Adopting STP for diet management

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***Abstract*—We devise a scenario the interaction between the man and the food is mediated by an intelligent recommendation system that, on the basis of various factors, encourages (or discourages) the user to eat a specific course. The main factors that the system need to account for are (1) the diet that the user intends to follow, (2) the food that s/he has eaten in the last days or that s/he intends to eat in the next days, and (3) the nutritional values of the courses and their specific recipes. Automatic reasoning and Natural Language Generation (NLG) play a fundamental role in this project: the compatibility of a food with a diet is formalized as a Simple Temporal Problem (STP henceforth) [1], while the NLG tries to motivate the user. In this paper we briefly sketch the formalization and the related reasoning facilities that we intend to devise.**

The system is composed by a smartphone app, a central module that manages the information flow, an information extraction (IE) module, a reasoning module, a NLG module. So, the system is a pipe of web services. Automatic reasoning and Natural Language technologies play a fundamental role in this architecture. The IE module computes the salient nutrition information about the course. The diet compatibility of a food with a diet is formalized as a constraints problem by the reasoner. Finally, the NL generator produces an explanation for the user in plain natural language as well as in a multi-medial format, e.g. by using icons. In the following we describe only the STP-based reasoner.

Often a user is not able to carefully follow a diet for a number of reasons. When a deviation occurs, it is useful to dynamically adapt the rest of the diet in the upcoming meals so that the global diet reference values could nevertheless be reached. In particular we intend to devise automatic reasoning mechanisms for (i) evaluating the compatibility of a course with a diet and (ii) showing to the user what are the consequences on the rest of the diet. Our goal is to devise a system tolerant to small and occasional episodes of diet disobedience, and also to persuade the user to minimize these acts.

In a diet it is necessary to consider parameters such as energy requirements and amount of macronutrients such as proteins, carbohydrates and lipids. In particular the literature (e.g., [2]) provides a system of Dietary Reference Values that can be computed from user information such as weight, gender, age, lifestyle. For example, let us consider a 40-year-old male who is 1.80 m tall, weighs 71.3 kg and has a sedentary lifestyle; such a person has an energy requirement [2] of 2450 kcal/day. Moreover, he is recommended to assume, among the macronutrients [2], e.g., 260 kcal/day of proteins, 735 kcal/day of lipids and 1455 kcal/day of carbohydrates.

We represent the Dietary Reference Values as STPs [1]. STP models a set of constraints as a conjunction of bounds on differences $c \leq x - y \leq d$, i.e., the distance between the time points x and y is within c and d. In STP the constraints are propagated by an "all-pairs shortest paths" algorithm such as the Floyd-Warshall's one in a time cubic in the number of points; such propagation checks the consistency of the constraints and it provides also the minimal network (i.e., the minimum and maximum distance between each pair of points). In our setting, we substitute the temporal distance between temporal points of STP with the Dietary Reference Values and the actual values of the ingested food. Thus, e.g., a constraint $500\ kcal \leq lunch_E - lunch_S \leq 600\ kcal$ imposes that the "distance" between the start and the end of lunch is between 500 and 600 kcal, i.e., that lunch provides 500-600 kcal. Furthermore, dietary recommendations have to be considered over significant amounts of time and we wish to allow users to make small deviations. Thus, we impose less strict constraints over the shortest periods (i.e., days or meals). For example the energy requirement of 2450 kcal/day can be considered over a week ($2450\ kcal/day \cdot 7\ days \leq week_E - week_S \leq 2450\ kcal/day \cdot 7\ days$) and for the single days we allow a deviation of 10% ($2450\ kcal - 10\% \leq Sun_E - Sun_S \leq 2450\ kcal + 10\%$, $\ldots$, $2450\ kcal - 10\% \leq Sat_E - Sat_S \leq 2450\ kcal + 10\%$). Now let us suppose that the user on Sunday, Monday and Tuesday had an actual intake of 2690 kcal for each day. By substituting the constraints about these days with the actual (and exact) constraints ($2690\ kcal \leq Sun_E - Sun_S \leq 2690\ kcal$, $\ldots$, $2690\ kcal \leq Tue_E - Tue_S \leq 2690\ kcal$) and by propagating the constraints, we discover that (i) the STP is consistent and thus the intake is compatible with the diet and (ii) on each remaining day of the week the user has to assume a maximum of 2465 kcal.

We plan to experiment the system in a clinical setting for the treatment of people affected by essential obesity.

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