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CHILD HEALTH CARE MONITORING SYSTEM

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Abstract : Children need adequate care and nutrition to grow and develop optimally. Parents must take adequate care in providing nutrition's and monitoring their children health regularly. Aim of Child Health Care Monitoring System is to monitor the nutritional status of children based on height, weight, age and gender. The Child Health Care Monitoring System is a restful web application that helps in monitoring the health condition of a child whose age is below 10 years. Parents can use this application to check the nutritional status of a baby regularly, update vaccination status and upload and save the reports related to the child. This application uses Naïve Bayes Classifier, a machine learning model to classify the data and shows the health condition of a child as 'malnutrition' or 'normal' or 'overnutrition.' The Anthropometric index and Z-score are used to assess the nutritional status of children under the age of ten years. The parameters that are used in the measurement of Anthropometry for children are the age, weight, height, and gender. These parameters are used to generate the index of the Anthropometry: height for age, weight for age, weight for height for kids under the age of 5 years and body mass index for kids above the age of 5 years these data can be interpreted, and we can classify the data as 'malnutrition' or 'normal' or 'overnutrition'. This study used 642 data sets of children, the model used 492 as training set and 151 as testing set with 97.6% accuracy.

IndexTerms : Naïve Bayes Classifier, Anthropometric index, Z-score, height for age, weight for age, weight for height

INTRODUCTION

Health Informatics, also called Health Information Systems, uses information technology to organize and analyze data health records to improve healthcare outcomes. It deals with devices, resources and methods required to acquire, store, retrieve and use health and medical data. It provides electronic access to medical records of patients for doctors, nurses, hospital administrators, insurance companies and health information techniques.

Anthropometry provides valuable assessment of nutritional status in children and adults; it is a study of human body measurement. These measurements are helpful in evaluating general health status, nutritional adequacy and growth development in infants, toddlers, and children. In adults, these body measurements can be used to determine body composition which helps in determining nutritional status and diagnose obesity, it also helps to assess the health status and future disease risk.

Machine Learning in Health Care:

Machine learning in health care helps the medical professionals to take care of patients and manage the clinical and medical data related to patients. It is an application of artificial intelligence, which involves programming computers to think and

learn like humans. In health care you can apply this to collect, manage patient data, identify health care trends, recommend treatments and more. Hospitals and health care companies have recognized the ability of machine learning to improve decision making and reduce risk in the medical field.

Children's growth and development can be monitored by doing assessment of nutritional status on a regular basis by performing Anthropometry measurements and the calculation of z-score [1]. The parameters that are used in the measurement of Anthropometry for children are the gender, age, weight, and height. These parameters are used to generate

Height for age, Weight for age and weight for height using z score charts provided by WHO. These Anthropometry measures provide information about the nutritional value of the children. To interpret the nutritional status based on the third nutritional indicator can be done with the classification technique.

LITERATURE REVIEW

Tiara Eka Putri et al 2020 demonstrated the classification of Toddler nutrition status using Naïve Bayes Classifier Based on Z- Score Value and Anthropometry Index. The anthropometry indices used are weight-for –age, height-for-age, weight-for-height. This study used 225 data of toddlers. The testing system used 55 data as training and 175 data as testing with 100% accuracy.

Ayi Purbasari et al 2021 demonstrated CRISP-DM for Data Quality Improvement to Support Machine Learning of Stunting Prediction in Infants and Toddlers. This research is focused on the processes that must be followed and Cross-Industry Standard Process for Data Mining (CRISP-DM) with the specifications and requirements of supervised and unsupervised learning was adopted which includes a methodology for Classification/grouping.

Riris Aulya Putri et al 2018 demonstrated Classification of Toddler Nutrition Status with Anthropometry Calculation using Naïve Bayes Algorithm, nutrition status monitoring for toddlers is done with Anthropometry calculations based on 3 index weight for age (WFA), height for age (HFA), and weight for height (WFA) and used Naïve Bayes for classification and this classification is tested with k-fold cross validation method to know the success of classification process. The results of this process of the toddler nutrition status classification, for each index, have 88% accuracy for WFA index, 64% accuracy for HFA index and 68% accuracy for WFH index [5].

