Diet Calorie Determination System using Case-Based Reasoning

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Abstract. The balance of food consumption plays a crucial role in the health and quality of metabolism in the body, especially for people with diabetes, because the balance of nutrients in the body is not balanced. But even for healthy people, it is necessary to maintain nutrition in the framework of a healthy lifestyle. To determine a healthy diet is not easy, especially food, which is a source of energy. By building a case-based reasoning (CBR) system, it can solve this difficulty. The flow of this system development includes 4R (retrieve, reuse, revise, retain). The work system of CBR is a new case having similarities with situations that have already existed (previous problems), so the solution has similarities with the earlier issues. The attributes used are age, gender, weight, height, and activity. This system will significantly help the community in determining the right calorie diet so that the body's health is maintained.

1. Introduction

Food is the fulfillment of the most basic needs of life because energy is obtained from food to be able to do daily activities. Foods that contain carbohydrates, fats, and proteins will produce a source of energy. Rice, sweet potatoes, wheat, and cassava will produce carbohydrates. Animal or vegetable, for example, eggs, chicken, tofu, and tempeh, will generate proteins, while avocado oil, cooking oil, olive oil, and so on can produce fat [1]. Fats and carbohydrates are needed by the human body as fuel to obtain energy and heat, which is used to maintain body condition, especially when the weather is cold. Carbohydrates provide most of the strength that the body needs. On average, there are 2100 calories per person of energy per day [2]. Calorie balance is the leading supplier of power required by the body, must be considered. If the amount of calories is excessive, it can cause a variety of diseases, such as coronary heart disease, high blood pressure, and diabetes [3]. One effort to balance calorie needs is to do a diet program.

Diet is a rule of food, specifically for health [4]. The cultural background adopted by specific communities has strongly influenced this type of diet. Although humans are omnivores, a community group usually has preferences or restrictions on certain types of food. Diets can increase the body's metabolism, which can reduce or increase body weight. Diet does not mean that you cannot eat at all, but only limits your calorie intake a little. Your body’s needs must calculate a proper diet. As stated by [5] compiled from various sources, namely [6][7][8][9][10] that the average woman needs an intake of 2000 calories per day, while men need an average of 2500 calories per day. To lose weight, ideally only need to reduce 500 calories every day, so that women need 1500 calories, and men need 2000
calories per day. With a reduction of 500 calories per day, your body weight will decrease by 0.5-1 kg per week. This diet calorie is a unit of the human need for a diet or weight reduction. Meager diet calories are at risk for health, especially if run for more than 12-16 weeks. Running a diet program for more than 12 weeks is not recommended [11].

Balance of food consumption plays a vital role in the health and quality of metabolism in the body. Unhealthy eating patterns, such as eating prepared food or junk food, contain too many calories (unbalanced). It can trigger various diseases, such as cholesterol, diabetes, high blood pressure (hypertension), and so on. For example, diabetes mellitus is a metabolic disorder syndrome that results in abnormal conditions at high blood sugar levels (hyperglycemia). Diabetes management (also known as Sugar Disease or DM) requires sufferers to adopt a healthy lifestyle. This article aims to control diabetes and blood sugar levels and to prevent long-term complications that can be caused by diabetes [12]. Based on this, it is considered challenging to determine the right and fast calorie diet to maintain health according to a healthy lifestyle. A computer-based system can overcome this problem.

Case-based reasoning/CBR is one of the developments in computer software in the field of intelligent systems in addition to Fuzzy Logic, Expert Systems, and Artificial Neural Network (ANN). CBR can identify cases based on existing facts. New problems are solved by reusing solutions that have been used to solve previous problems [13]. The assumptions used are if new cases have similarities with situations that have already existed (past issues), then the solution also has similarities to previous problems [14]. If necessary, solutions are adapted to current facts so that it becomes the right solution to solve the current problem [15]. CBR performs its duties using four cycles, namely retrieval, reuse, revise, and retain or what is known as 4R [16]. Similarity measurement in CBR case representation uses the feature or attribute approach of the case. Aggregation of differences in attributes between two cases will calculate a measure of similarity [17]. Research on CBR has matured as a case-based problem-solving method [18][19]. Therefore, with this CBR, it is expected can help those difficulties in determining the right calorie diet.

