnutrition, and overweight, and obesity, diet-related noncommunicable diseases. It is stated that combating all these said forms of malnutrition is a big challenge and is one of the greatest global health challenges. Women, infants, children, and adolescents are at risk because of malnutrition. The absence of a clearly defined minimum complete package of evidence-based treatments, according to The World Bank, has led to the fragmented implementation of these interventions at the local level. During the period from 1999 to 2004, the Philippine Plan of Action for Nutrition (PPAN) continued to be conducted, as briefly summarized below. The Nutrition Education Programme aims to increase the level of nutrition awareness and appropriate knowledge and practices to ensure nutritional wellbeing. It is an integral component of other impact programs to ensure effectiveness. Overall, although the government is implementing nutrition specific and nutrition-sensitive interventions targeting women and children, progress on improving the nutritional status of children has been very slow.

The goal of the study is to help Barangay 35 in preventing and fighting malnutrition. According to the interview conducted by the researchers with a Barangay Health Worker (BHW)/Kagawad, in Barangay 35 Zone 3 Tondo Manila, Philippines, there is no existing study about malnutrition in the barangay. The barangay also implements a feeding program that is also self-funded with the help from Fugoso Health Center, the feeding programs are scheduled from time to time, and it depends on who is around the vicinity, sometimes the malnourished children or any child in general. The study helps in multiple ways, first is the way that the barangay collects data is by manually inputting on a sheet of paper, with attributes like weight, height, and age. Manually collecting, recording, and encoding the data is a problem since it takes quite a lot of time to record individual records, also these papers are prone to damage. Second, Risk factors for malnutrition are only observed by their household situations and hearsays without formal study. Lastly, the understanding and knowledge about nutritional foods and meals is lacking since the barangay uses only the given funds and resources provided by their sponsors to make said nutritious meals. There is no presence of any nutritionist, dietician, or any related professionals available in the barangay as well; having professionals in the barangay could have potentially helped manage these said health-related illnesses and help spread awareness to the citizens.

2. Review of related literature

According to Talukder, Ashis and Ahammed, Benojir study about Machine Learning for Predicting Malnutrition among Under-Five Children in Bangladesh (2020) The RF algorithm performed the best with the best classification accuracy for predicting malnutrition in Bangladeshi children. This examination features the utility of ML calculations as well as the significance of utilizing common socio-demographic and wellbeing related attributes to anticipate malnutrition status.[2]

Based on S. Kar, S. Pratihar, et al (2021) Sometimes malnourished children fall into some serious health issues and doctors are unable to find out the root causes of their illness, but they used to apply some practices which were not appropriate for every child. Children often die because of this reason, so it is very dangerous for malnourished children.[1]

According to the World Health Organization, one of the ways in optimizing children's nutrition is by prioritizing it early in life, so that there would be fewer problems and more long-term benefits for the children and further prevent the risks in the future. This explains the double burden of malnutrition now facing many countries worldwide – characterized by the coexistence of undernutrition along with overweight, obesity or diet-related noncommunicable diseases (NCDs).[3]

3. Methods

3.1. Research Design

The research will make use of statistical analysis and graphs, the primary topic of this study is quantitative - correlational research design. It will make use of the attributes and risk factors of malnutrition in Barangay 35 Tondo, Manila. This hybrid research design aims to know the who, what, where, and how of the entire research. Quantitative research uses statistics, graphs, charts, and numbers in representing the data involved in the research in order to fully understand and compare each data. Correlational research design also aims in showing the relationship between variables in order to fully grasp the scenario and environment of the research, in this case the classifications for malnutrition are shown and compared in order to know how impactful each factor is and what is the most prominent risk factor based on the data gathered. The researchers will use Random Forest Algorithm to find the malnutrition rate present in Barangay 35 Tondo Manila. The algorithm would also show the most prominent risk factor based on the classifications of malnutrition used by the researchers. The data would be shown in a graph and would be compared and analyzed by the researchers based on the result of the study.

3.2. Research Development

The researchers used the Agile Model Flow for requirement analysis, system design, developing, integration and testing, and deployment of the system software.
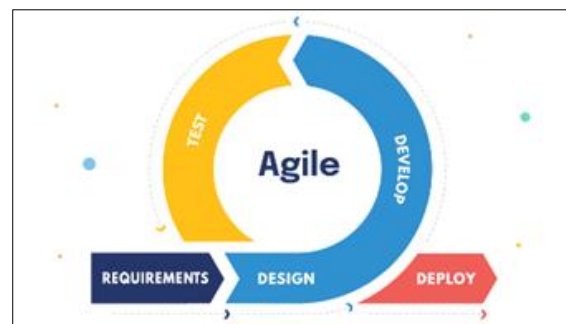

Figure 1 Agile Model Flow

- Requirement Analysis - The requirements for the system and the data needed to be studied for the use of machine learning were all documented and obtained by the researchers.
- System Design - The researchers created a layout that draws inspiration from the requirements documentation. The right hardware and software specifications were established by the researchers to develop the system.
- Development phase - The system was built by the researchers in accordance with its design and separated the whole work into various sections that would eventually be combined and assessed individually.
- Integration and Testing - All the units were combined by the researchers, and they went through a variety of tests that analyze each unit's success and failure.
- Deployment of System - The Web Application will be launched online when each unit has undergone testing.

