Extraction of Naming Concepts Based on Modifiers in Recipe Titles

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***Abstract*—On user-generated recipe-sharing sites such as Rakuten recipe, various modifiers such as "Kid-friendly" and "Simple" are often used in the titles of the recipes to signify thier characteristics. Although a modifier is used in a number of recipes' titles, the underlying concepts utilized vary. In this paper, we propose a method that extracts Naming Concepts for recipes based on modifiers in their titles. Specifically, we obtain typical ingredients and cooking utensils by summarizing the recipes for a dish to extract the differences between the elements of recipes and the typical elements in terms of addition, deletion and exchangeability and extract additional information from procedures. Then, we identify Naming Concepts for the recipes by extracting feature patterns based on the differences extracted and grouping them on the basis of the patterns. We also present a system that provides recipes with granted Naming Concepts for readers.**

***Index Terms*—Modifiers, Cooking Recipe, Naming Concepts.**

I. INTRODUCTION

COOKING is one of the most important creative activities in daily life. Nowadays, we can obtain large numbers of recipes from cooking websites. For example, Rakuten recipe [1] provides over 740,000 user-generated recipes written in Japanese. COOKPAD [2], another famous cooking website, provides more than 1,600,000 recipes. Although these websites have recipes that meet a wide variety of users' demands, they are difficult to find because numerous recipes for any particular dish are available on the sites. For example, when we searched for recipes on the Rakuten recipe website using the query "carbonara," we were presented with more than 1,300 different recipes. Thus, in order to find recipes that meets users' demands, invariably, clear distinctions must be made among recipes. In this paper, we propose a method called to extract "Naming Concept," which can identify the features of each recipe.

Each recipe on the Rakuten recipe website comprises a title, dish categories, an ingredient list, and a procedure that gives step-by-step instructions on how to cook the dish. Here, recipe titles are typically represented in the form "modifier + dish name." For example, in the two titles, "Simple! carbonara" and "kid-friendly omelette rice," "Simple!" and "kid-friendly" are modifiers and "carbonara" and "omelette rice" are dish names. The modifiers are assigned after considering the features of each recipe. In addition, the same modifier might be used in different ways. Fig. 1 shows Naming Concepts for recipes whose titles include the modifier "Kid-friendly." In the figure, there are three types of Naming Concepts: "Kid-friendly" is used in the title of a recipe in the first type of Naming Concept because soy milk, which is considered to be preferred by many children, is used as an ingredient in carbonara instead of garlic and milk. In the second type of Naming Concept, the same modifier is used from a procedure in each recipe because a mixer is additionally used to mince the ingredients and enable children to eat without difficulty.

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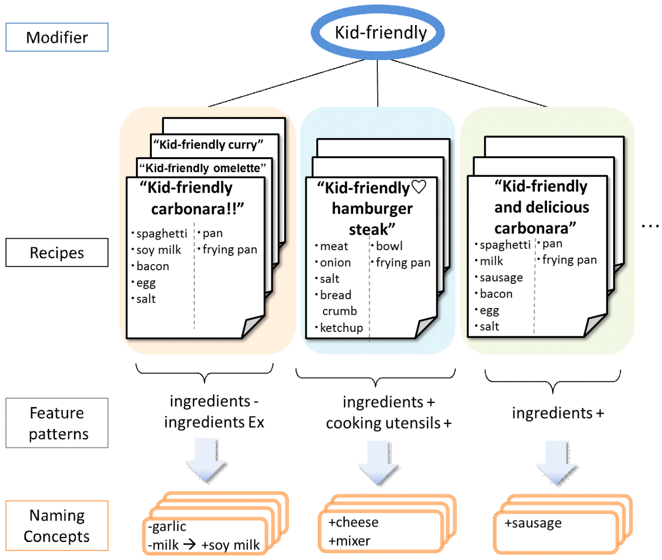

Fig. 1. A modifier of recipes based on Naming Concepts

In this paper, we propose a method that extracts Naming Concepts for recipes by identifying the characteristic ingredients, cooking utensils, and procedure in each recipe using the following four steps: 1) extracting the typical ingredients and cooking utensils for the dish, 2) extracting the differences between the typical elements of the dish and the elements of a recipe for the same dish, 3) extracting tips as additional information, 4) grouping recipes with the same modifier by feature patterns of the differences.

