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期刊简介：本刊供我国高技术研究人员及时发表其研究成果和进行国内、国际学术交流的园地，旨在促进我国高技术研究的发展和扩大其在国内外的影响。内容涉及生物、计算机、电子与光电子技术、现代通讯、自动化、机器人能源、新材料、海洋及其它高技术领域，主要读者对象是科研院所研究人员、科技管理人员、大专院校师生及大中型企业科研人员。

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Daas:A Web-based System for User-specific Dietary Analysis and Advice for the Public Healthcare Domain

Deirdre Nugent, Kudakwashe Dube, Wu Bing (Computer Science Department, School of Computing, Dublin Institute of Technology, Dublin, Ireland)

This paper presents a Dietary Analysis and Advice System (DAAS), a web based system for providing, within the public healthcare dom ain, user specific diet advice based on a preliminary analysis of current diet or eating habits and lifestyle, using knowledge from domain exp ertise and experts' interpretation of national dietary guidelines.

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DAAS: A WEB-BASED SYSTEM FOR USER-SPECIFIC DIETARY ANALYSIS AND ADVICE FOR THE PUBLIC HEALTHCARE DOMAIN

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ABSTRACT

This paper presents a Dietary Analysis and Advice System (DAAS), a web-based system for providing, within the public healthcare domain, user-specific diet advice based on the preliminary analysis of the current diet or eating habits and lifestyle, using knowledge from domain expertise and experts' interpretation of national dietary guidelines.

KEYWORDS: web-based system, diet and nutrition, production rules, public healthcare

INTRODUCTION

Guidelines on diet for the public have been developed but largely remain paper-based and difficult for administrators to disseminate and for the population to access. The easy dissemination and availability of this type of information would allow people to take charge of their own dietary health. This could be achieved by developing a system, which will: 1) elicit dietary and lifestyle information from a user; 2) analyse this information; 3) determine the appropriate advice to give to the user with respect to diet and lifestyle improvements. The *Dietary Analysis and Advice System* (DAAS) is designed to: 1) capture diet and nutritional domain knowledge; 2) use a knowledge representation formalism to capture and exploit the knowledge in analysing a user's diet and lifestyle; 3) generate the relevant advice; and 4) present the advice to the user using a web-based mechanism. Existing systems require the user to have some knowledge of, or training in, diet and nutrition. DAAS aims at providing and environment that is easier to use for an untrained member of the public. The rest of this paper is organized as follows: Section 2 outlines the background and analysis of the problem; Section 3 presents the domain requirements with focus on diet analysis and advice determination; Section 4 presents the technical solution to the problem; Section 5 presents the conceptual approach and modeling of DAAS; Section 6 presents the DAAS graphical user interface; Section 7 outlines related work; Section 8 outlines future work and, finally, Section 9 summarises and concludes this paper.

BACKGROUND AND PROBLEM

There is a lack of public awareness regarding what is a healthy diet for an individual. There is also a lack of easily accessible diet advisory services and tools. The aim of this work is to investigate the problem of using a computer-based approach in order to give dietary improvement or adjustment advice, which is specific to the individual using the system. As illustrated in Fig. 1, the problem is as follows: 1) the system needs to acquire dietary information from the user; 2) this information is then mapped onto an internal model of a diet; 3) this mapping results in the generation of dietary advice; and 4) the advice should then be presented back to the user.

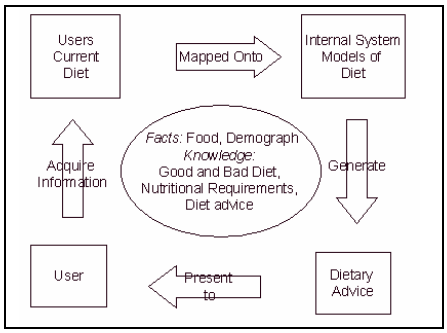

Fig. 1 Problem model

The system needs to have 1) facts relating to user's current diet and lifestyle; 2) knowledge about an adequate and healthy diet; 3) knowledge about the effect of lifestyle on a diet; and 4) knowledge about the relevant dietary advice.

