"Easy" Cooking Recipe Recommendation Considering User's Conditions

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***Abstract*—It is natural to think that couples who work at a company or a person who lives by her/himself want to cook food for themselves as quickly and easily as possible when they are busy. However, to keep having the same food they can easily cook fed them up, therefore, it should be preferable for them to be recommended a variety of food that they can cook "easily". Currently, there are so many Web sites for cooking recipes, and there are also recipes regarded as "easy" to cook. However, those recipes are not estimated as "easy" by taking user's conditions into account. Therefore, in this study, we aim to propose a method to recommend "easy" cooking recipes by analyzing the content of recipes and considering user's conditions and then develop a recommendation system with the proposed method.**

***Keywords*-Recipe Recommendation; User's Schedule; Browsing Log; Recipe Retrieval**

I. Introduction

It is natural to think that couples who work at a company or a person who lives by her/himself want to cook food for themselves as quickly and easily as possible when they are busy. However, to keep having the same food they can easily cook fed them up, therefore, it should be preferable for them to be recommended a variety of food that they can cook "easily". Currently, there are so many Web sites for cooking recipes, and there are also recipes regarded as "easy" to cook. However, those recipes are not estimated as "easy" by taking user's conditions into account. The meaning of the word, "easy", would be differently interpreted by each user's conditions. Therefore, in this study, we aim to propose a method to recommend "easy" cooking recipes by analyzing the content of recipes and considering user's conditions and then develop a recommendation system with the proposed method. Concretely, we collect approximately 10,000 recipes from AJINOMOTO Web recipe site; analyze the kinds of seasonings, ingredients, and cooking methods; and then make a ranking data set which expresses the difficulty of cooking. We develop a system that recommends "easy" cooking recipes based on the ranking data, considering user's conditions.

II. Recommendation resources

A. Recipe collection and its database

We use AJINOMOTO recipe encyclopedia [1] for the resource of recipe recommendation. The reason why we chose this recipe site is because the site is well structured, therefore, we could easily collect the necessary information for recommendation shown as follows:

- Recipe name
- Seasonings used in a recipe
- Ingredients used in a recipe
- Calorie of dishes
- Cooking time
- The category of dishes
- Main cooking methods
- Seasons for eating

These pieces of information are stored in a MySQL database.

III. Recipe recommendation method

A. Overview

Fig. 1 shows the overview of our proposed recipe recommendation method.

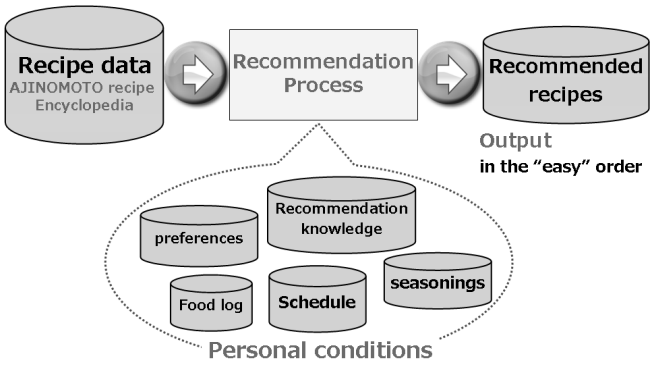

Figure 1. Overview of recommendation

The system constructed based on the method retrieves recipes from approximately 10,000 recipes collected from the AJINOMOTO recipe encyclopedia and recommends some of them in the order of "easy" cooking. Furthermore the system also considers the user's conditions, e.g., user's schedule, date, time, and season when retrieving a recipe, etc.

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B. Definition of "easy" cooking

In this paper, the "easy" cooking recipe is defined as follows:

- Few cooking processes
- Few kinds of seasonings and ingredients used in a recipe
- Few seasonings to be additionally prepared
- Less cooking time

C. Definition of "User's condition"

In this paper, the "user's condition" is defined as follows:

- Seasonings a user possesses
- Preference on ingredients
- User's schedule
- Date & time when retrieving a recipe
- Season when retrieving a recipe

IV. Estimation of an "easy" recipe

We have introduced several scores which estimate the easiness of cooking for each recipe. We firstly estimate the easiness from a viewpoint of user's familiarity for the seasonings, the numbers of ingredients, and the cooking methods used in a recipe. They are estimated with the seasonings score (SS), the ingredients score (IS), the cooking methods score (CMS) respectively. And then the total recipe score (RS) is estimated based on SS,IS,and CMS — as the higher value of RS a recipe gets, the more difficult to cook the recipe. The detail of each estimation is explained in the following.