The remainder of this paper is organized as follows: Section II discusses related work. Section III presents our procedure for extracting Naming Concepts from recipes in detail. Section IV shows the Naming Concepts for some recipes and discusses experimental results obtained. Finally, we conclude this paper and outline future work in Section V.

II. RELATED WORK

Ueda et al. [3] proposed a method that recommends personalized recipes by measuring each user's food preference based on ingredients extracted from the user's recipe browsing and cooking history.

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Tsukuda et al. [4] proposed a method that enables users to browse from the current recipe to a desired recipe by adding one element into it or deleting one element from it. However, they considered only element addition and deletion, whereas, we consider both those factors along with element exchangeability. Tsukuda et al. [5] also analyzed the typicality of an object from two viewpoints: target of analysis and type of typicality. By contrast, we extract typical elements and identify differences by comparing the elements of a particular recipe with the typical elements used for the dish. Yamakata et al. [6] proposed a method that creates a typical cooking procedure from multiple recipes by converting each recipe text into recipe trees and by integrating them. Then, they extract features of each recipe by comparing with the typical one. Although this work is similar to ours in terms of its attempt to define typicality and to extract recipe features on the basis of typicality, our work differs in that our aim is to extract recipe features based on modifiers.

Approaches focusing on modifiers include the method proposed by Takahashi et al. [7] to measure relevancy between a web text and modifiers in its title by extracting suitable words and conflicting words. The method determines whether modifiers are relevant to the contents or not by measuring information credibility. By contrast, our assumption is that recipes' Naming Concepts based on modifiers in their titles can be interpreted from multiple perspectives.

Chung [8] proposed an efficient method that finds related words in a recipe domain using a data structure. Interestingly, their investigations revealed that people usually write the main ingredient in the first position of the ingredients list of each recipe and that such an ingredient is strongly related to the categories to which the recipes belong. Nanba et al. [9] constructed a recipe ontology based on Chung's method [8] and distributional similarity [10][11], which they used for multi-recipe summarization. We utilize this ontology to extract Naming Concepts.

III. Extraction of Naming Concepts based on Modifiers in Recipe Titles

A. Our Proposed Approach

In this work, we define Naming Concepts as features of recipes that present concepts of modifiers. We assume that a Naming Concept can be extracted by considering the differences in the various recipes for a dish and the patterns of differences in the recipes of a modifier. On the right side of Fig. 2, the arrows indicate the differences between typical elements of a dish and the elements of each recipe. For example, in the analysis focused on the recipe with the title "Kid-friendly carbonara!!," we can extract atypical ingredients and cooking utensils by analyzing the recipes for "carbonara." Focusing on the modifiers of the recipes, we extract the elements that can possibly signify the features of the recipes such as deletion of ingredients or exchange of cooking utensils. On the left side of Fig. 2, we extract the pattern of differences between a set of recipes based on a modifier. Consequently, our proposed method extracts Naming Concepts by extracting elements that are typically used in the dish from recipes for the same dish, extracting the elements that are different from the typical elements in each recipe, extracting additional information from the procedures, and grouping the recipes using feature patterns.

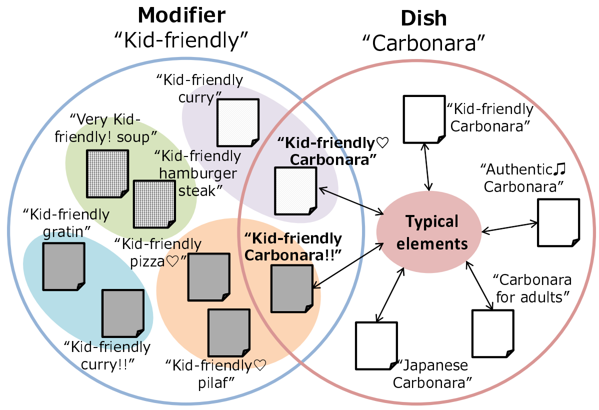

Fig. 2. Extracting typical elements and Naming Concepts based on relations between modifier and dish

We extract Naming Concepts as follows:

1) Extracting elements that are typical in the recipes
2) Extracting the differences of recipes
3) Extracting additional information
4) Grouping recipes based on feature patterns

The steps used to extract Naming Concepts are described in Sections III-B – III-E, respectively.

