Formalizing Harmony Rules for Nutrition Counseling Expert System

Balázs PINTÉR, Balázs GAÁL, István VASSÁNYI

University of Pannonia, Medical Informatics R&D Center
Hungary, H-8200 Veszprém Egyetem u. 10.
bpinter@virt.uni-pannon.hu

Abstract

The development of IT and related technologies made it possible to provide personalized lifestyle assessment to the general population by using online services and smartphones, which can have great impact on the health of the population. The MenuGene nutrition and lifestyle counseling expert system provides services for the logging of lifestyle-related activities like food consumption, physical activities, measurement of some physiological data, medication. We give the user assessment based on the logged activities. This paper focuses on the formalization of rules in our expert system, which rules can be evaluated by algorithms and the result can be visualized to the user. Expert knowledge is formalized in our database in two parts: sets of foods and dishes, and rules, that match a pre-defined pattern of sets and foods / dishes. Because conflicts can occur between the rules a simple conflict resolution algorithm has to be implemented. We implemented several hierarchies of sets to support the definition of rules, and a lifestyle assistant application for Android platform. The system may improve the quality of life of patients, especially for patients with chronic diseases. The rules can be used to make more detailed analysis of the logged activities. We are doing trials to evaluate the quality of our database and also the usability and precision of our application.

Keywords: nutrition, lifestyle, counseling, harmony rules

1. Introduction

Nutrition and physical activity has severe impact on the probability of cardio-vascular and other chronic diseases, so bringing tailored advice to the general population can improve life expectancy and quality of life. One important part of nutrition and lifestyle counseling is the recording of lifestyle related activites like food consumption, physical activity, and medication. Our system, MenuGene nutrition and lifestyle counseling expert system supports the following tasks of dietary counseling:

- Easy knowledge base maintenance
- Meal plan generation
- Logging of activities
- Dietetic anamnesis which takes the most widespread diseases into account
- Analysis based on the personal anamnesis

Computer-aided meal plan generation and analysis is a traditionally hard problem since it is characterized by a very large search space and hard-to-formalize expert dietary knowledge on the harmony assessment of a menu. Human experts probably build better meal plans than computers even now, although research on computerized methods has been ongoing since the 1960's. In 1964 Balintfy developed a linear programming method for menu optimization [1], while Eckstein used random search to satisfy numerical nutrient constraints [2]. Later more advanced artificial intelligence methods were developed using Case-Based Reasoning (CBR) or Rule-Based Reasoning (RBR) or by combining the two methods with other techniques [3]. A web based system called DietPal has been built in Malaysia that models the workflow of dietetic experts in order to support their work [4]. There are solutions for parts of a nutrition counseling expert system, but so far there were no complete solutions published and validated. Our system implements all aspects of this area in a user friendly and effective way.

2. Dietary Logging

The workflow of dietary logging and analysis can be seen on Fig. 1.

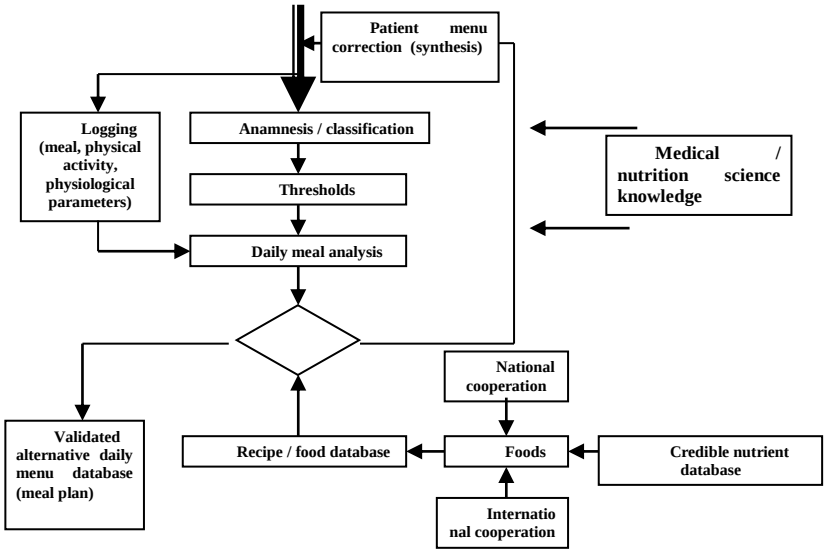

Fig. 1. Workflow

The logged activities are checked against the rules daily. Rules are related to meals, or set of meals, so the first step is to organized meals into sets.