- Seasonings score (SS)
  This score is estimated by the number of seasonings and the user's familiarity for the seasonings used in the recipe. Here, we define TS_a as the score indicating the frequency of the seasoning a appeared in all recipes. We estimate the familiarity of a seasoning based on how often the seasoning is used in all recipes. This is based on an assumption that the seasonings often used in cooking can be regarded as popular seasonings and as the ones which most people possess. Therefore, it must not be difficult for people to cook such recipes. If we assume that there are l kinds of seasonings, the seasoning score (SS) for a seasoning x is estimated in the following equation.

$$SS_x = 1 - \frac{TS_x}{max(TS_a)} \quad (a = 1, \cdots, l) \tag{1}$$

  SS is estimated within $[0, 1]$ and the seasonings often used in cooking get the low value of SS.
- Ingredients score (IS)
  The ingredient score (IS) is estimated based on the number of ingredients used in a recipe and the unfamiliarity for ingredients used in cooking. Here, we define TI_b as the score indicating the frequency of the ingredient b appeared in all recipes.
  If we assume that there are m kinds of ingredients, the ingredient score for an ingredient y is estimated in the following equation.

$$IS_y = 1 - \frac{TI_y}{max(TI_b)} \quad (b = 1, \cdots, m) \tag{2}$$

- Cooking method score (CMS)
  The cooking method score (CMS) is estimated based on the kind of cooking methods in a recipe. Since the cooking methods are often expressed by the verbs which express cooking procedures, therefore, we analyzed the kinds of verb in all recipes and defined the cooking method score (CMS) for a verb z as follows:

$$CMS_z = \begin{cases} 0 & : \texttt{Verbs not related to cooking} \\ 1 & : \texttt{Verbs expressing an easy cooking method : e.g., } remove, \\ & \quad scoop, etc. \\ 2 & : \texttt{Verbs expressing a laborious cooking method : e.g., } boil, \\ & \quad grill, \ etc. \end{cases} \tag{3}$$

- Recipe score (RS)
  The recipe score (RS) is estimated by the sum of each value calculated by dividing the total score of each SS, IS, and CMS, which are expressed with TSS, TIS, and $TCMS$[1], for the recipe k by the maximum score of each SS,IS,and RS among all recipes respectively. The RS of the recipe k is expressed in the equation (4). The parameters, t, s,and v, in the equation (4) are weighting factor. In this study, we set them as a equivalent value.

$$RS_k = t\frac{TSS_k}{max(TSS_a)} + s\frac{TIS_k}{max(TIS_b)} + v\frac{TCMS_k}{max(TCMS_c)} \tag{4}$$
$$(a = 1, \cdots, l; b = 1, \cdots, m; c = 1, \cdots, n)$$

  The value of RS will be within $[0, 3]$.

V. Recommendation with knowledge

As an additional recommendation method to the recommendation based on the standard of "easiness" of cooking, we propose a recommendation method considering user's conditions with recommendation knowledge.

A. Recommendation policy

Even if the system recommends some recipes, there are many cases where a user chooses a recipe different from the recommended ones. Therefore, in order to avoid

[1] TSS_k, TIS_k, and $TCMS_k$ correspond to the total values of each SS, IS, and CMS to the all kinds of seasonings, ingredients, and cooking methods in the recipe k.

this situation, in this study, we adopt a recommendation method to remove the candidates with low possibilities to be chosen which is likely expressed with knowledge "If the case is A then B is not recommended." By using this type of recommendation knowledge, only recipes with the possibility of being chosen will remain as recommended candidates. This provides users with more possibility of choosing a variety of recipes.

B. Knowledge used for recommendation

In order to recommend a recipe based on user's schedule, three kinds of knowledge are adopted.

- *Knowledge registered by a user*
  Users can register knowledge for recommending recipes by themselves, for example, "If the month when a user retrieves is February, then the recipes usually cooked in summer will not be recommended." By registering this type of knowledge to the system, users can avoid to be recommended the recipes with low possibility of being chosen by them.
- *Knowledge acquired from browsing log*
  The system learns users' preferences on cooking methods, food categories, etc. at any time when users operate the system by observing the patterns of retrieving their interesting recipes,
- *User's preference on ingredients*
  Whenever a user uses the system, the system learns user's preference on ingredients — the system counts the number of main ingredients which appear in the recipes the user has browsed. By this knowledge, the system will be able to recommend recipes including the ingredients that the user often uses.