B. Extracting Elements that are Typical in the Recipes

In this work, R is constructed from a set of recipes separated by dish categories. A recipe r_{j_k} belongs to a dish category j consisting of M_{j_k}, I_{j_k}, and U_{j_k}. M_{j_k} is a set of modifiers included in the title of the recipe r_{j_k}. I_{j_k} is a set of ingredients of the recipe r_{j_k}, and U_{j_k} is a set of cooking utensils in the procedure of the recipe r_{j_k}. Then, M, I, and U are universal sets of modifiers, ingredients, and cooking utensils, respectively.

$$R = \{R_1, ...R_j, ...R_m\},$$
$$R_j = \{r_{j_1}, ...r_{j_k}, ...r_{j_n}\},\ r_{j_k} = (M_{j_k}, I_{j_k}, U_{j_k})$$
$$M_{j_k} \subset M,\ I_{j_k} \subset I,\ U_{j_k} \subset U$$
$$M = \{m_1, m_2, ...\},\ I = \{i_1, i_2, ...\},\ U = \{u_1, u_2, ...\}$$

In this work, we assume that the Naming Concepts of modifiers are detected in the differences between a recipe and its typical elements. Therefore, we extract typical elements of a recipe for a dish. One recipe's data is input, and we extract ingredients $t_j.I'$ and cooking utensils $t_j.U'$. Here, t_j is a set of recipe R_j of a category that one recipe belongs to. In this work, we consider ingredients and cooking utensils that are frequently used as typical ingredients and cooking utensils for a dish. Therefore, we extract ingredients and cooking utensils from a set of recipes R_j and calculate recipe frequency (RF) of each element. Thus, a set of typical elements t_j consists of a set of ingredients I', which means that RF is α and over and a set of cooking utensils U' which means that RF is β and over, as follows:

$$\begin{aligned} t_j &= (I', U'),\ t_j \in T \\ t_j.I' &= \{i_l | RF(i_l, R_j) > \alpha, i_l \in I_j\} \\ t_j.U' &= \{u_o | RF(u_o, R_j) > \beta, u_o \in U_j\} \end{aligned}$$

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C. Extracting the Differences of Recipes

Next, we extract the differences between elements of a recipe r_{j_k} and the typical elements t_j in the category R_j to which that recipe belongs. First, we extract a set of additional ingredients I_{add}, a set of deleted ingredients I_{del}, a set of additional cooking utensils U_{add}, and a set of deleted cooking utensils U_{del} as differences.

$$\begin{aligned} I_{add} &= r_k.I - t_j.I' \\ I_{del} &= t_j.I' - t_k.I \\ U_{add} &= r_k.U - t_j.U' \\ U_{del} &= t_j.U' - t_k.U \end{aligned}$$

We determine the relation between the differences of the extracted ingredients and the cooking utensils, because in some cases one different element influences another different element, or different elements are independent of each other, making it irrelevant. Next, the element included in a set of additional elements I_{add} and U_{add} is represented by $+$, and then in a set of deleted elements I_{del} and U_{del} is represented by $-$. For example, when we compare the ingredients of a recipe with a title such as "healthy sweet and sour pork" that has typical ingredients "healthy sweet and sour pork," we extract differences $I_{add} = \{chicken, bambooshoot\}$, $I_{del} = \{pork, liquor\}$. Then, we use "chicken" instead of "pork," so we consider that these correspond. Conversely, "bamboo shoot" and "liquor" are only added and deleted; therefore, they have no relation. Thus, in a scenario where an element $+$ is included in I_{add} or U_{add} and an element $-$ is included in I_{del} or U_{del} correspond mutually, we consider that they have an exchangeable relation. Otherwise, we consider that there is no relation between their differences.

