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A Rule-Based Expert System for Efficient Food Planning and Consumption

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Abstract
Proper food planning is essential to consume nutritious food that keeps people healthy. Hygienic food offers a favorable existence that helps us to cut the chance of illness and to save time in selecting food. Food planning may ensure a new way to change our buying nature as well as bring variation in our food consumption. Selecting the right food at the right time is necessary. This paper presents an expert system that is intended to select the right food for the right meal for any age people. The expert system also suggests the amount of energy in Kcal required per day. We use rule rule-based expert system to carry out the system. The knowledge base, inference engine, and user interface are combined to give the service. This system helps us to cut the amount of food wastage as well as gives the proper nutritious diet.

Keywords: Expert System, Inference Engine, Rule-based System.

1. Introduction

Expert systems were introduced in the 1970s. They are an affiliate of artificial intelligence (AI) that uses knowledge specialized for a definite difficulty realm to unravel a realm at the equilibrium of a human expert. The expert system consists of the components −Knowledge Base, Inference Engine, and User Interface. The knowledge base gathers knowledge from a human expert. Inference Engine recommends a solution by forward and backward chaining and the user interface provides service to the user. The user may or may not be an expert.

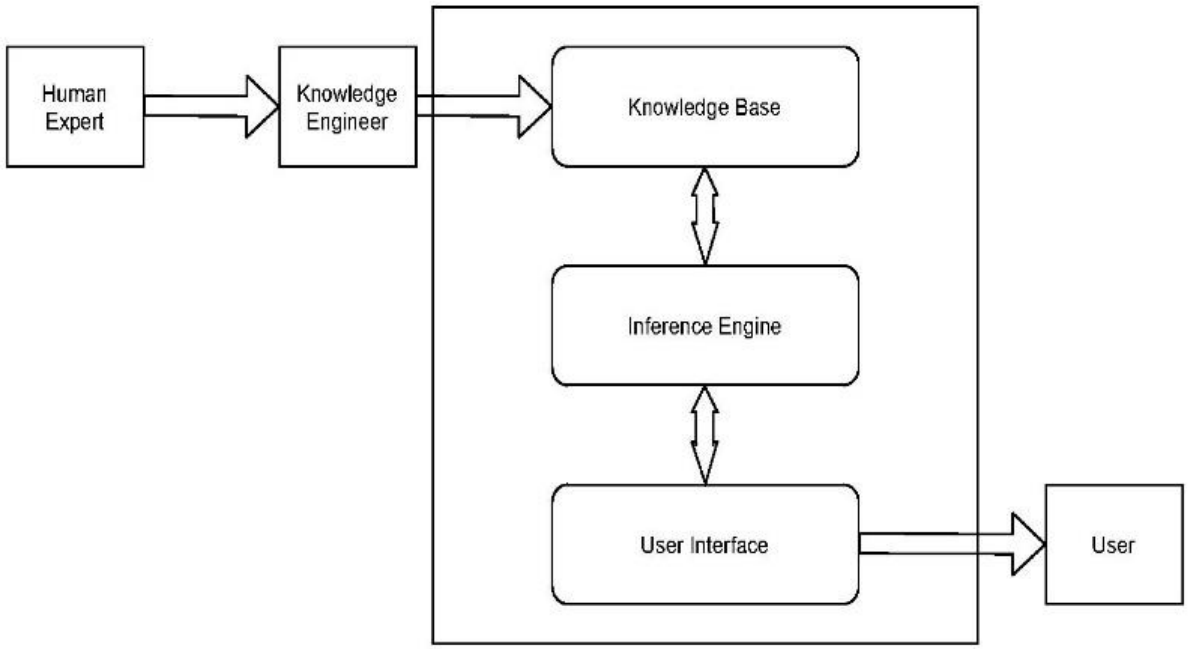

Figure 1. Components of the expert system.