REQUIREMENTS

(1) Dietary Analysis

There are a number of different methods used by dieticians to assess a person's diet. They all take account of what a person eats, compare this to a healthy diet, and advise the patient regarding what their diet should be. The model used as the basis for a healthy diet is based on a food guide [1]. As illustrated in Fig. 2, the core recommendation is commonly expressed as a *food pyramid.*

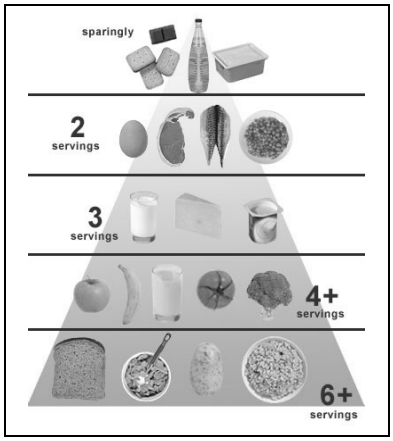

Fig. 2 The Irish food pyramid

The general guideline is to consume large amounts of grains, vegetables, and fruits with moderate intake of meat, milk and dairy products. In DAAS, the food pyramid is converted into a set of rules, which are used to analyse the users diet [2].

(2) Dietary Advice

DAAS advises a user regarding three aspects of their diet. 1) Their adherence to the food pyramid rules, 2) Their weekly consumption of alcohol, and 3) The nutritional content of their daily diet. The knowledge base contains the guidelines regarding each of these areas as rules in the rule base. The users' diet triggers these rules and advice is generated specific to the user and their diet. This advice is presented to the user as messages pertaining to the various aspects of their diet.

APPROACH

The technologies used in DAAS are illustrated in Fig. 3.

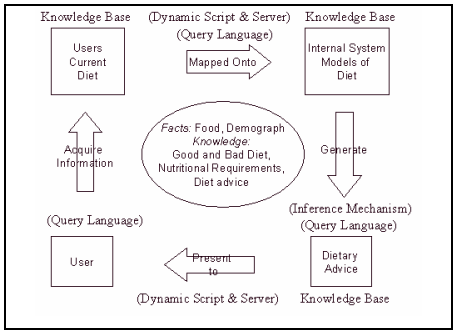

Fig. 3 Problem model with enabling technologies

The system acquires dietary information from the user via a web page. A dynamic scripting language with a query language is used to facilitate communication with the knowledge base. Using the same query and dynamic scripting language, and via a web server, the users diet is mapped onto an internal diet model (the food pyramid) which is stored in the knowledge base. This information triggers the rules in the knowledge base, which generates advice to be presented back onto the web site. A relational database is used to store food and nutritional facts as well as advice messages.

MODEL AND ARCHITECTURE

(1) Knowledge Model

The production rule formalism is used to represent the diet analysis and advice knowledge. The Irish Food Pyramid [2] is encoded into a set of production rules. The rule presented in Fig. 4 models this advice (#C1 is the number of portions from category 1 consumed).

```
If #C1 > 6
 You are getting more than the accepted maximum
Else if #C1 < 6
 You are getting less than the recommended amount
Else if #C1 = 6
 You are getting the correct amount
If #C1 <= 4
 You are getting less than the accepted minimum
```

Fig. 4 Sample rule

The rule illustrated in Fig. 4 is explained as follows: If the number of servings per day of category 1 is greater than 6, the relevant message is retrieved from the database i.e. that the user is getting more than the recommended amount. If the number of servings is less than 6, the user is told they are getting less than is required. If the number of servings is 6, they are told they are getting the correct amount. 4 or less servings per day is designated as less than the accepted minimum. All the advice regarding the layers of the pyramid, alcohol consumption, and nutritional intake have similar rules stored in the knowledge base.

(2) Data Model

Fig. 5 illustrates the ERD for DAAS. The *person* is the core entity in the system. DAAS stores information relating to each *visit* a user makes to the system. The system must have access to *food item* information the user consumes. The relationship between a person and a food item is the person's *diet*. Each food item belongs to a *food category*. FOOD_CATEGORIES contains information about the 5 layers of the food pyramid [2]. Each food item is also composed of various different *nutritional elements*. The relationship between these two entities is the *nutritional value* of the food item. Each *nutritional element* has a recommended daily amount (RDA), which a person should consume. This RDA depends on the users demographic information. A person's diet is analysed according to the amount of alcohol they consume in a week. The BEVERAGES

entity represents information about alcohol. The user will be given three type of advice: ALCOHOL_ADVICE, NUTRITIONAL_ADVICE and CATEGORY_ADVICE. There is a super entity - ADVICE. The ADVICE that the system will offer the user will be made of a number of advice MESSAGES concatenated together. The ERD illustrated in Fig. 5 is used to produce the relational schema for the database used in DAAS [3].