3. Set Model

The sets are manually constructed and populated by our dietetician in order to be in line with recent professional recommendations and also support the easy construction of harmony rules. We now have a total of 1409 sets in several hierarchical structures or ontologies. Part of this set structure can be seen on the screenshot of our database handling GUI on Fig. 2.

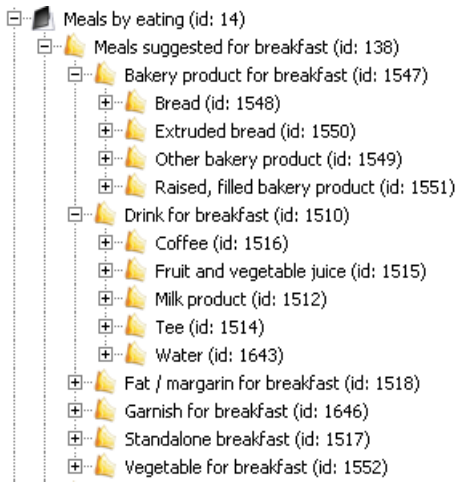

Fig. 2. Part of the set hierarchy

4. Rule Model

We are developing a novel knowledge representation framework, which will be able to represent the rules dietitians use in assessing meals and menus. In our framework, we use the following concepts and notation for representing expert knowledge.

concept: represents an entity in the menu plan. A concept can be a nutrient, an ingredient, a foodstuff, a dish, a meal, or a menu plan.

aspect: the point of view of the assessment. Many aspects are exist when considering the assessment of dietary menu plans. Aspects are, for example: seasonality, price range, value per price, healthiness, color.

quantity: we handle length, mass, time and volume based quantities.

component: represents a concept with a corresponding quantity. For example, 1kg of tomato, 1dl of wine, one vegetarian meal. Components can have any number of subcomponents. For each subcomponent, its relation, role and time can be defined.

relation: Identifies the relation of two components.

role: identifies in which role a subcomponent is part of its container component

time: the temporal dimension is used to record the scheduling of the menu plans.

rule: With these concepts, we can define rules which allow for the assessment of menu plans. A rule is either for supervising the numerical content of the menu plan, or for the harmony of the various components making up the plan. Each rule has an aspect, and its rating modifies the assessment value belonging to that aspect.

quantity rule: is a simple rule, which records minimum, optimum and maximum quantities for a given concept in a component (eg. meal).

harmony rule: records a list of concepts which make up a combination. This combination is rated by the rule. The rating of the rule defines whether the rule is

decreasing or increasing the value of the component that has the combination of concepts the rule records.

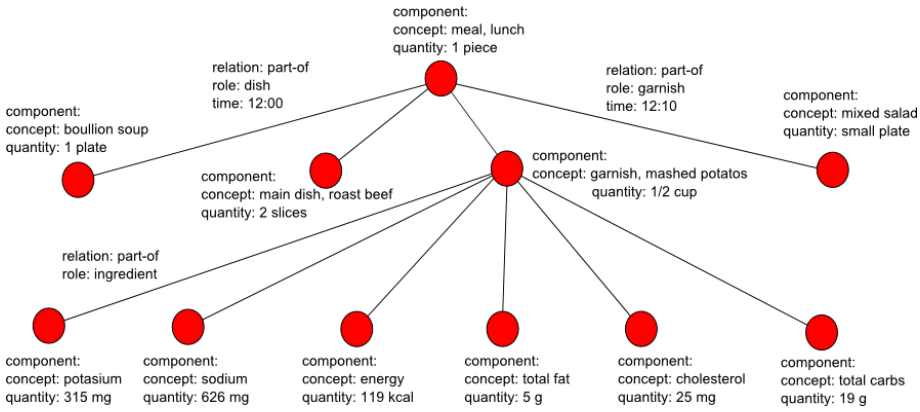

Fig. 3. Sample rule

5. Acknowledgement

The work presented was supported by the European Union and co-funded by the European Social Fund, project title: “Telemedicine-focused research activities in the field of Mathematics, Informatics and Medical Sciences”, project number: TÁMOP-4.2.2.A-11/1/KONV-2012-0073.

