NUTRITION DIET PROGRAMME - AN EXPERT SYSTEM

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Abstract

With advances in modern medicine, it is being increasingly realised that therapeutic diet planning is as important as the medical treatment of diseased patients-both acute and chronic. The patient is advised a specific intake of different nutrients, which have to be converted into exact quantities of food items of the patient's personal choice. This process involves the prescription of various nutrients and modifying them according to conditions of obesity index, disease etc. Given the different nutrition values of various food items, matching of prescribed nutrients becomes an operational research problem. The conversion of food items into a menu of dishes requires heuristic rules and reasoning. This paper describes the development of an Expert System, the Nutrition Diet Programme (NDP) for therapeutic meal planning, which incorporates mathematical programming, databases, knowledge bases and expert systems techniques. The importance of such a comprehensive customised diet planning system need hardly be emphasized, particularly in view of large rural population with no access to medical help, as well as the wide spread food habits in different regions of the country. The design of NDP system, currently under DOS, is highly open ended and with little effort it can be ported across platforms as well as to countries.

Introduction

Recent advances in medical sciences have revealed the importance of therapeutic diet planning as an important tool that helps in faster convalescence, and in some cases even arrests the progress of the disease. Alongwith proper medical treatment, the patient needs to be advised on the kind of food which provides him/her the **essential nutrients** specific to his/her disease. At the same time the diet should result in appropriate menus in order for it to be useful in practice to the patient. Every individual is normally used to a particular subset of foods from the large number of available food items. With all the limitations imposed by a particular disease and the requirements of nutrients, matching of the prescribed nutrients with appropriate quantities of food items, duly converted into proper dishes is a challenging task. This has resulted in the dieticians being forced to estimate and generalize their prescription of diets. Exact quantities of food items cannot thus be prescribed with the traditional methods of estimation. The complexity of the problem, even from the view point of arithmetic calculations, can be gauged from the fact that the **Recommended Dietary Allowance (RDA)**, which gives the daily intake of 16 essential nutrients, varies significantly from person to person depending upon the physical constitution, type of work habits, age, sex, obesity index etc. The RDA gets further modified depending upon the type of disease one is suffering from. It is mostly the expert rules which operate at this stage. The nutrients recommended after all these considerations have now to be matched with the food items which the patient is normally used to eating. It is not uncommon in practice to see the doctors prescribing what not to eat, rather than recommending the exact items matching the patient's choice of dishes. The need for customised therapeutic meal planning is thus obvious. The **Nutrition Diet Programme (NDP)** is an **expert system** which incorporates mathematical programming, databases, knowledge bases and expert systems techniques. The NDP does not aim at replacing the dietician or the medical doctor; but it aims at providing their expertise to a paramedic or a less qualified medical attendant to help the rural population who do not have access to such expertise.

NDP System

The NDP has been designed to handle large volumes of data both in numeric and heuristic rule form. There are over 500 different food items falling under 13 broad categories of foods namely, cereals, pulses, leafy vegetables, milk and milk products, oil and fat, fruits, meat and poultry, etc. For each of these, the amount of nutrients present per hundred grammes of food are indicated in the tables provided by the National Institute of Nutrition, Hyderabad. These include calories, proteins, fat, calcium, iron, phosphorous, vitamins, etc. In addition to this large database, the system also stores the RDAs for different groups of individuals depending upon age, sex, work groups and regional food and dietary habits. For specific diseases additional parameters which modify the RDAs, and are not

necessarily mathematical rules, have to be stored. These rules are mostly in the form of heuristic rules suggested by the expert dieticians.

The system has been developed on DOS platform, with Prolog from Logic Programming Associates as the development vehicle. Facts, such as nutrients in food items and rules, in both numeric as well as heuristic form, can be conveniently expressed in this language. The mathematical programming techniques, in particular, the OR Linear Programming package (LP88) can be easily interfaced with Prolog. The NDP, in its present form, already includes the database on about 575 food items, 200 common diseases prevalent in India, arithmetic calculations, LP88 interface and the necessary heuristic rules.

The NDP aims at delivering a complete customised diet plan for the patient. For this purpose, details about the patient have to be entered into the system. This process has been divided into two parts, one of which is the fixed information about the patient such as personal details like age, height, sex, type of work etc. These can be entered into the system through an appropriate form displayed at the time the consultation session begins. All the dynamic parameters about disease etc., are entered through appropriate queries generated by the system. It is this **user interface** which increases the level of cooperativeness between the patient and the NDP user. Query the User (QtU) techniques of Prolog have been used for the user interface.

Once the primary inputs on the patient have been entered into the system through the form, NDP retrieves the appropriate RDA which gives a daily intake of 16 essential nutrients prescribed in the table. The system then queries the user as to the disease of the patient, by grouping the diseases into disorder category and the list of diseases into the relevant category. The inputs provided by the user modify the RDA for the specific type of disease selected. The obesity index of the individual plays an important role since it influences the total calorie and fat intake. It is at this stage that the patient is asked to provide his preferred food items and eating habits. The interplay of these and the heuristic rules shapes the construction of a batch file which forms the input to the LP88 package. The system takes the RDAs and the food items as the input and comes out with appropriate quantities of food items taking into consideration the constraints. Simple methods of linear programming and more sophisticated goal programming have been used to modify the quantities of food items. Further, at this stage either the solution is found to be feasible or infeasible. In the case of a non-optimal solution, the heuristic rules regarding the importance of main nutrients like calories, fats and proteins enable the system to modify the non-optimal solution in some ways so as to reach a partially optimal solution. The expert rules, however, ensure that the other nutrients are not grossly violated.

The next task of the system is to try and fit the quantities of different food items into appropriate dishes such that they conform to patient's eating habits. At this stage some other heuristic rules in the form of food exchange tables also come into play. The final output of NDP consists of three different parts: (1) A daily menu for seven days with food table so that the user can readily interchange the contents of his/her dishes. (2) A list of food restrictions as to the foods which are strictly forbidden. (3) In case of any excess of calories coming out of the solution, a recommended list of exercises.

Conclusion

It may be pointed out that in India, which is like a subcontinent of 25 states, the eating habits and dishes prepared are very large in number and result in a complexity which might equal that posed by the whole of Europe. In the first instance we are endeavouring to cater to the needs of patients in 58 districts spread over 10 states. We propose to eventually make NDP available on computer systems already installed by the National Informatics Centre (NIC) in all the districts of the country for consultation by doctors and paramedics. A number of modern hospitals in cities like Bombay and Delhi have also expressed a desire to install and experiment with the NDP, besides the National Institute of Nutrition, Hyderabad.

There are many avenues open to improve the system or to modify for other environments. New ideas evolving from the system, such as the user feedback facility, can be used to enhance the knowledge base of the NDP based on the queries of the user. The package can be easily ported on to other computer platforms using different versions of Prolog. It can also be easily tailored to the requirements of various countries by suitably enhancing the database on their respective dishes.

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