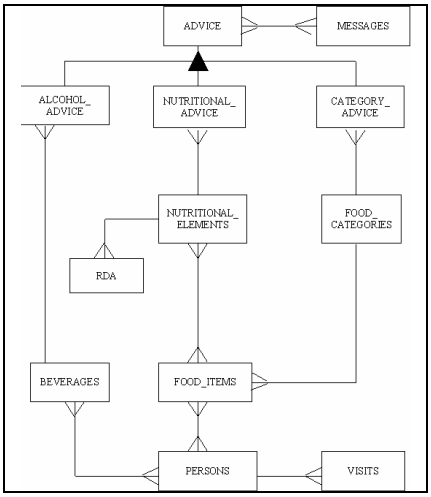

Fig. 5 Entity relationship diagram

(3) System Model

As illustrated in the Use Case Diagram of Fig. 7, a user or a dietician can use the DAAS system.

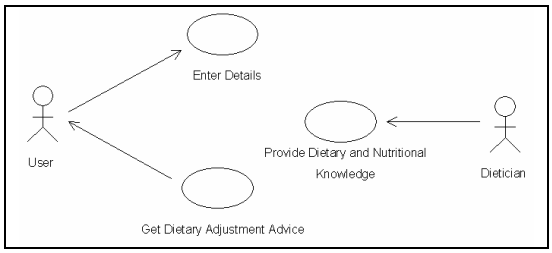

Fig. 7 Use case diagram

The user enters their dietary information, which results in the output of dietary advice, while a dietician can provide the dietary and nutritional knowledge as well as maintain the knowledge base.

(4) DAAS Architecture and Implementation

As can be seen in Fig. 8, the DAAS architecture has a web server [4], which allows the user interact with the system using an HTTP client. This server will in turn interact with the knowledge base and inference mechanism. The generated advice is returned to the client and displayed on its screen.

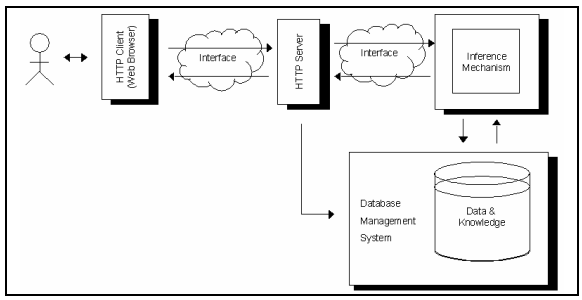

Fig. 8 DAAS system architecture

The server renders web pages that include Java Server Page (JSP) [5] code. These JSPs are embedded into HTML code. The HTML creates the web document and the JSPs afford the functionality of the interface. The knowledge base is created using an Oracle database. This is used in conjunction with the Structured Query Language (SQL), which is used to create, populate, and query each of the tables in the DAAS database. The inference mechanism used to generate the required advice is embedded in the JSPs.

DAAS USER INTERFACE

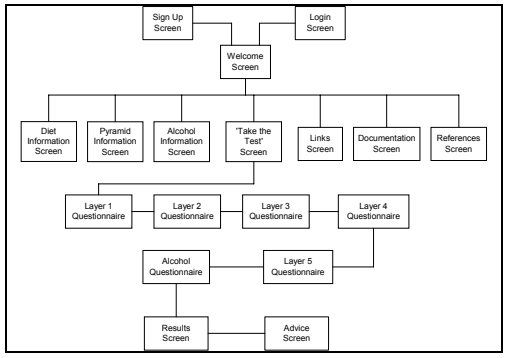

Fig. 9 HCI model

Fig. 9 presents the model of the DAAS HCI. As illustrated in Fig. 9, there are a number of routes the user can take through the system, but when they begin the test they must continue until they receive their dietary advice.