Intelligent system technology developed an expert system in 2012 to solve health problems, especially those related to calories for diet. This expert system uses certainty to help determine the daily calorie needs for diabetics [20]. Meanwhile, [21] developed an expert system application for the diagnosis of diabetes mellitus, which was produced later by [22]. A rule-based system for consulting dietary rules for rule-based diabetes mellitus patients was developed by [23]. Reference [24] developed a fuzzy logic-based application to diagnose diabetes mellitus and was further developed by [25].

2. Method

Research data obtained from documents related to the calculation of diet calories. The source of this document is print and electronic media. Some activities carried out in determining diet calories are representing cases, indexing cases, case retrieval, and making case adaptations. Reference [16] has illustrated the process of finding solutions in the CBR method, as in Figure 1. The figure explains, when there are new cases in the form of user conditions that are similar to cases stored in a database (case-based), the system will adapt and compare the suitability or similarity of the solution with the solution stored on case-based. If the answer is suitable, then that solution is the solution to the case.
3. Results and discussion

The variables in this study consisted of input variables, as in Table 1 and the output variable in the form of the number of calories needed per person.

| No. | Variable | Class Code | Variable Type |
|-----|----------|------------|---------------|
| 1   | Age      | 1          | 10-14         |
|     |          | 2          | 15-19         |
|     |          | 3          | 20-24         |
|     |          | 4          | 25-29         |
|     |          | ...        | ...           |
| 2   | Gender   | 1          | Female        |
|     |          | 2          | Male          |
|     |          | ...        | ...           |
| 7   | Activity | 1          | Mild          |
|     |          | 2          | Moderate      |
|     |          | 3          | Severe        |

The data in Table 1 are the basis for developing a CBR system. The CBR system designed contains several relevant pages, namely the main page (Figure 2), the login page (Figure 3), and the consultation page (Figure 4-7).

This CBR system has two groups based on users who can access the system. Both groups are end-users and admins. Besides being based on group access by users, this system consists of two groups of pages that can be accessed. These pages are consultation pages that can be accessed by end-users and admins, and administration pages that can only be accessed by the admin via the login page. The main page is the page that first appears when the application starts. On the main page, there are home, data input (Input Data – in Bahasa), and calorie calculation (Perhitungan Kalori – in Bahasa) buttons, as in Figure 2.
The login page in Figure 3 can only be used by admin or expert to process data masters and food data masters. If there is a new case, the admin can enter data with approval and validation from the expert. Some facilities on this page can be used to manage case-based. Experts can revise, save (retain) or delete the case-based data.

The consultation page, accessed through the "calorie calculation" menu on the main page, is used to enter new cases that will be processed by the system to find the number of calories needed per day according to user needs based on input variables (Figure 4). The solution provided by the system is the number of calories needed and examples of food according to the caloric content (Figure 5-7).

New case entry pages with activity parameters have three choices, namely mild, moderate, and severe (Figure 5). From the three options, the user can choose with his daily activities, and on this page, there is an explanation of what the work is according to daily activities. Age and gender variables are the first factor in calorie calculation because a generation has a different function between children, adolescents, adults, and parents, while gender also determines that women need fewer calories than men.
After the user enters the required parameters, the system will provide information on the number of calories needed and any food solutions that match the number of calorie calculations, as in Figure 6. Examples of these food solutions for one meal a day are divided into several groups. If there is an unwanted food in the solution, users can look at the bottom of this page. In this section, there is a list of exchange foods for each calorie needed by each person (Figure 7). Fig. 7 is a page listing the exchange of food items and is divided into each group to be a food solution.

Figure 5. Display of new case entries for activity parameters

Figure 6. Display of results the number of calories per person
Case-based stored some similar cases recommended to users of the results of the calculation of the number of calories needed. After getting a similar case search based on the selected root node, it does the similarity calculation. By tracing a similar case with comparing the input value with case-based will result in the same situation. The data in Table 2 is a new case as test case data.

