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Automated Menu Planning Algorithm for Children: Food Recommendation by Dietary Management System using ID3 for Indian Food Database

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Abstract

Adequate nutrition is essential in early childhood for the proper body growth and organ formation, to have a strong immune system, cognitive and neurological development. Children in India are mostly suffered from malnutrition. It happens because most of the mothers don't have proper knowledge about nutrition facts, which is to be feed to her child. To give proper diet to children as per their profile, Dietary Management System using ID3 is proposed. In this paper, ID3 is implemented with an example of Beverages using Weka tool and proposed work will be implemented in JAVA.

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Keywords:- BMI; BMR; Entropy; Information Gain; Nutrition; Calories

1. Introduction

Malnutrition in early childhood has long term consequences. Nearly 30% of all new born babies are facing problems like a low-birth weight, and leads to malnutrition, different diseases in their early childhood [1].Vitamins and mineral deficiencies also affect children's survival and development. Anaemia affects 74% of children below the age of three, more than 90% of adolescent girls and 50% of women. Vitamin A deficiency leads to blindness and increases morbidity and mortality among pre-schoolers, also remains a public health problem [1]. It is necessary to

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provide proper diet plan to child according to his necessity. The proposed automated menu planning System for children helps the user to fulfil nutritional needs of children. This paper mainly concentrates on methodology used for balance diet planning and recommendation based on decision tree structure ID3. The implementation of ID3 is validated through Weka tool for food recommendation. This food recommendation is mainly built for North Indian and Maharashtrian food database. There is very less research has been done on nutrition in India [7].

2. Outline of the Work

The proposed system of food recommendation for children is based on the factors such as food preferences, availability of food, medical information, disease information, personal information, activity level of a child, for Indian food database. The important task in implementation is to recommend the particular food item from the food database based on certain constraints such as likeliness of a child, availability of that food, its nutritional contents such as protein, carbohydrates, fats in that food. This recommendation helps to select the food from the database such that the deficiencies will not occur in near future and proper diet plan will be given to the child.

The main objective of presented work is to construct the decision tree until the appropriate classification is reached to select the proper food item based on food availability, Category of user, Likeness Factor, Overall content of Nutrients in that food and then to define the decision rules and constraints on it, for child age group 7 to 9 years.

3. System Framework

The proposed systems framework is shown in the figure 1. The level 0 includes the basic information such as personal information, medical information, disease information, activity level of child is considered. At level 1, user's food preferences, climate information, food availability, specific requirements if any are considered.

The personal information includes child's age, height, weight, gender to calculate BMI [2] and BMR [2]. BMI is used to predict whether child is underweight, normal, or overweight [2]. BMR helps to find daily calorie needs of the child. Medical information includes category of child such as underweight, normal, or overweight. Disease information helps to proposed system such as, if the child is having any disease and child is not allowed to eat some food such as potato, banana, etc by doctor's advice then it will not be assigned in Menu Plan. Activity level of child is used to calculate total number of daily calories required as per child's activity level [2]. The food preference is the likeness factor of a particular user with reference to some food. This factor is taken as an input from the user in ranges from low, medium, high. If the child likes Milk in high portion then likeness factor will be high for Milk. The climate information helps to recommend the foods beneficial in particular seasons are considered. Food Availability helps the recommendation system to select the food depending on its availability. Indian food database contains nutritive value of North Indian food stored in it [3].