3.2.1. Hardware and Software Requirements

For the software requirements, the study uses the Python programming language as its main code to apply the machine learning to be used which is the Random Forest Algorithm. The Django framework is used as well to create the front end of the system. HTML and CSS is also used to design and present the front end of our application. MySQL is used to create the back end database where the user can store data to the system, and lastly, Microsoft Excel spreadsheets is used to store the data gathered by the researchers from the study in order for the prediction to happen. Lastly, all software and devices used runs on a Windows 10 operating system.

The hardware requirement of the system is not specified as well but in order to have a smoother experience the researchers used 2 different laptops and a computer with the following specifications: A computer with a Ryzen 3 core, 8 GB of ram, and an average processing speed. laptops 1) Processor Intel(R) Core (TM) i7-7700HQ CPU @ 2.80GHz, 2808 MHz, 4 Core(s), 8 Logical Processor(s), and lastly, 2) AMD Ryzen 5 4600H with Radeon Graphics, NVIDIA GeForce GTX 1650, 16 GB RAM.

3.2.2. Research Population and Sample

The researchers would be using stratified sampling, classifying children 1-12 years based on the factors of their malnutrition in Barangay 35 Zone 3, Tondo Manila, Philippines. The researchers collected 200 individual data of children across the barangay.

The following data is the classification of malnutrition that the researchers determined to be suitable for the research.

- Underweight
- Healthy Weight
- Overweight
- Obese

Building Phase

3.3. Research Evaluation

A product quality evaluation system is built around the quality model. The quality model specifies which quality characteristics will be considered when assessing the properties of a software product. The degree to which a system satisfies the stated and implied needs of its various stakeholders, and thus provides value, is defined as its quality. The needs of those stakeholders (functionality, performance, security, and maintainability, for example) are precisely what are represented in the quality model, which divides product quality into characteristics and sub-characteristics. A framework for assessing the quality of software products can be found in the ISO/IEC 25000 set of standards, popularly known as SQuaRE (System and Software Quality Requirements and Evaluation). Security, dependability, and maintainability are three of the eight software quality attributes, or system "-ilities," that are defined by ISO/IEC 25010.

3.3.1. Statistical Tool and Instrument Use

$$Precision = \frac{TP}{TP + FP} \qquad Recall = \frac{TP}{TP + FN} \qquad Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$F1 - Score = \left(\frac{2}{precision^{-1} + recall^{-1}} \right) = 2 \cdot \left(\frac{precision * recall}{precision + recall} \right)$$

Figure 2 Confusion Matrix Formula

A confusion matrix is a summary of prediction results on a classification problem. Count values are used to describe the number of accurate and inaccurate predictions for each class. This is how the confusion matrix operates. The confusion matrix demonstrates the manner in which your classification model which in this case Random Forest Classifier makes predictions while being confused. It provides you with information on the types of errors being produced, which is more essential than just the faults your classifier is making. This breakdown gets over the drawback of relying solely on categorization accuracy.

The Researchers will be using the following risk factors to determine the malnutrition rate in the barangay. The risk factors are Inadequate nutrient intake, Ill health, Poor access to health services, Inadequate access to diverse, nutritious foods, Unhealthy household environment, Inadequate care and nutritional practices for women. According to the UNICEF determinants of childhood nutrition in the Philippines these risk factors greatly affect the nutritional status of every child in the Philippines.

4. Results and discussion

4.1. Analysis Results

Figure 2 shows a pie chart of the importances of each classification on the result of the prediction. The classifications are as follows: Number of kids in the household, Age of the children, their weight: (kg), height: (cm), if they eat three meals every day, if the kids suffer from a chronic illness, if their income is sufficient to pay for the nutritious food you

eat each day, if they are ordering mineral water from a local mineral water station, and lastly if the mother in the household is pregnant.

According to the results of the importances as predicted and used in the system, the weight (kg) is the biggest factor in the prediction which got a total of 35.5%, next is the height (cm) getting a 26.59%, age of the children being interviewed got 17.39%, number of kids in the household got 7.7%, if they are ordering mineral water from a local mineral water station got 3.6%, if their income is sufficient to pay for the nutritious food you eat each day got 2.98%, if the mother in the household is pregnant got 2.36%, if they eating three meals every day got 2.23%, and lastly, if the kids suffer from a chronic illness got a 1.73%, everything rounding up to a total of 100%..
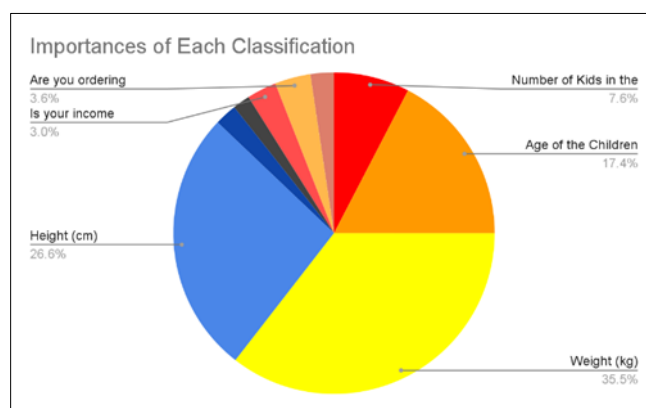