Expert system have already given their expert services successfully in various fields, some examples of early successful expert systems [1] are

- MYCIN: bacteria that could reason for exquisite taint are identified by this expert. Based on the patient weight MYCIN recommends drugs to the patient.
- DENDRAL: used for discovering molecular formation of material through chemical inquiry and by using spectrometry.
- PXDES: used to portend the rate and type of cancer in the lung.
- CaDet: Used to figure cancer at an erelong period or before cancer occurs.

Hayes-Roth divides expert systems applications into 10 categories [2] (a) Interpretation. (b) Prediction. (c) Diagnosis. (d) Design. (e) Planning. (f) Monitoring. (g) Debugging. (h) Repair. (i) Instruction. (j) Control. Among these categories, our proposed expert system belongs to the "planning" application. Our expert system intends to offer strict planning of repast for people of various ages according to their needs. To offer these services, we have classified ages through a certain range. We have proposed our system with the following features:

- Opportunity to select food for various meals.
- Opportunity to select food according to age.
- Separation of baby's food from aged people.
- Give the amount of energy (Kcal) needed by a person per day.

This paper is divided into five sections, section two reflects the contribution involved in the related work, and section three provides the working principle in detail of our method. In section four result and related discussion with some demo output is provided, and section five provides the conclusion of this article.

2. Related Work

The authors of paper [3] present a nutrition expert system for children that allows the users to choose a nutrition plan for their children. The system considers several factors such as activity level, age, gender, and health condition of a child to give a perfect level of nutrition for children. Therefore, the system is limited only for children but the expert system provides a proper nutrition plan for children. In paper [4], the authors worked on a project to develop an online-based expert system for nutritious food monitoring and menu planning. Several factors are considered by the expert system to make an ordinary menu as well as a drug menu for various illnesses. The factors that are considered by the system include age, gender, and condition of illness. The authors of the paper [5] introduced an expert system based on mobile. The expert system uses an optimum neighbor for ingestion planning. This expert system uses an excellent method with lightweight and simple procedures to offer the consultation of nutrients for ill people. The version of the software is offline to give service when no internet connection is available. The Android Platform is used to implement the system. The authors of the paper [6] developed an expert system that solves the difficulty of feeding the minor kid. The author of the paper [7] proposed an expert system for an intelligent home to optimize food consumption. Fulfilling the operation of the rational refrigerator process is the main target of this expert system. To cut the food cost and to provide nutritious service through the optimization of food, consumption is the primary objective of this project. Invest in an expert system developed to boost commit pecuniary reasoning. Which is described by the authors of the paper [8]. The aim of the paper [9] was to develop an expert system to provide service to the type 2 diabetes patient. It offers auto counseling so that a patient finds an exact quantity of regular calories with accurate ingestion. The limitation of this paper is that it works only for patients with diabetic type 2. In paper [10] the purpose of this system is to make a process that can learn itself from the datasets. The system is implemented by using deep learning. A model is developed that may learn itself by rearing several images and resembling data. After building a proper model the model needs to be trained so that it may auto-learn itself as sharply as possible like an expert human driver. The goal of the paper [11] was to develop an expert system for older adult people. The diet and nutrition of older adults are sensitive therefore much effort should be taken for their nutrition strait. The system is limited only to older people which is one of the disadvantages of this expert system.

3. Proposed Method

In this section, we have discussed the method of our implemented system. We have painted this system to provide the facility to pick proper and alimentary food for any meal by people of any age. We have classified the proposed method section into four parts. Firstly, we have mentioned the working principles, here we have discussed the knowledge base as well as the process of our system. Secondly, we have discussed the basic rules of our system and the result with the inference of the rule. Thirdly we have drawn the pseudocode. Finally, we have discussed the implementation process.