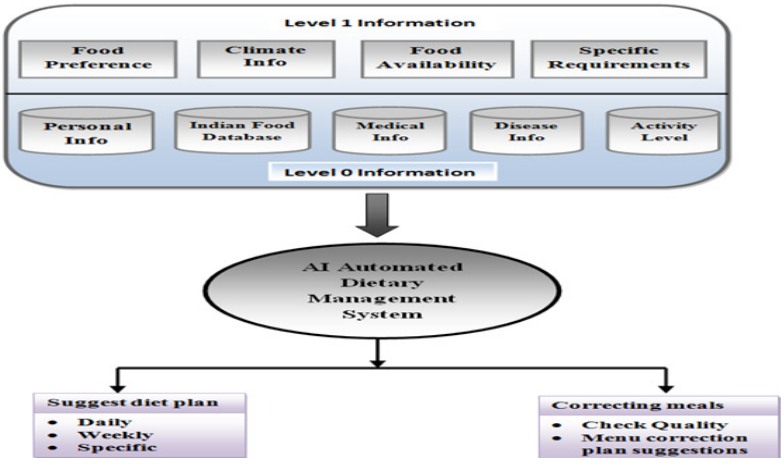

Figure 1: System framework for Menu Planning

4. Methodology used

Decision tree learning is a procedure for calculating the target value having discrete function. The function that has been learned is symbolized by a decision tree. For the inductive inference, decision tree learning is one of the most commonly and broadly used methods which are practical in nature [6][8].

The decision tree learning algorithms are mostly used because of the following three reasons:
1. Decision tree is a good infer from the particular cases that are unobserved instance.
2. The calculations in these methods are efficient and are proportional to the instances that are observed.
3. At the final, the decision tree which is produced is easily understood by the human [5][6].

Here, ID3 algorithm is used for decision tree learning like, which proper food item should be assigned in menu planning. To solve this, the training data is provided to classify the decision tree. Entropy and Information gain factors are calculated over training data [9]. After this, outcome will be derived as negative or positive to a certain conditions.

The problem considered here is to determine whether particular food item to be given to child or not by considering the factors such as food availability, Category of user, Likeness Factor, Overall content of Nutrients. Based on the outcome positive or negative value, one can suggest efficient food to be assigned to child. The ID3 algorithm is used to take proper decision among available foods.

Thus the proper menu planning can be done considering user choices. The outcome will be more accurate, when the training set is larger. As number of possible cases in attributes increases, training set will get increased. Here, the training data set is considered as all the possible cases of each user so that the result is always accurate.

4.1 Implementation

To train ID3 proper set of attributes and output decision is to be provided. For calculations, assumed sample dataset is as shown below in table 1. First, create training data set using following attributes shown in table 1. It classifies database depending on below attributes.

i. Food Item (Milk, Tea, Coffee)
ii. Food Availability(yes, no)
iii. Likeness Factor(low, medium, high)
iv. Category(Underweight, Normal, Overweight)
v. Overall Content of Nutrients(Low, Medium, High),
vi. The outcome class is: Decision (positive, negative).

The following table 1 shows the assumed sample data set of attributes for training ID3 considering only three types of beverages such as milk, Tea, coffee. All the possible cases are shown in this table, when food is available. Same cases will be considered in table, when food is not available. In that case, decision will be no always, if food is not available, no matters what are the other corresponding attributes. In table 1,'--'shows that attribute value can be anything there, but decision will be always 'no', since food item is not available.

For Example:
If food is not available and
If food is any item and
If category of child is underweight or normal or overweight and
If like factor of child is low or medium or high and
If overall content of Nutrients is low or medium or high then
Decision is always "negative".

Table 1: Sample attributes for training ID3

Food Item	Food Availability	Category	Likeness Factor	Overall Content of Nutrients	Decision
Milk	yes	Underweight	low	high	negative
Milk	yes	Underweight	medium	high	positive
Milk	yes	Underweight	high	high	positive
Milk	yes	Normal	low	high	negative
Milk	yes	Normal	medium	high	positive
Milk	yes	Normal	high	high	positive
Milk	yes	Overweight	low	high	negative
Milk	yes	Overweight	medium	high	positive
Milk	yes	Overweight	high	high	positive
Tea	yes	Underweight	low	low	negative
Tea	yes	Underweight	medium	low	positive
Tea	yes	Underweight	high	low	positive
Tea	yes	Normal	low	low	negative
Tea	yes	Normal	medium	low	positive
Tea	yes	Normal	high	low	positive
Tea	yes	Overweight	low	low	negative
Tea	yes	Overweight	medium	low	positive
Tea	yes	Overweight	high	low	positive
Coffee	yes	Underweight	low	medium	negative
Coffee	yes	Underweight	medium	medium	positive
Coffee	yes	Underweight	high	medium	positive
Coffee	yes	Normal	low	medium	negative
Coffee	yes	Normal	medium	medium	positive
Coffee	yes	Normal	high	medium	positive
Coffee	yes	Overweight	low	medium	negative
Coffee	yes	Overweight	medium	medium	positive
Coffee	yes	Overweight	high	medium	positive
--	no	--	--	--	negative