Siti Sendari et al 2019 demonstrated classification of Nutritional Status of toddler with Anthropometry calculations are based on 3 index weight for age (WFA), height for age (HFA), and weight for height (WFA) and used K-Nearest Neighbor Method The K values used are k = 3, k = 9 and k = 15 of all K values, the highest accuracy results of the testing data in WFA is 85.24% by using value k=3, k=5, k=7, k=9 and the lowest accuracy is 84.76% by using k=15. The highest accuracy in the HFA index is 73.81%. The highest accuracy in the WFA index is 73.33% by using value k=3, true and false k-fold cross-validation. [4].

NEED OF THE STUDY

Children need adequate care and nutrition to grow and develop optimally. Parents must take adequate care in providing nutrition's and monitoring their kid's health regularly. The Child Health Care Monitoring system uses height, weight, age, and gender parameter to access the nutritional status of the child by calculating Anthropometric measures Height for Age, Weight for Age and Weight for Height for children below the age of 5 years and Body Mass Index for children above the age of 5 years, here Naïve Bayes algorithm is used to classify the nutritional status of child as "Malnutrition" or "Normal" or "Over Nutrition" according to the standards provided by World Health Organization [WHO] .For this study the data related to children is collected from Anganwadi schools of villages near Visakhapatnam

RESEARCH METHODOLOGY

A Naive Bayes classifier is a machine learning model that is used for classification tasks. Bayes theorem is the basics of Naive Bayes classifier. Using Bayes theorem, we can find the probability of happening of event A, given that event B has occurred. Here, event B is the evidence and A is the hypothesis.

$$P(A|B) = \big(P(B|A)P(A)\big)/P(B)$$

where P(B) ≠ 0. We are trying to find the probability of occurrence of event A. Event B is also termed as evidence. P(A) is priori of A. P(A|B) is a posteriori probability of B, i.e., probability of event after evidence is seen. There exists independence among the features is the assumption made for Naive. That is, the presence of one feature does not affect the other. The Naïve Bayes Classifier method is the method in data mining to classify data using probability calculations.

The classification is divided into two phases consisting of learning and classifying. Phases of learning read the data known to the class, while the classification phase is formed the data that will be tested. The naïve bayes are classified and predicted for the future values based on the previous value.

The following is the general equation of bayes's theorem.

$$P(Ci|X) = \big(P(X|Ci)P(Ci)\big)/P(X) \quad (1)$$

Naïve bayes classifier steps are as follows:

If P(X) is independent, then (X|Ci) (Ci) are calculated for achieving maximum values. If the prior class probabilities are previously unknown, then it is assumed that the same class is P(C1) =P(C2) =.....=P(Cm) to calculate $P(X|Ci)$) then P($X|Ci$) $P(Ci)$. Previous class probability can be predicted by P (Ci) = |Ci,D| / |D|, when |Ci, D| were the amount of data training for Ci, which is in D. Class prior Probabilities can be calculated using the equation of:

$$P(Ci) = \frac{|Ci,D|}{|D|} \quad (2)$$

2.) Because the data set has many attributes, it will be difficult to calculate P (X|Ci). To minimize the calculation of P(X|Ci), naïve bayes is a term creation of independent classes. If the values of these attributes are independent, then the equation becomes:

$$P(X/Ci) = k = 1nP(xk|Ci)$$

According to the above equation then it can easily estimate the probability ($x1$ |Ci)), P ($x2$ | Ci) …, P (xn | Ci) of training data.

Terms used for calculation of Nutritional Status:

Z-score:

Z-score growth reference is used by WHO in 2005 as the standard Anthropometry for under five years. Those standards are differentiated according to gender. To determine the classification of nutritional status the calculation of z-score table reference based on z-score is done first.