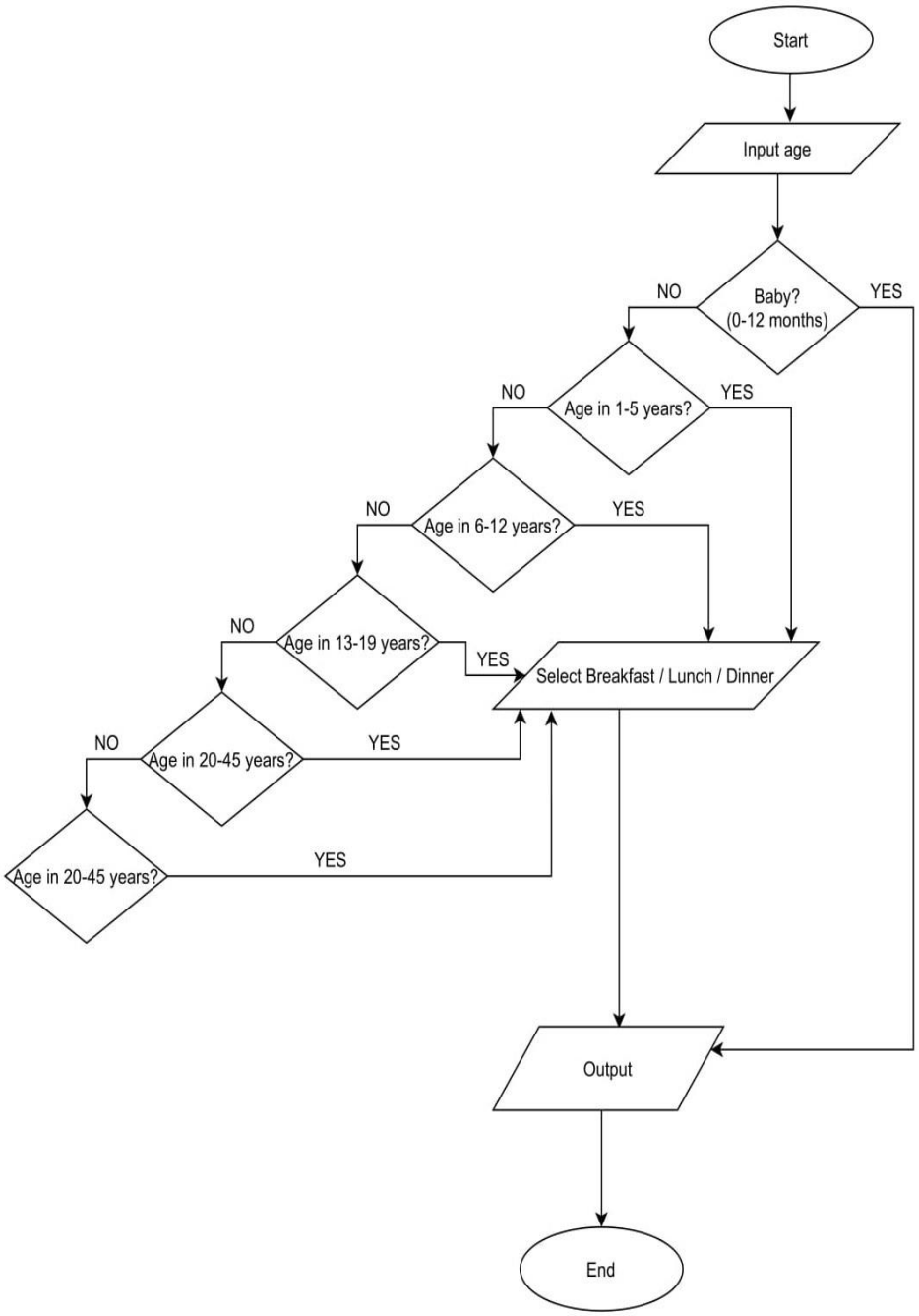

Figure 2. Working flow chart of our method.

A. Working Principles

A knowledge base integrated with a composition of facts, rules, and ways organized into a design. Knowledge of the knowledge base is gathered from any human expert. Knowledge is either declarative, procedural, or metaknowledge. Human experts generate a collection of rules and facts are put together to form the knowledge base. Rules typically work on the process of the IF-THEN structure.