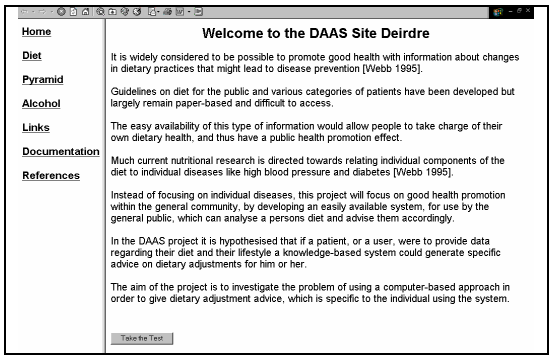

Fig. 10 DAAS welcome page

The site is composed of a number of screens that provide the user with information about DAAS (Fig. 10), diet, the food pyramid, and alcohol intake. There are also pages with links to other relevant sites, references, and the documentation of the system. The user can also 'Take the Test' where they are taken through a number of screens where they are questioned regarding the amount of foods they eat from each layer in the Food Pyramid [2]. The user is shown screens questioning them about their daily intake of layers 1, 2, 3 (Fig. 11), 4, & 5, and their weekly intake of alcohol.

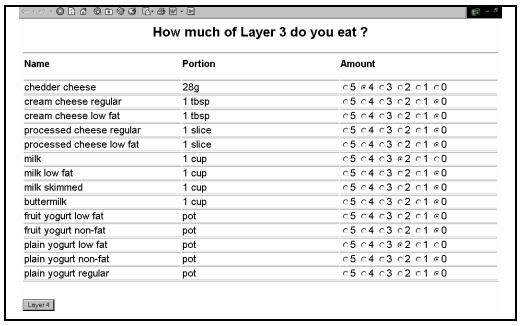

Fig. 11 Layer 3 questionnaire

This information is used to compare the users diet to the information stored in the database. The advice relevant to the user and their diet is then outputted to the screen.

RELATED WORK

The problem of easily accessible personal dietary advice has been identified before [6, 7]. In the *Interactive Healthy Eating Index (IHEI)* system the user enters the foods they have eaten in a day. This triggers a search engine, which produces an extensive list of foods, which the user must choose from. The user then enters what portion of this food they have eaten. This is repeated until the user has entered all the foods they have eaten in a day. They are then provided with information about their *nutritional intak*e, their *Healthy Eating Index* (HEI) [6], and their *food pyramid intake.* The IHEI System is difficult to use, as the user must search for individual foods eaten in a day. The food search engine can have difficulty in finding some foodstuffs. DAAS provides the user with lists of foodstuffs so it is quicker, easier, and more intuitive to use. In the *Dietsure* system [7], the user must answer a questionnaire in order to get analysis of their diet. The user is taken through a series of 40 web pages with questions about what types of foods they eat, and the number of times they ate a particular type of food in the last week. When the user has answered the questions they are given dietary advice. This is in the form of an explanation of each nutritional element and why a person needs them; at the end of each explanation specific advice is displayed. The questionnaire takes quite a long time, as does getting to the final analysis/advice page. The analysis is based more on the *type* of diet a user has, rather than the specific food they are consuming. The final advice given is difficult to decipher because of the large amount of information that is irrelevant to the user. DAAS provides easily understandable advice, specific to each user, which is easy to read. The advice provided by DAAS is generated using the foods consumed in a single day, so a user can return to DAAS to see how their diet is changing, if at all.

FUTURE WORK

As part of future work, DAAS could be enhanced and extended to providing dietary advice for diabetics in relation to insulin dosage requirement. Similarly, DAAS could be adapted for the domain of food allergies or sensitivities. The presentation mode could also be adapted for use on ubiquitous devises such as PDAs and WAP devices.

SUMMARY AND CONCLUSION

This paper has presented the approach, method and architecture of the web-based dietary analysis and advice system, DAAS. The system addresses the need to have individual members of the public be in control of their own diet. Making such a system is available in the public healthcare domain would ensure that people may no longer be unaware of whether they have a good or bad diet, as they could have their diet and lifestyle easily analysed in order to receive advice from a system which was developed in consultation with dieticians and national diet guidelines.

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