VI. Recommendation process

- **step 1.** *Obtaining information about situation*
  Before starting recommendation, the system obtains the information about a situation in which a user retrieves a recipe. The pieces of information expected to be obtained by the system are shown as follows:
  * Date & Time
  * User's schedule on the day
  * Food that the user had yesterday
  * Recommendation target: i.e., either breakfast, lunch, or dinner
- **step 2.** *Input a query*
  A user inputs a query based on a rough idea for a target recipe. We call this query "the initial query to the system."
- **step 3.** *Output from the AJINOMOTO recipe database*
  1) The system uses the three types of knowledge explained in V-B and then make an additional query based on the information obtained in step 1.
  2) The system combines the additional query made in 1) with the initial query made in step 2, and then retrieves recipes with the combined query. For example, in case that the user provided information about only 'food category' and 'season' to ask the system to recommend recipes, the system will add the other information necessary to recommend recipes; for example, 'cooking method', 'cooking time', 'calorie', etc., to make a better query to retrieve recipes that make the user satisfied.
  3) If there is not any information provided by the user. The system will provide the information shown below by default.
     * cooking time must be less than 60 minutes.
     * The top 30 ingredients that the user often use have to be included in the recommended recipes.
  4) The recommended recipes are put in the order of easy cooking (see, Fig. 2).
  5) The recommended recipes are shown together with the reason of recommendation.

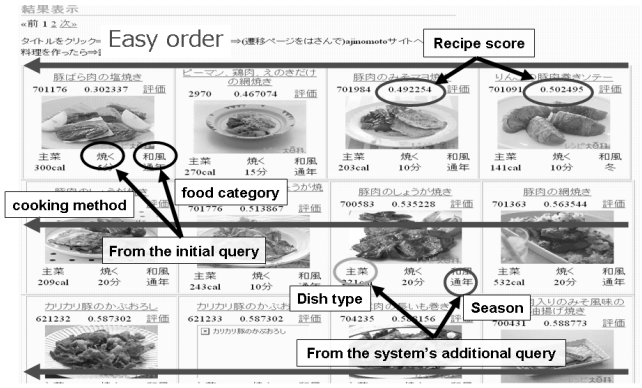

Figure 2. Result —recommended recipes—

- **Step.4** *Browsing recipes by a user*
  If the user chooses and clicks a recipe among the recommended recipes, the system guides the user to the AJINOMOTO site and displays the recipe (see, Fig. 3). Whenever the user chooses the recipes, the system collects user's browsing log to make recommendation knowledge which suits to the user's preference.
- **Step.5** *Recipe evaluation*
  After cooking a recipe among the recommended recipes, the user evaluates the recipe in three degrees such as 'easy', 'average', and 'difficult'.

Figure 3. Choosing and browsing the recipe

The system takes user's evaluation into account at the next time when recommending.

– **Step.6** *Add the recipe to the food record*
The user adds the selected recipe to the record of his/her having food. The system analyzes the record and produces knowledge for recommending recipes as shown in V-B.

VII. Related studies

There are many studies related to cooking recipe recommendation. As the studies of recipe recommendation for anonymous people, Tsuji et al. [2] applied fuzzy mathematical programming to make a menu considering the quantity of intaking nutriment. Takada [3] applied the linear programming method to make a menu considering user's food preference and nourishment balance. Karimai et al. [4] propose a method to recommend a recipe with a good nourishment balance considering the food elements. These methods were developed to recommend a recipe or a menu which suits to anonymous people, whereas, we have proposed a method to recommend a recipe for a personal user considering his/her conditions. Our system has a learning mechanism of user's preference by observing user's browsing log of the system and the log of his/her having food, therefore, the accuracy of recommendation is getting better as the user uses the system. As the studies aiming recipe recommendation for a personal user, Ueda et al. [5] constructed a recipe recommendation system in which the system observes the frequency of the ingredients used in the recipe a user cooked in the user's cooking record and reflects it to the user's preference and then recommends recipes considering the user's preference. Suzuki et al. [6] also proposed a similar recommendation method as the one proposed in [5], however, in their method a user registers his/her preference on ingredients in advance before using the system.

On the other hand, our system does not deal with only user's preference on ingredient to recommend a recipe, but learns the user's behavioral partterns of selecting recipes as recommendation knowledge based on user's schedule, the date when the user uses the system, and the user's food record. By using the acquired knowledge and user's preference in recommendation, we have constructed a system that can recommend "easy" recipes considering the user's conditions.

VIII. Conclusion

In this paper, we have proposed a method to recommend "easy" recipes considering "user's conditions" — In the proposal, we have introduced a scoring method to estimate easiness of a recipe in terms of cooking, and have introduced recommendation knowledge for a recipe considering user's conditions. The system acquires the knowledge about users' preferences and their behavioral patterns of choosing recipes by analyzing user's browsing history of recipes, the record of user's having food. Based on scoring the recipes and the acquired knowledge, the system outputs recommended recipes in the order of easy cooking, considering user's conditions.

We have conducted a small experiment to use our developed system. Though we have not yet got a quantitative evidence, the experiment subjects were considerably satisfied with the system's output result.

As the future work, we are going to conduct an experiment to confirm our proposed method useful and to further develop the system based on the result of the experiment.

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