IF <antecedent>
THEN <action>

In our expert system first, we take age as input, and according to the age we have built our knowledge base, as same as any other knowledge base on an expert system it works on the process of the IF-THEN structure. The input age is classified in the following way:

•**Baby:** Foods that normal people consume are not as same as the foods that are fed to a baby. Baby's foods are sensitive, hence we have separated them into a separate sections. Age from 0-12 months here we consider as a baby. Efficient food chart gathered from [12]

- **Kid:** Age from 1-5 years is classified into kids here. Total average nutrition required: 600-800KCal on a day for any people whose age is 1-5 years. We offer three necessary meal items for any Kid and give the freedom to choose any meal.
- **Children:** Age from 6-12 years are classified into Children here. Total average nutrition required: 1000-1600 KCal on a day for any people whose age is 6-12 years. We offer three necessary meal items for any Child and give them the freedom to choose any meal.
- **Teenager:** The age from 13-19 years is classified into Teenagers here. Total average nutrition required: 1800-2000 KCal on a day for any person whose age is 13-19 years. We offer three necessary meal items for any Teenager and give them the freedom to choose any meal.
- **Young adult:** The age from 20-45 years is classified as a Young adult here. Total average nutrition required: 2200-2800 KCal on a day for any people whose age is 20-45 years. We offer three necessary meal items for any Young adult and give the freedom to choose any meal.
- **Older adult:** Age from 45-above years is classified as Older adult here. Total average nutrition required: 2000-2400 KCal on a day for any people whose age is 45-above years. We offer three necessary meal items for any Older adult and give the freedom to choose any meal.

Table 1. Category of ages in our expert system.

AGE	NAME	Total Kcal/per day
1-5 years	Kid	600-800
6-12 years	Children	1000-1600
13-19 years	Teen ager	1800-2000
20-45 years	Young adult	2200-2800
Up to 45 years	Older adult	2000-2400

B. Inference Mechanisms

After the establishment of the knowledge base and according to the choice of the user, the inference engine and the user interface combine to give the proper results to the user. The inference engine matches the rules from the knowledge base and provides the solution. A simple block diagram for the inference engine procedure is given below.

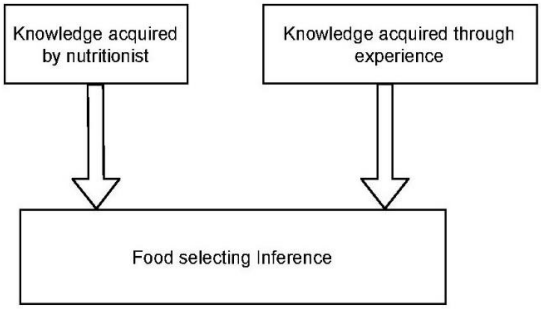

Figure 3. Inference engine procedure of the system.

The production rules of the system are held by the long-term memory of the knowledge base and the facts are held by the short-term memory. In figure-4 a production rule of our system is shown on the knowledge base and this is known as long-term memory, this block is responsible for holding all the production rules (Rule1, Rule2, . . . , RuleN). The facts are held by the fact-base and this is known as short-term memory, this block is responsible for holding all the facts (fact1, fact2, . . . , factN).

The inference engine tries to match the fact with the antecedent of the long-term memory and when matching takes place the long-term memory fires the action to the certain fact or facts of short-term memory. Inference engines use an inference chain as well as an inference engine cycle to establish a match-fire procedure. A simple inference engine cycle for a match-fire procedure is given in the figure-4 and how the inference engine chain works on an expert system is illustrated on the figure-5 through some arbitrary rules.

