Health-aware Food Recommender System

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ABSTRACT

With the rapid changes in the food variety and lifestyles, many people are facing the problem of making healthier food decisions to reduce the risk of chronic diseases such as obesity and diabetes. To this end, our recommender system not only offers recipe recommendations that suit the user's preference but is also able to take the user's health into account. It is developed on a mobile platform by considering that our application may be directly used in the kitchen. This demo paper summarizes the complete human-computer interaction design, the implemented health-aware recommendation algorithm and preliminary user feedback.

Categories and Subject Descriptors

H.4.2 [**Information Systems Applications**]: Types of Systems—*Decision support*

Keywords

Recommender systems; smart health; food, utility

1. INTRODUCTION

Nowadays, food, healthy eating and new recipes have become central subjects in our daily life. In fact, there is an extensive growth of food variety and ingredient combinations, and more and more recipes are created, even by IBM supercomputers[1]. Therefore, it can be time-consuming to make better and healthier recipe choices and, notwithstanding this increase in choice options, for many people food selection is driven by bad habits that lead to poor healthy conditions [1]. Still, many people are not aware of the potential health problems that can be caused by improper eating habits. Therefore, it is valuable to conduct research on food recommender systems by taking both user preference and nutritional factors into account [2].

[1]`http://www-03.ibm.com/innovation/ca/en/cognitivecooking/`

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To further explore the demand of healthy food recommendations, we have conducted a survey about the user's opinion on recipe recommendations. 20 subjects from different countries such as Italy, Germany, France, China, USA, Spain and India, were involved in the survey. Their ages were in the range of 22-50 years old, 65% of them were male and 35% were female. In the survey, we asked "would you like to have healthier recipe recommendations by adapting or yielding your personal taste?" The possible answers were *yes*, *yes but to some extend*, and *absolutely not*. Futher, we provided the following descriptions for the three answers. *Yes* means the user prefers healthier recipe recommendation, the healthier the better. *Yes but to some extent* means the user would like to receive the recommendation that balances his taste and health. *Absolutely not* means the user only wants the food recommendation that suits his taste.

The survey results show that 10% users selected yes, 85% users selected yes but to some extent, and 5% users selected absolutely not. That means 95% of the surveyed users would like to somehow adapt their taste in order to obtain healthier food recommendations. This confirms that in the food domain recommendations that only consider user preference do not suffice. When obtaining recipe recommendations, people would like to take the health factor into account. Therefore in addition to using traditional recommendation technologies, our demo system proposes a health-aware recommendation algorithm by including calorie balance.

In this demo paper, we firstly summarize the user and recommender interaction procedure. Further, we describe the key aspects of the implemented health-aware recommender algorithm. Then, we highlight the novelties of our system and conclude the paper by reporting the preliminary user feedback and future works.

2. SYSTEM DESCRIPTION

The system demo is illustrated by a video, which can be found at `http://goo.gl/R3PDYd`. We have designed a complete interaction process that includes preference elicitation, recommendation generation and presentation, user support for browsing and critiquing the given recommendations as well as for providing the user alternative recommendations.

The interaction begins with a regular login interface, if the user is new to the system, the user needs to register in the system. In this step, the system will ask the user to provide some personal profile data such as height, weight and routine activities. The user profile data are then used to estimate the daily calories the user needs.

Afterwards, it begins the long-term (stable) preference elicitation. This is to collect what the user generally likes to cook or eat. The user can browse a full catalog of recipes and mark those that he has used before. This is to let the user find the recipes that she can actually evaluate. Different categories of recipes such as fish or meat are presented to the user. Users can easily navigate through the categorization to find a concrete recipe, for example, Meat -> Beef -> Roasted Beef with Salad.

After the user has marked some recipes, these are presented to the user for rating and tagging. If the user has not marked enough recipes, the system provides some additional recipes that are selected by guessing what the user may have used but not marked. In order to find such recipes, an active learning technique, which is called Binary Prediction, is used. Details can be found in [2].

The rating interface uses a 5-star Likert scale. When the user tags a recipe, she can her own tags or use suggested tags. These tags (normally between 5 and 10) are identified by the system on the base of their relevance to the recipe. While tagging, the user also can mark whether the selected tags indicate positive or negative aspects of the recipe. Positive and negative aspects are clearly shown by different colors of the tags.

Until this point, the user registration is finished. During the registration, we have collected the user profile and her long-term preferences. This process is only done once when the user registers to the system. It is then followed by session-based preference elicitation.

Session-based preference elicitation is to ask the user which ingredients she would like to use for cooking. It enables the user to cook recipes that are based on what she has. In this step, the user can enter the ingredient (e.g., tuna fish) or specify a feature of the recipe (e.g., Italian dish) that she wants to cook. If the user already registered before, after logging in, the session-based preference elicitation is the first interface that the user interacts with.

Based on the user profile, the long-term and the session-based preferences, the system generates a set of recipe recommendations and present them, one by one, to the user. The user can evaluate the recommendations to find the most suitable recipe. When the user is satisfied with a recommendation, she can select it and its detailed cooking instruction are shown. The user can also "critique" a recommendation. When the user clicks the critique button on one recommended recipe, a list of tags related to this recipe is shown for critiquing. The user can choose the option of more or less towards certain tag. For example, more spicy and less garlic, in which spicy and garlic are the given tags. After the critique, alternative recommendations are given based on the adjusted factors. This is similar to the critiquing function implemented in [4].

3. HEALTH-AWARE RECOMMENDER ALGORITHM

In our recommendation algorithm we have considered both the user's preference and health requirements. For the user u, the utility *util* of the recipe rp is computed as:

$$util(u, rp) = w_p * pref(u, rp) + w_h * health(u, rp)$$

Regarding the preference component $pref(u, rp)$, we have proposed an algorithm that extends matrix factorization by including additional parameters that are used for modelling the dependencies between assigned tags and ratings. The details of this algorithm can be found in [2].

We have now extended this algorithm by including the health component $health(u, rp)$. This is based on a calorie balance function of the difference between the calories the user still needs and the calories of the recipe. The smaller the difference is, the healthier the recipe is estimated. This assumes that calorie balance is one indicator for health. The calories that the user needs are calculated using the typical user activity (profile data) [3], while calories of the recipe are determined by the nutritional values of the recipe.

The weight w_p and w_h can be manually adjusted by the user. The user can define if the recommendations should be more taste-oriented or more health-oriented.

4. NOVELTIES IN THE SYSTEM

Many food recommendation algorithms are lacking a precise real-world application context, and many of them have not been coupled with a precise interaction design. We have provided a complete user/recommender interaction design from preference elicitation, to recommendation presentation and critique. Compared to our recent work [2], we have added to the supported interaction: user profile collection and recommendation critiquing. Further, most food recommendation applications provide just non-personalized suggestions and without considering the health factor. Compared to other systems such as [1] and [2], this new system has taken into account the health concerns and also provides to the users the possibility of adjusting the relative importance of personal taste and health.

5. CONCLUSION

The application of recommender system to the food domain is emerging. We have implemented a new system that allows users to balance their tastes and health. The described demo system has been developed on the Android platform. Users can easily access the applications in a ubiquitous way. After using our application, users commented that the system is easy to use and the quality of the recommendations is high. As future work, we will take into account in the utility function the cooking effort and recipes' diversity (between recommendation sessions). Beside the calorie balance, we will also construct healthy recommendations by leveraging domain knowledge from nutritionists.

6. REFERENCES

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