In order to determine relations, we calculate the degree of co-occurrence between different elements. In general, when two elements $+$ and $-$ are exchangeable, we consider that they do not co-occur. Therefore, a recipe that contains element $+$ does not contain element $-$, and a recipe that contains element $-$ does not contain element $+$. Thus, when the frequency of co-occurrence is low, we consider that elements $+$ and $-$ are exchangeable. Then, we pair elements $+$ and $-$ and extract the pair as differences in order to determine their relations. Consequently, we calculate the degree of co-occurrence of the various pairs of elements. Next, we treat element $-$ (which is included as a typical element) and element $-$ (which is included in one recipe) as denominators. In cases where only the degree of co-occurrence based on a typical element and one recipe are lower than the threshold amount, we determine that the different elements in the pair have an exchangeable relation. Therefore, a pair comprising different elements is added to a set of pairs comprising exchangeable ingredients I_{ex} or a set of pairs comprising exchangeable cooking utensils U_{ex}, and the elements that fall under I_{add} and I_{del}, or U_{add} and U_{del} are deleted. Then, the exchangeability relation of the different elements are determined and signified as "-** $\rightarrow$ +**" using the arrow. For example, we represent the recipe called "easy carbonara" that contains "+microwave" and "-pan" in cooking utensils as "-pan $\rightarrow$ +microwave." On the other hand, when the degree of co-occurrence of different elements is higher than the threshold amount, we consider that the different elements in the pair are independent, and therefore have no relations. Thus, we determine that elements $+$ are additional elements and elements $-$ are deleted elements.

D. Extracting Additional Information

We consider that recipes' features of modifiers can be extracted from cooking procedures. For example, recipes for "Kid-friendly" may have features such as "small cut" and "easy-to-eat size." Therefore, we extract these features by analyzing the cooking procedures for the recipes. In order to extract them, we use word segmentation on the cooking procedures. Next, the cooking procedures are associated with word classes. We then extract additional information by dependency parsing.

E. Grouping Recipes based on Feature Patterns

We define the feature patterns of recipes $P_{r_{j_k}}$ based on viewpoints grouped by the relations between different elements in Section III-B. More specifically, we define them based on a set of six viewpoints: additional ingredients I_{add}, deleted ingredients I_{del}, exchangeable ingredients I_{ex}, additional cooking utensils U_{add}, deleted cooking utensils U_{del}, and exchangeable cooking utensils U_{ex}. Then, to simplify, we represent patterns using binary vectors: when the element count is one or more, we present "1"; when the element count is zero, we present "0."

$$\begin{aligned} P_{r_k} = [&bi(|I_{add}|), bi(|I_{del}|), bi(|I_{ex}|), \\ &bi(|U_{add}|), bi(|U_{del}|), bi(|U_{ex}|)] \end{aligned}$$

We group recipes that use the same modifier by the feature patterns of viewpoints that have up to 64 ($= 2^6$) patterns as Naming Concepts of modifiers.

IV. Experiment

A. Dataset

We conducted an experiment using a recipe dataset provided by Rakuten Data Release from Rakuten Institute of Technology. From the dataset, we selected 192 recipes whose titles included the modifier "kid-friendly." We then extracted ingredients and cooking utensils as recipe elements by considering inconsistent spelling using a recipe ontology [9] that we constructed by integrating methods for extracting related words of a given word based on the data structure of user-generated recipes [8] and summarizing multi-documents. In order to extract the typical ingredients and cooking utensils for a dish, we calculated RF (Recipe Frequency) of all the recipes used in ten recipes for the dish. In the experiment, we set the values of thresholds α and β at 0.5. TABLE I presents the typical elements extracted for three dishes: hamburger steak, carbonara, and curry.

B. Result: Naming Concept Extraction

We extracted different elements by comparing the elements in a recipe with the typical elements for that recipe. Examples of the recipes used to extract Naming Concepts are shown in TABLE II, and examples of the elements that differ from typical elements are shown in TABLE III. In order to determine the relations between different elements, we made all possible pairs of elements of $+$ and $-$ from the set of different elements.

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TABLE I
TYPICAL ELEMENTS IN RECIPE CATEGORIES

	hamburger steak	carbonara	curry
I	onion ground meat bread crumb salt pepper egg nutmeg Worcester sauce ketchup milk cooking oil	egg pepper salt bacon spaghetti cheese water cooking oil fresh cream garlic	curry powder onion water rice carrot cooking oil salt butter
U	frying pan bowl	frying pan	pan

TABLE II
EXAMPLE OF RECIPES

	Kid-friendly, excellent and simple cheese in hamburger steak	Kid-friendly carbonara of tuna and corn	Beans curry can eat with children
I	ground meat onion butter bread crumb soy milk egg salt pepper wine sauce ketchup cheese tomato	spaghetti cheese egg milk Non-dairy creamer pepper cooking oil garlic tuna corn water	onion garlic tomato soy bean ground meat curry powder soy milk water cooking oil
U	bowl frying pan	bowl frying pan	mixer frying pan