Table 2. New case

| Input Variable | Item of Input Variable | Item Class of Input Variables |
|----------------|------------------------|-------------------------------|
| Age            | 29                     | 20-59                         |
| Gender         | F                      | F                             |
| Pregnant       | Yes                    | Yes                           |
| Breastfeeding  | No                     | No                            |
| Weight         | 65                     | 62-100                        |
| Height         | 165                    | 165-200                       |
| Activity       | Moderate               | Mild                          |

From the input entered by the user, the next process is to calculate a similar variable from the base of the case based on the root node selected by the system. Table 3 presented the results of calculating related variables.

Table 3. Results from similar case searches based on a new case

| No. | Age (year) | Gender | Pregnant | Breast-feeding | Weight (kg) | Height (cm) | Activity | Solution |
|-----|------------|--------|----------|----------------|-------------|-------------|----------|----------|
| 1   | 29         | F      | Yes      | No             | 62-100      | 165-200     | Mild     | 2535     |
| 2   | 16         | M      | No       | No             | 50-53       | 153-155     | Mild     | 2500     |

The next step is to calculate the number of input similarities by comparing inputs with the results of calculating similar variables. A similar case will give value 1. Otherwise, it will provide a value of 0, then the calculation of the total number of similarities will be calculated. Similarity calculation between new cases and cases stored in the case-based used equation 1. Table 4 presented the results of
the similarity calculation. While the comparison between the original case with case-based to produce similarity values given in Table 4, is shown in Figures 8 and 9.

\[
similarity(e, e_i) = \frac{\text{common}}{\text{common + different}}
\]

(1)

**Table 4. Calculation of similarity**

| No. | Age (year) | Gender | Pregnant | Breastfeeding | Weight (kg) | Height (cm) | Activity | Number of similarity | Similarity | Solution |
|-----|------------|--------|----------|--------------|-------------|-------------|----------|---------------------|------------|----------|
| 1   | 1          | 1      | 1        | 1            | 1           | 1           | 0        | 6                   | 0.857      | 2835     |
| 2   | 0          | 0      | 0        | 1            | 0           | 0           | 0        | 1                   | 0.143      | 2500     |

**Figure 8.** Comparison of the new case with case-based for data 1

**Figure 9.** Comparison of the new case with case-based for data 2

According to Figure 8 and 9, case similarity calculations can be calculated using the equation one as follows:

Data 1:

\[
similarity(e, e_i) = ((1+1+1+1+1+1))/((5+2)) = 6/7 = 85.7%
\]

Data 2:

\[
similarity(e, e_i) = ((1))/((5+2)) = 1/7 = 14.3%
\]

Based on these calculations, the system will display the highest value of all existing data on a case-based, which is 85.7%, then the value is used as a solution candidate for the given problem, namely 2835 Kcal. In Figure 7, the calories that are the solution to the needs of each person have a food solution as indicated by several examples of food exchanges which are divided into seven groups as follows:

- group 1: food ingredients as a source of carbohydrates
- group 2: food ingredients as a source of animal protein (low fat, medium fat, high fat)
- group 3: food ingredients for vegetable protein
- group 4: vegetables
- group 5: fruit and sugar
- group 6: milk
- group 7: oil and fat

As consideration, that some preliminary studies conducted by [26] stated that a low-calorie diet and metformin could reduce weight higher than a low-calorie or metformin diet in obese patients and [27] have developed a decision support system to calculate calorie diet values for diabetics. This research was conducted to determine the amount of calorie intake per day for people with diabetics to make it easier for diabetes to regulate their diet so that the threat of a drastic increase in blood sugar could receive them. Otherwise, reference [28] have also conducted research that refers to calorie labels influenced by various foods for diet, but not for free diets. The results show that the rush to provide calorie information does not prove to be the best approach to combat the obesity epidemic. Determination of the menu of healthy food in people with diabetes mellitus using an expert system has also been developed by [29].

4. Conclusions
A system of determining a calorie diet per day has been developed using Case-Based Reasoning. This Case-Based Reasoning system is a system that can decide diet calories for each person per day with similarity values based on case-based. The number of cases that are on a case-based will make the system better in conducting case searches. Researchers can develop this CBR system into an online system so that it can be utilized further wherever and whenever it is needed.

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