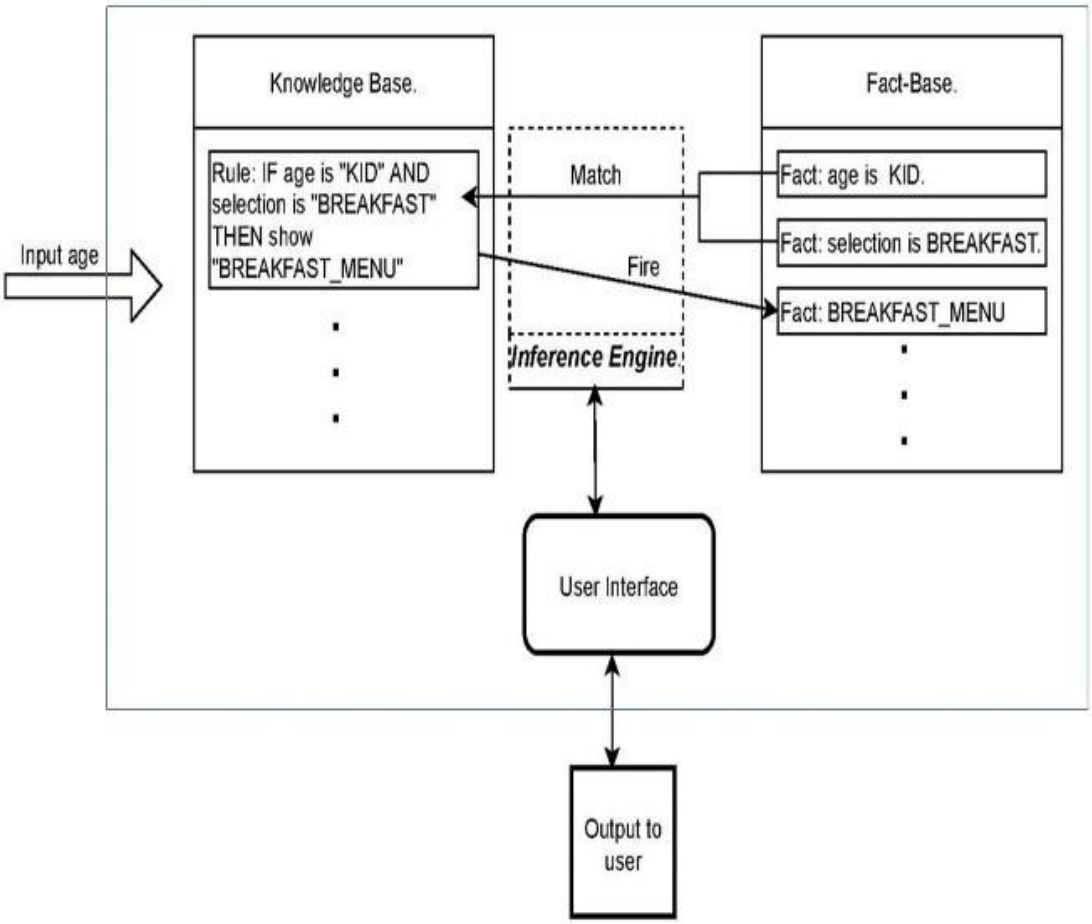

Figure 4. A simple inference engine cycle of our system.