5. Proposed Mathematical Constraints:

Once the food items are filtered from ID3, it is necessary to define Mathematical Constraints for assigning food item in proper portion and considering contents of nutrients available in food items [3]. Suppose daily Calorie intake for a particular child is 'CAL' depending upon child's Activity level and BMR [2]. These numbers of calories will be assigned in different timings such as morning beverages, breakfast, lunch, evening snacks, dinner, etc. Equations are defined as,

Morning Beverages: $a1 + a2 + a3 + ... + an1 = CAL / 20,$
Breakfast: $b1 + b2 + b3 + ... + bn2 = CAL / 5,$
Lunch: $c1 + c2 + c3 + ... + cn3 = 3 * CAL / 10,$
Evening snacks: $d1 + d2 + d3 + ... + dn4 = 3 * CAL / 20,$

Dinner: $e1 + e2 + e3 + ...+en5 = 3 * CAL / 10,$

Such that, $\sum_{i=0}^{n} P[i] \approx 41,\ \sum_{i=0}^{n} C[i] \approx 130,\ \sum_{i=0}^{n} F[i] \approx 25,\ \sum_{i=0}^{n} Ca[i] \approx 400,\ \sum_{i=0}^{n} Ir[i] \approx 26$

Where n1 ,n2, n3, n4, n5 denotes number of food items eaten in different timings such as in morning beverages, breakfast, lunch, evening snacks, dinner, etc.

$a_i,\ b_i,\ c_i,\ d_i,\ e_i$ denotes the calories eaten from different food items 'i' in morning beverages, breakfast, lunch, evening snacks, dinner, etc.

P, C, F, Ca, Ir denotes protein, carbohydrates, fats, calcium, iron getting from i^{th} number of food items eaten in a whole day.

Daily intake of protein, carbohydrates, fats, calcium, iron required for child age group between 7 to 9 years is 41grams, 130 grams, 25 grams, 400grams, 26 grams [4].

6. Results and Discussion

Using ID3 algorithm, it is necessary to decide whether particular food item should be given to children or not. To use ID3, it is important to train it. Following snapshots shows the steps for implementing ID3 in Weka.

Step 1: First of all, import the dataset in table 1 into the Weka tool using Excel Sheet as shown in figure 2(a). Select button visualize all. Figure 2(b) shows overall dataset.

Step 2: Choose ID3 classifier. Select test option, use training set. Click on start. Classifier output is shown in figure 3(a). Error rate is 0, since correctly classified instances are 100%. Once the data set is trained, further it can be used for classification. It shows that ID3 is best for proposed System.

Step 3: Then visualize decision tree generated using ID3.Tree shows, how it divides on sample attributes and take the decisions [9]. In decision tree, yes denotes positive outcome and no denotes negative outcome.

If food is available and child likes it in medium or high portion belongs to any category then only it will be suggested in Menu Plan. UW and OW denotes underweight and overweight in figure 3(b). If food is not available then that case will be rejected as shown in tree.