Calculation of Z-score using LMS parameters:

To obtain the z-score (Z) of given measurement (X), we use the following equation:

$$Z = \Big(\big((X/M) ** L\big) - 1\Big)/L * S$$

where X is the physical measurement (e.g., weight, length, head circumference, stature, or calculated BMI value) and L, M and S are the values from the appropriate z score table corresponding to the age of the child in months (or length/stature). For example, to obtain the weight-for-age z-score of a 9-month-old baby boy who weighs 9.7 kg, we would look up the L, M and S values from the weight for age z score table, which are L=-0.1600954, M=9.476500305, and S=0.11218624. Using the above equation above, we calculate that the z-score for this child is 0.207.

Nutritional Status Calculation Process:

Step 1: Start
Step 2: Consider the data set with parameters height, weight, age, and gender.
Step 3: Divide the data set into training data set and testing data set.
Step 4: Compute Weight for Age, Height for Age and Weight for Height z-scores for both training and testing data sets
Step 5: Evaluate anthropometric measurements WFA, HFA, WFH using z-scores calculate for training and testing data sets for children of age below 5 years.

a. WFA: if WFA z-score is less than -2 assign value Underweight, if value is greater than -2 and less than 2 assign value Normal and if z-score value is greater than 2 then Over weight
b. HFA: if WFA z-score is less than -2 assign value Stunted, if value is greater than -2 and less than 2 assign value Normal and if z-score value is greater than 2 then Tall
c. WFH: if WFA z-score is less than -2 assign value Wasted, if value is greater than -2 and less than 2 assign value Normal and if z-score value is greater than 2 then Obese

Step 6: Use OneHotEncoder to convert the categorical values of WFA, HFA, WFH for children of age below 5 years into numerical for both training and testing data.
Step 7: Now feed training data to the GaussianNB model which is imported from the sklearn library of python and train the model
Step 8: Test the model using the test data set
Step 9: Calculate accuracy
Step 10: Stop
Similar steps we follow for the children whose age is above 5years and less than 10 years considering anthropometric measurements WFA, HFA, BMI.

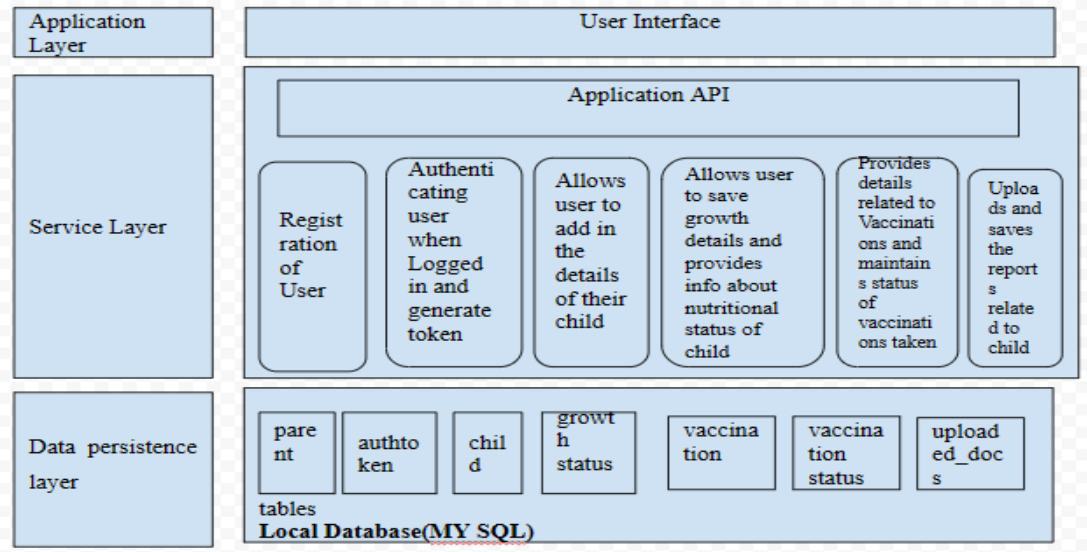
SYSTEM IMPLEMENTATION

Child Healthcare Monitoring System is used to monitor health condition of children of age less than 10 years, services provided by it are Check Nutritional Status, Get List of Vaccinations, Save the reports related to children, Food Suggestions, Registration of User, User Login, Add child details, Update growth details of baby and Update Vaccination details of baby.
It is a Django Restful Web application, here the machine learning model that predicts nutritional status of babies has an integrated user interface, so users can access the service with better flexibility.