Next, we calculated the ratio of co-occurrence of each pair $+$ and $-$ in all the recipes for a dish. In the experiment, we set the value of the threshold at 0.1. Then, when the degree of co-occurrence was lower than the threshold, we determined the relation of the pair to be exchangeable. Conversely, when the degree of co-occurrence was higher than the threshold, we determined that no relation existed between the pair. TABLE IV presents the results of the determination of the exchangeability relation using the typical elements in TABLE I and target recipes in TABLE II and calculating the degree of co-occurrence. We calculated the number of recipes containing elements $+$ and $-$ as the denominator, and determined the exchangeability relation when the degree of co-occurrence was lower than the threshold. We present the results for the extracted differing elements and features in the three recipes. Then, we present the different elements and viewpoints in TABLE V

We grouped 150 recipes into feature patterns of differences extracted from the experimental recipes, and extracted Naming Concepts for the modifier "kid-friendly." The recipes were grouped into 21 patterns from the 64 patterns in Section III-E. In TABLE VI, we present the feature patterns grouped as more than five percent. As a result, eight patterns included the feature I_{ex} and five patterns included the feature I_{del}.

TABLE III
ELEMENTS THAT DIFFER FROM TYPICAL ELEMENTS

	Kid-friendly, excellent and simple cheese in hamburger steak	Kid-friendly carbonara of tuna and corn	Beans curry can eat with children
I_{add}	+butter +soy milk +wine +cheese +lettuce +tomato	+milk +Non-dairy creamer +tuna +corn	+garlic +tomato +soy bean +ground meat +soy milk
I_{del}	-nutmeg -milk -cooking oil	-salt -bacon -fresh cream	-rice -carrot -salt -butter
U_{add}		+bowl	+mixer +frying pan
U_{del}			-pan

TABLE V
RESULTS OF EXTRACTED DIFFERENCE ELEMENTS AND FEATURES IN THE THREE RECIPES

recipe titles	different elements	viewpoints
Kid-friendly, excellent and simple cheese in hamburger steak	+wine +cheese +lettuce +tomato -cooking oil -nutmeg → +butter -milk → +soy milk	I_{add} I_{del} I_{ex}
Kid-friendly carbonara of tuna and corn	+milk -salt -fresh cream → +Non-dairy cream -bacon → +tuna -bowl	I_{add} I_{del} I_{ex} U_{del}
Beans curry can eat with children	+garlic +tomato +ground meat +soy milk -rice -salt -butter -carrot → +soy bean +mixer -pan → +frying pan	I_{add} I_{del} I_{ex} U_{add} U_{ex}

TABLE VII presents recipe titles grouped into the top-three patterns. The recipes grouped by feature patterns do not become unbalanced because of the dishes. Therefore, recipes for the same dish are grouped by various patterns.

C. Discussion

In our extractions, typical cooking utensils that are normally included in typical elements were not included. For example, when cooking carbonara, a pan is typically used to boil spaghetti. However, in the experiment, it was not included in the typical elements because there were few recipes that had "pan" expressly written. When we extracted difference elements, cooking utensils were included in the difference elements that were normally included in typical elements because cooking utensils were used in pictures, but not included in the procedures. In the future, we need to

TABLE IV
RESULTS OF CALCULATION OF CONFIDENCE FOR JUDGING THE RELATION

recipe titles	pairs to determine relations	degree of co-occurrence		exchangeable
		+	−	
Kid-friendly, excellent and simple cheese in hamburger steak	+butter, -nutmeg	0.12	0.16	
	+butter, -cooking oil	**0.06**	**0.05**	○
	+soy milk, -milk	**0.00**	**0.00**	○
	+wine, -milk	**0.00**	0.18	
Kid-friendly carbonara of tuna and corn	+milk, -fresh cream	0.24	0.17	
	+Non-dairy cream, -fresh cream	**0.00**	**0.00**	○
	+tuna, -bacon	**0.00**	**0.00**	○
	+corn, -bacon	**0.00**	0.25	
Beans curry can eat with children	+garlic, -salt	0.13	0.23	
	+garlic, -butter	0.10	**0.06**	
	+tomato, -carrot	**0.04**	0.13	
	+soy bean, -carrot	**0.00**	**0.09**	○
	+ground meat, -carrot	**0.00**	0.15	
	+mixer, -pan	0.70	**0.00**	
	+frying pan, -pan	**0.00**	**0.00**	○