References

[1] István Vassányi et. al.. Applications of medical intelligence in remote monitoring. XXIII International Conference of the European Federation for Medical Informatics (MIE2011), Oslo, Norway, 28-31 Aug. 2011. In: Studies in Health Technology and Informatics, vol. 169.: User Centered Networked Health Care, ISSN 0926-9630, pp. 671-675, 2011.

[2] B. Gaál, I. Vassányi, G. Kozmann. "A Novel Artificial Intelligence Method for Weekly Dietary Menu Planning" Methods Inf Med 2005; 44: 655–64. (ISSN: 0026-1270)

[3] Seljak, B.K. “Dietary Menu Planning Using an Evolutionary Method" Proc. Int. Conf. on Intelligent Engineering Systems, London, UK, 26-28 June 2006, pp. 108-113.

[4] The MenuGene project home page at http://www.menugene.com/ (Jan. 2013)

[5] **Amazigh Speech Recognition and characteristics of people with pathological voice;** Hassan Satori (1, 2), Safae Elouahabi (1) (1):Mohammed Premier University, Nador, 2): Sidi Mohamed Ben Abbdallah University, Fez - Morocco) **TO SEE BY GHAZAL**

[6] **Brain-Computer interface systems in the rehabilitation of chronic stroke patients with no cognitive impairments;** Giulia Cisotto, Francesco Piccione, Silvano Pupolin (University of Padua, Italy)

[7] **Clinical Avatars for Breast Cancer Prediction in the Moroccan Population;** Yassine ouilmi[1,4], Hassan Ghazal[2,3], Saaid Amzazi[1], Noureddine Boukhatem[2], Peter J. Tonellato[4] (1Faculty of Sciences of Rabat, 2Faculty of Sciences of Oujda, Morocco, 3Polydisciplinary Faculty of Nador, University Mohammed Premier, Nador, Morocco, 4Center for Biomedical Informatics, Boston, MA, USA) **TO SEE BY GHAZAL**

[8] **Low Prevalence of p.G352fsdelG Mutation in Phenylketonuria Patients from Morocco;** Fatima Zahra Laarabi, Afaf Lamzouri, Ilham Ratbi , Abdelaziz Sefiani (Université Mohamed V Souissi, Rabat, Institut National d'Hygiène, Rabat) Amina Barkat (Centre National de Référence en Néonatologie et en Nutrition, Rabat, Morocco) **NOT PRESENTED TO SEE BY GHAZAL**

[9] **The Moroccan Genetic Disease Database (MGDD): A Country-Specific Database for DNA Variations related to Inherited Disorders and Multifactorial Diseases**; Hicham Charoute, Halima Nahili, Omar Abidi, Khalid Gabi, Hassan Rouba, Abdelhamid Barakat (Institut Pasteur du Maroc, Casablanca, Morocco), Malika Fakiri (Université Hassan I, Settat,Morocco) **NOT PRESENTED TO SEE BY GHAZAL**

[10] Algorithm for Gene Selection using within and between Replicates Comparisons; Kaissi Ooufae1, Singh Raj2, Moussa Ahmed3 (1Adbelmalek Essaadi University, Tangier, Morocco, 2Jaypee University of Information and Technology, Solan, H.P., India, 3University of Poitiers, France) **NOT PRESENTED TO SEE BY GHAZAL**

[11] **GT- DB –GPU: Gene Tracer for fast scanning of sequence databases on graphics processing units;** Mohamed Issa[1], Hitham M. Abo Bakr[1], Ahmed Mansour Alzohairy[2], Julie D. Thompson[3] ([1]Faculty of Engineering, Zagazig University, Egypt., [2]Genetics Department, Faculty of Agriculture, Zagazig University, Egypt, [3]Institute of Genetics and Molecular and Cellular Biology, Illkirch, France) **NOT PRESENTED**

[12] **EG Gel Analyzer: Advanced clustering Algorithms for analysis of DNA and protein Gel Images;** Riham Alewadi1, Ahmed M. Alzohairy2,3, Wael M. Khedr1 (1Faculty of science, Zagazig university, 2Faculty of Agriculture, Zagazig University, 3Egyptian Center of Bioinformatics And Genomics- ECBAG, Zagazig University, Egypt) **NOT PRESENTED**

[13] **Modeling and Simulation of the Blood Coagulation Cascade;** Matteo Bellini, Giancarlo Mauri, Marco S. Nobile (University of Milano Bicocca),, Daniela Besozzi (University of Milan), Paolo Cazzaniga (University of Bergamo, Italy)