Figure 3 Classification of Malnutrition Results Diagram

Table 1 Confusion Matrix Score of Malnutrition Prediction Using Random Forest Algorithm

	Precision	**Recall**	**F1-Score**
0	0.88	0.97	0.92
1	0.89	0.67	0.76
accuracy	N/A	N/A	0.88
Macro avg	0.88	0.82	0.84
Weighted avg	0.88	0.88	0.87

While examining the relationship between the nourished and the factors, and risk factors, the model gained a Precision score of 0.88 or 88%, a Recall score of 0.97 or 97%, and a F-1 score of 0.92 or 92%. On the other hand, the model, while determining the relationship between factors and the malnourished, acquired a 0.89 or 89% in Precision, 0.67 or 67% in Recall, and 0.76 or 76% in F-1 score. The model has an accuracy of 0.88 or 88% in overall scale, Macro avg of 0.88 or 88% in Precision, 0.82 or 82% in Recall, and 0.84 or 84% in F-1 score, while the weighted avg gives score of 0.88 or 88% in Precision, 0.88 or 88% in Recall, 0.87 or 87% in F-1 score.

The researchers also acquired a 22.5% malnutrition rate based on the given data, meaning that about 40 out of 200 children in barangay 35 are considered malnourished. The proponents also got the probabilities of each prediction.

The risk factor that is of high importance and has a significant amount of influence on the results is 'Are you ordering mineral water from a local mineral water station?' which gained an importance score of 3.6%.

Pe-M: Prediction of Malnutrition of Barangay 35 Tondo Manila City Using Random Forest Algorithm can be recommended to be used for predicting the malnutrition rate in a barangay. The system is programmed using the Django framework and the Python language through Visual Studio Code. Pe-M is a web application which is aimed to predict the malnutrition rate within Barangay 35 in Tondo Manila City and also give food recommendations based on the

classification the children are categorized. The website also serves as a working website for the barangay that they could use to monitor their area. Based on the tests and evaluations performed by the researchers, the following are the results. The researchers have successfully developed a web application using the Django Framework and the Python language. Built the web application in accordance with the objectives. The web application is evaluated in compliance with the ISO 25010 standards with 50 barangay respondents. The participants tested the web application and rate their experience based on the following categories.

In Performance Efficiency, the web application received a total of 45 out of 50, concurs that the system's response, processing, and throughput rates are reasonable. Functional Suitability scored 45 out of 50 of the respondents, or the majority, agreed that the functions of the system provide the correct results with the needed degree of precision and can accomplish specific tasks and objectives. For the Compatibility of the system a score of: 46 out of 50 of the respondents agreed that the functions of the system can exchange information and use the information that has been exchanged. System Reliability results show that about 48 out of 50 respondents responded that the system is dependable and capable of recovering data or restoring the system to the intended condition. The system's Usability shows that around 45 out of 50 respondents, it is easy to learn how the system works and can correct user mistakes. For the Count of Security: Based on the evaluation, 46 out of 50 respondents, the system ensures that data are accessible only to those authorized to have access and action of an entity can be traced uniquely to the entity. System Maintainability showed a score of 43 out of 50 respondents, stating that the system can be modified to improve, correct, or adapt to changes in environment and in requirements. System Portability showed 43 out of 50 respondents evaluation results show that the system can be transferred from one hardware, software or other operational or usage environment to another.

5. Conclusion

Pursuant to the Confusion matrix, which was used to forecast the rate of malnutrition and identify risk variables' effects on malnutrition, the Random Forest Algorithm, which has the best accuracy of any other Machine Learning algorithm for this provided a result with an accuracy of 88%.

The identified risk factors are used in order to predict the malnutrition rate of Barangay 35. Based on the confusion matrix results, each risk factor shows varying percentages of effects, the risk factor "Are you ordering mineral water from a local mineral water station?" have the biggest impact out of all the risk factors meaning that it is a highly important risk needed to be resolved immediately by the Barangay. The model also showed a 22.5% malnutrition rate based on the data given. Out of 200 children interviewed in Barangay 35, Tondo Manila, about 35 of them are considered malnourished.

It is necessary to recommend meal plans since malnutrition affects children's health and dietary intake, both of which must be monitored to ensure that the food is healthy and nutritious for the children.

Recommendation

A number of recommendations were identified based on the findings and conclusions presented for further improvement of the study. The researchers recommend that the scope of the study be expanded from barangay to several barangays or cities.

The researchers recommend that the system should be re-programmed for cross-platform compatibility as it is currently running and operating on a browser only.

The researchers recommend devising another process that would aid in detecting the malnutrition rate by using the

The researchers recommend applying other machine learning models to improve prediction accuracy and provide more valuable data and feature extraction that would predict malnutrition rate by using the risk factors of malnutrition.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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