TABLE VI
NAMING CONCEPTS FOR ”KID-FRIENDLY”

	I_{add}	I_{del}	I_{ex}	U_{add}	U_{del}	U_{ex}	appearance ratio
pattern1	0	0	1	0	0	0	18 %
pattern2	0	1	1	0	0	0	18 %
pattern3	0	0	1	0	1	0	8 %
pattern4	0	1	1	1	1	0	7 %
pattern5	1	1	1	0	0	0	6 %
pattern6	0	1	1	1	0	0	5 %
pattern7	1	1	1	0	1	0	5 %
pattern8	1	0	1	0	0	0	5 %

TABLE VII
RECIPE TITLES GROUPED INTO THE TOP-THREE PATTERNS

pattern	recipe titles
pattern 1	Kid-friendly! Sweet and sour pork of pork loin
	Smile for children 3 kinds of hamburger steaks
	Kid-friendly hamburger steaks of fish
	Healthy, big and kid-friendly hamburger steak with vegetable
	Kid-friendly the curry with being grated up vegetable
	Chocolate in the curry for children
	Kid-friendly! Corn in the curry for children
	The curry for children
	The curry eat with children
	Kid-friendly milk curry
	The curry for children with a milk
pattern 2	Tomato in the sweet and sour pork kid-friendly!
	The hamburger steak in Denmark! Kid-friendly!
	Kid-friendly hamburger steaks of tohu
	Kid-friendly hamburger steaks! Not use flour and egg
	Kid-friendly hamburger steaks with many kinds of vegetables
	For children don’t like vegetables! Hamburg steak of green pepper
	Kid-friendly! Curry with pork cutlet and mushroom
	Kid-friendly Cheese hamburg steak
	The curry for children!
pattern 3	Kid-friendly sweet and sour pork with potato
	Kid-friendly and soft hamburg steak
	Kid-friendly! Hamburg steak with hijiki
	Kid-friendly! Raisin in dried curry
	Simple and kid-friendly curry in Keema
	Kid-friendly Curry of Japanese radish and tohu
	Kid-friendly mochi in the curry

improve the extraction of typical elements and determine the exchangeability relations. Therefore, we consider that we can make up for cooking utensils by inferring the cooking utensils used from the actions in the procedures. For example, we can infer that “boil” means “pan” and “fry” means “frying pan,” and so on.

When we determined the exchangeability relation and compared our results with the correct data, we found that a number of pairs had appropriately determined the relation. However, with regard to cooking utensils, there are many recipes in which only actions are written (e.g. “boil” and “fry”). Therefore, cooking utensils that would not normally determine the relation of exchangeability here, do so because of the lowness of their degree of co-occurrence, resulting from them not being cooking utensils are not expressly written in recipes.

In TABLE V, we consider that the Naming Concepts for “kid-friendly” are addition, deletion, and exchange of ingredients. For example, in the recipe for carbonara in TABLE V, we could extract the exchangeability relation in which “tuna” is used instead of “bacon” as the feature. Thus, there are also many recipes that include cooking utensils as Naming Concepts. However, there are some extracted cooking utensil elements for which it is difficult to consider that the elements are Naming Concepts. For example, in the recipe for curry in TABLE V, we extracted and used “frying pan” instead of “pan.” However, it is difficult to consider these elements as Naming Concepts. Therefore, we need to consider whether extracted elements really present the concepts of modifiers or noise.

In the results of grouped recipes based on feature patterns and extracted Naming Concepts, we found that recipes included in the same category have various Naming Concepts such as those listed in TABLE VII. In this paper, we extracted Naming Concepts for “kid-friendly.” However, we need to extract more Naming Concepts for various modifiers. By comparing the difference between modifiers, we could analyze the relations between modifiers. For example, when the trends for Naming Concepts are similar between modifiers, they have similar relations.