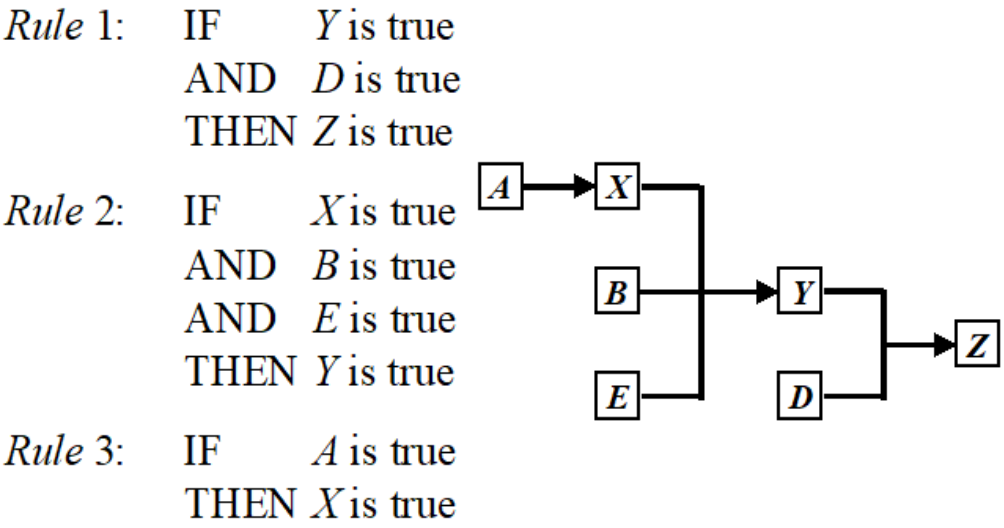

Figure 5. Illustration of an inference engine chain.

C. Pseudocode of our procedure.

The entire procedure of our food-selecting expert system is summarized in the given pseudocode. The pseudocode is written from the working flow chart given above.

1. *Start the procedure.*
2. *Input age.*
3. *IF "Baby"*
(A) YES
- *Go to step 9*

(B) NO
Go to step 4
4. *IF "Kid"*
(C) YES
- *Show total nutrition required per day.*
- *Select breakfast / Lunch / Dinner*
- *Go to step 9*

(D) NO
Go to step 5
5. *IF "Children"*
(E) YES
- *Show total nutrition required per day.*
- *Select breakfast / Lunch / Dinner*
- *Go to step 9*

(F) NO
Go to step 6
6. *IF "Teen ager"*
(G) YES
- *Show total nutrition required per day.*

- *Select breakfast / Lunch / Dinner*
- *Go to step 9*

(H) NO

Go to step 7

7. *IF "Young adult"*

(I) YES

- *Show total nutrition required per day.*
- *Select breakfast / Lunch / Dinner*
- *Go to step 9*

(J) NO

Go to step 8

8. *IF "Older adult"*

(K) YES

- *Show total nutrition required per day.*
- *Select breakfast / Lunch / Dinner*
- *Go to step 9*

(L) NO

Go to step 1

9. *Show Result.*

10. *End procedure.*

D. Implementation.

We use rule rule-based expert system to implement our food-selecting system. Rule-based systems or expert systems are also sometimes called production systems. A details explanation of rule rule-based expert system can be from the article [13]. Why is a rule-based system used to implement the system? The answer is-we can apply rule-based system to make any system automated simply by using a set of facts, a set of rules, and a termination criterion. The main reason that makes rule-based expert systems an important branch of AI is that they can provide the human equivalent serving through simple rules known as IF-THEN rules or production rules

IF X THEN Y

which is also equivalent to:

$$X \Rightarrow Y.$$

Any part of the rule-based expert system can be designed straight away by the rule $X \Rightarrow Y$.