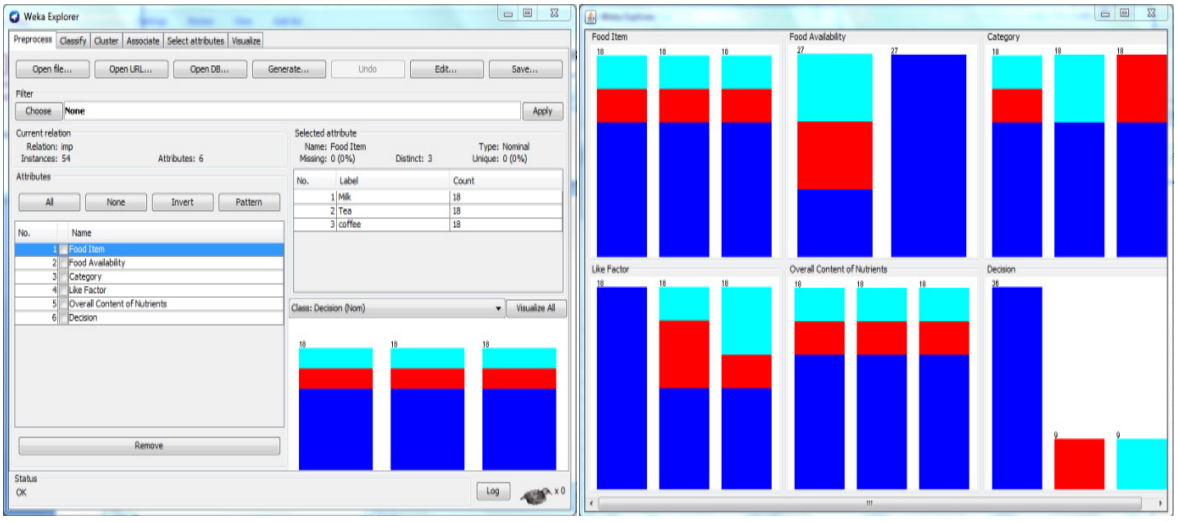

Figure 2. (a) Importing data set into Weka; (b) Overall dataset for ID3

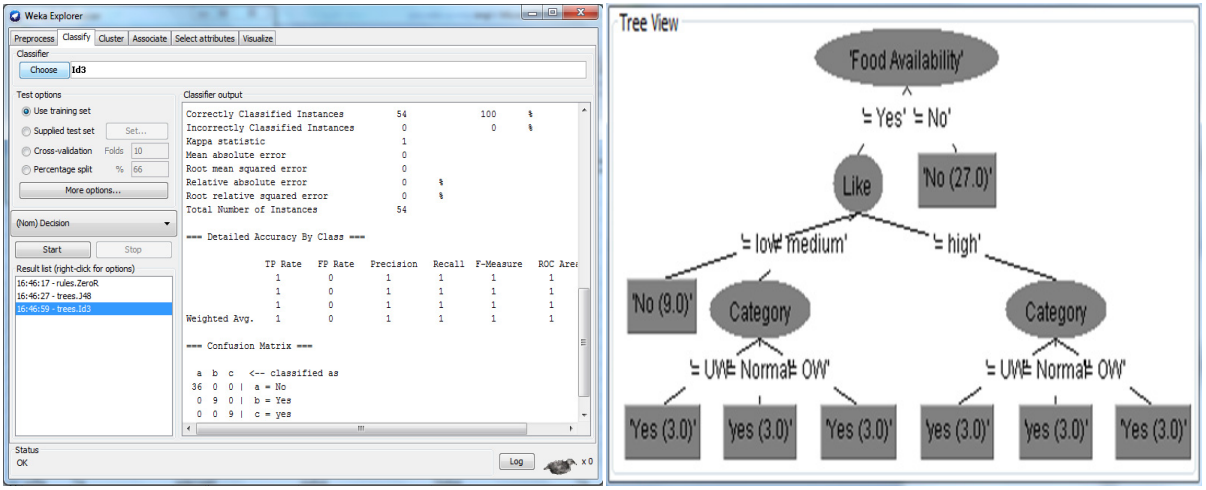

Figure 3. (a) Accurate Classified instances using ID3 classifier; (b) Tree generated using ID3 classifier

7. Conclusion

The importance of nutritional guidance is going to increase day by day from childhood only. Nutrition guidance is carried out by accepting the user's food preferences and user's profile. Typically, balancing the diet requires expert knowledge on nutrition, it is time consuming process. This paper presents the development of automated menu planning system for a nutrition guidance application.

The studies and their implementation conducted here shows that the decision tree learning algorithm ID3 works well on any classification problems having dataset with the discrete values [6]. Related to the proposed research work it concludes that diet plan can be built using ID3 algorithm, as its error rate is zero. It produces proper decision making which food item should be assigned to particular child by considering factors such as their likes, food availability, content of Nutrients, etc. After that it is easy to map daily menu planning for a child, by taking decision about particular food based on proposed Mathematical Constraints. The proposed system will be very beneficial for mothers to take care of her child's health. In future work, all the details of disease, plan to cure that disease along with the diet for all age groups will be considered.

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