Fig. 3 depicts a system that presents the Naming Concepts of recipes based on our method. In this system, when a user searches for recipes containing modifiers such as “Kid-friendly” and “Simple”, it is difficult to understand the features of the recipes because a list of search results often show only titles and pictures for the recipes. Therefore, if

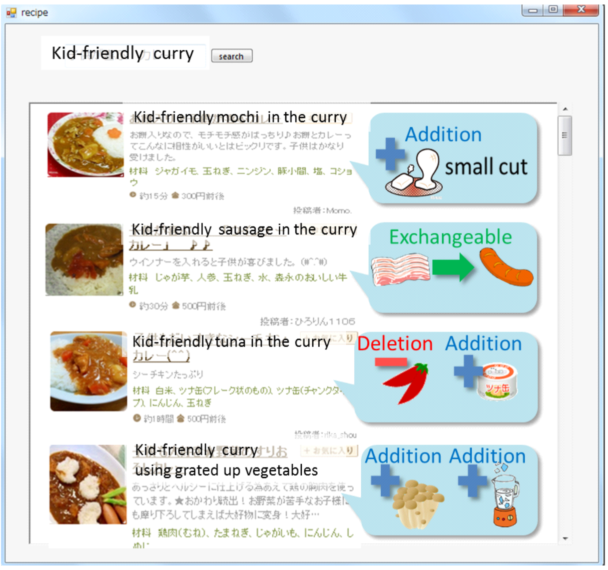

Fig. 3. System for retrieving and presenting recipes with Naming Concepts

users want to know the features of the recipes, they look into the details of each recipe. However, it is a really daunting task and determining its features is a time-consuming process. Therefore, our system enables users to comprehend the features of the recipes solely by checking the list of search results.

V. Conclusion

In this work, we proposed a method that extracts Naming Concepts for recipes, which are defined as characteristic elements summarized by modifiers in the recipes' titles. We extracted different elements of ingredients and cooking utensils, determined the relations between them by calculating their degree of co-occurrence and extracted Naming Concepts by grouping the recipes based on feature patterns. Further, we experimented with a real recipe dataset to extract the Naming Concepts of given recipes.

In future work, we plan to enable the inferring of cooking utensils that are not written expressly in procedures because we found that typical cooking utensils tend to be omitted in the procedures of recipes. For instance, although we generally use a "frying pan" when "frying" something, it is often omitted because users/readers can easily associate the action "fry" with the cooking utensil "frying pan" in the recipes. Therefore, we plan to infer cooking utensils from procedures by considering actions in procedures.

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References

[1] Rakuten recipe, http://recipe.rakuten.co.jp/.
[2] COOKPAD, http://cookpad.com/.
[3] M. Ueda, M. Takahata, and S. Nakajima, "User's Food Preference Extraction for Cooking Recipe Recommendation," Proc. of the 2nd Workshop on Semantic Personalized Information Management: Retrieval and Recommendation, pp.98-105, 2011.
[4] K. Tsukuda, T. Yamamoto, S. Nakamura, and K. Tanaka, "Plus One or Minus One: A Method to Browse from an Object to Another Object by Adding or Deleting an Element," Proc. of the 21st International Conference on Database and Expert Systems Applications, pp.258-266, 2010.
[5] K. Tsukuda, S. Nakamura, T. Yamamoto, and K. Tanaka, "Typicality Analysis of an Object and its Application to Search," WebDB Forum 2011, 2G-1-2, 2011, (in Japanese).
[6] Y. Yamakata, S. Imahori, Y. Sugiyama, S. Mori, and K. Tanaka, "Feature Extraction and Summarization of Recipes using Flow Graph," Proc. of the 5th International Conference on Social Informatics, LNCS 8238, pp.241-254, 2013.
[7] R. Takahashi, S. Oyama, H. Ohshima, and K. Tanaka, "Evaluating Truthfulness of Modifiers Attached to Web Entity Names," Proc. of the 11th International Conference on Web-Age Information Management, pp.429-440, 2010.
[8] Y. Chung, "Finding Food Entity Relationships using User-generated Data in Recipe Service," Proc. of the 21st ACM International Conference on Information and Knowledge Management, pp.2611-2614, 2012.
[9] H. Nanba, Y. Doi, M. Tsujita, T. Takezawa, and K. Sumiya, "Summarization of Multiple Cooking Recipes," The 5th Symposium on Wisdom of Crowds, Vol.113, No.338, NLC2013-41, pp.39-44, 2013, (in Japanese).
[10] L. Lee, "Measures of Distributional Similarity," Proc. of the 37th Annual Meeting of the Association for Computational Linguistics, pp.25-32, 1999.
[11] D. Lin, "Automatic Retrieval and Clustering of Similar Words," Proc. of the 36th Annual Meeting of the Association for Computational Linguistics and the 17th International Conference on Computational Linguistics, pp.768-774, 1998.