4. Result and Discussion

This scheme is designed through rule rule-based system. Baby's food is separated as they are different from the foods of normal people. When we start our system, it recommends us to enter symbol (e) for the baby's food. The system displays all the nutritious food that a baby may consume. A baby age less than 6 months needs only Breast milk or formula and we suggest four meals including breakfast, Lunch, Snack, and Dinner for the age greater than 6 months. We suggest different items of food for different meals for ages from 6 to 9 months and suggest different items of food for different meals for ages from 9 to 12 months. A paradigm output is shown in the figure below

```
1 ?- start.
age?[for 0-12 Months Enter e]: e.
Sample Meals for Baby: <= 6 months of age
         .Breast milk or formula

 Sample Meals for Baby: 6-9 months of age
 Mealtimes                       Sample Meals
-----------                      ------------
Breakfast                  .iron fortified infant cereal
                           .strawberries, mashed or cut-up
                           .water in a cup

Lunch                      .chicken, minced or chickpeas, mashed
                           .cooked sweet potato, mashed
                           .water in a cup

Snack                      .pear, mashed

Dinner                     .ground beef or lentils
                           .brown rice
                           .cooked broccoli, mashed
                           .water in a cup

 Sample Meals for Baby: 9-12 months of age
 Mealtimes                       Sample Meals
-----------                      ------------
Breakfast                  .iron fortified infant cereal
                           .kiwi, chopped
                           .water in a cup

Snack                      .whole wheat toast with thinly spread peanut butter, cut into strips

Lunch                      .canned salmon, mashed
                           .cooked carrot, chopped
                           .avocado, chopped
                           .yogurt
                           .water in a cup

Snack                       .whole grain crackers

Dinner                     .chicken, chopped
                           .brown rice
                           .cooked green beans, chopped
                           .cantaloupe, chopped
                           .water in a cup

Yes
2 ?-
```

Figure 4. A simple output for baby's food.

Any age greater than 1 year is classified into Kid, Children, Teenager, Young adult, and Older adult In all these cases after the input ages are taken the system gives the name of the group it belongs to and the total average energy required per day for any normal person of that age. After that we need to select any meal, For any of these categories, we have three meals to suggest-breakfast, Lunch, and Dinner by selecting any meal we can see the nutritious food and energy belonging to each food. A demo output is shown in the figure below.

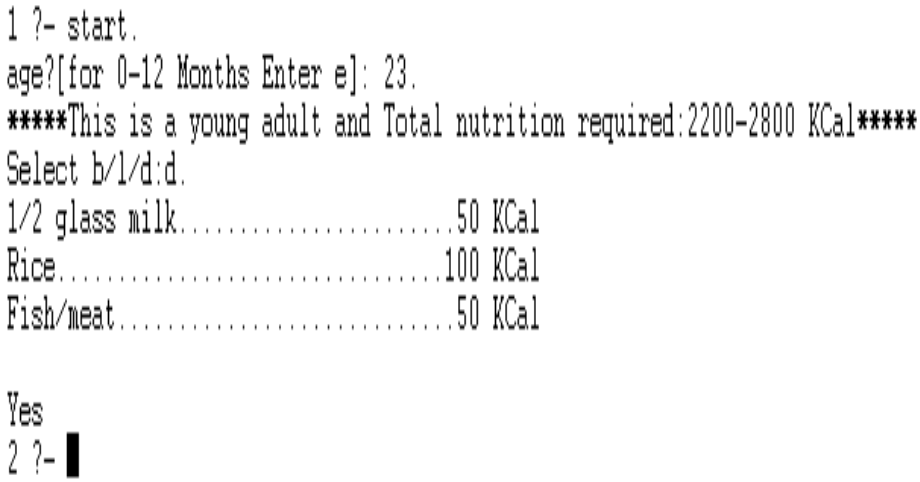

Figure 5. A demo output for a young adult.

The expert system is more diverse than other existing expert systems in the way it suggests food as well as required energy for any age. The existing food-selecting expert system suggests food for a particular age like children, diabetes patients, or older people but our system combines all ages.

5. Conclusion

In conclusion, this research introduces a comprehensive and versatile rule-based expert system for food planning, addressing the nutritional needs of individuals across all age groups from infancy to 45+. By combining a knowledge base, inference engine, and user interface, the system not only streamlines food selection but also provides personalized recommendations for daily energy intake. The approach contributes significantly to reducing food wastage and promotes healthier dietary choices. Unlike existing systems catering to specific age groups, our diverse expert system offers a unified solution for a wide demographic. This innovation marks a significant step forward in enhancing the efficiency of food planning, fostering a positive impact on public health and well-being.

6. Conflict of Interest

The authors declare they have no conflict of interest regarding publishing this paper.

7. Acknowledgement

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