System Architecture

The system architecture of Child Healthcare Monitoring System shown in Figure 1 gives an overview of the services provided.

Figure 1 System Architecture



The services provided by Child Health Care Monitoring System:
Registration and Login Services: These services can be used by user to register and login to the application.
Authentication Service: It helps to authenticate user on successful login and creates auth token and this token expires when user logs out.

Add Child Details: Users can add details of children of age less than10 years.
Update Vaccination Details: Users can update the status of Vaccination given to the baby and save updated status and can view them.
Update and Save growth Details: Users can check nutritional status of added baby/toddler and save the details every month and can view them and use for later purpose
Save and View Reports: Users can upload the reports and can view them later.

RESULTS

Accuracy of the model developed is 97.35%

Table 1 Sample Results of children whose age is below 5 years

S. No	Gender	Age	Height in cm	Weight in KG	WFA	HFA	WFH	Nutritional Status
1	Girl	5 days	45	2	Underweight	Stunted	Wasted	Malnutrition
2	Boy	5 months	72	7.2	Normal	Tall	Normal	Overnutrition
3	Boy	1 year 11 months	87	12	Normal	Normal	Normal	Normal
4	Girl	2 years 3 months	79	9	Underweight	Stunted	Normal	Malnutrition
5	Girl	3 years 6 months	95	15	Normal	Normal	Normal	Normal
6	Boy	4 years	100	19	Overweight	Normal	Obese	Overnutrition

Table 1 shows nutritional status of few children of different age groups. Here Anthropometric measures HFA, WFA and WFH are calculated using the parameters gender, age, height and weight. To determine the nutritional status of children these anthropometric measures are then classified using Gaussian Naïve Bayes classifier.

Table 2 Sample Results of children whose age is above 5 years.

S. No	Gender	Age	Height in cm	Weight in KG	WFA	HFA	BMI	Nutritional Status
1	Girl	5 years 1 month	110	14	Underweight	Normal	Thin	Malnutrition
2	Boy	7 years 2 months	128	20	Normal	Tall	Normal	Overnutrition
3	Boy	8 years 4 months	126	24	Normal	Normal	Normal	Normal
4	Girl	9 years 7 months	134	28	Normal	Normal	Normal	Normal

5	Girl	6 years 3 months	100	12	Underweight	Stunted	Thin	Malnutrition

Table 2 shows nutritional status of few children of age above 5 years and less than 10 years . Here Anthropometric measures HFA, WFA and BMI are calculated using the parameters gender, age, height and weight. To determine the nutritional status of children these anthropometric measures are then classified using Gaussian Naïve Bayes classifier.

CONCLUSION AND FURTHER SCOPE

The Child Health Care monitoring system helps in monitoring nutritional status of the children regularly. The combination of the Naïve Bayes Classifier method and the z-score value classifies the interpretation of toddler nutritional status based on the anthropometric index with an accuracy of 97.65%. The system undertakes the training data to determine learning classification interpretation of nutritional status using naive bayes classifier method toddler classifier. This Monitoring System also helps in reminding about vaccinations. This application provides services to save the growth details, nutritional status details, vaccination details and reports related to children which can be accessed by parents, doctors, and any health officers.

This application can further be extended to find the nutritional status of children above the age of 10 years and even for adults and old people. Can send an Email to parents reminding about vaccination and food to be given to kids according to the age of the kid. Can also include details of nearby Pediatricians, so users can approach them in case of emergency. The medical data related to patients can be used for further studied, can use machine learning and deep learning mechanisms to recognize the different patterns in data and help in a way to predict any health issues in advance to help humankind.

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