Vol.2015-MPS-104 No.12
2015/7/27

Recipe clustering based on Japanese Food Guide Spinning Top

Yasuhiro Tajima[1,a)] Yoshihiro Suwa[1] Genichiro Kikui[1] Rikako Inoue[2] Megumi Kubota[2]

Abstract: Food recipe site is one of the hottest web service in recent years. Especially, a user posting style recipe site is the most popular service style. Such a recipe site contains thousands recipes posted by users, and the variation is very wide such that daily meal, take out foods, special conditioned meal for allergy and so on. On the other hand, Japanese government prepares an illustrated tool called "Japanese Food Guide Spinning Top" for selecting daily foods. There are some classes of foods and if you select foods from each class then daily food balance will be kept good. We propose an automatical method to classify a recipe to a class of the foods in Japanese Food Guide Spinning Top. Experimental evaluation is done and we obtain about 70% of accuracy as the result.

1. Introduction

Recipe sites are the hottest web service, now. There are many service sites and we can summarize them into the following types.

- User posting style : Service site is operated by some companies but recipe contents are constructed from users' post. Various and many recipes can be gathered but it is difficult to keep the service provider's policy for each recipes. There are many similar recipes and reliability is also low.
- Operated by an organization : one company or one organization controls all contents and recipes. For example, if a cooking school operates a recipe service site, then they can present nutrition values of each recipe. The balance of recipes can be controlled. For example, the site operator can select vegetable recipes as many as meat recipes.

Now, user posting style is more important for web technologies because there exists big data and remains many unorganized data. There are many related studies for user posting style recipe sites. In [2], the title of a recipe is evaluated whether it matches the recipe's content. In [3], using recipe clustering, subsutitutional ingredients are found from the recipe repository.

On the other hand, Japanese Food Guide Spinning Top is provided by Japanese government. This is a tool for selecting daily foods to balance nutrition. In this tool, there are 6 class of foods and if we take appropriate quantity from each class per day, then we can keep healthy life.

In this paper, we propose a mapping method from a recipe to the class on Japanese Food Guide Spinning Top. Then experimental evaluations are also done.

[1] Department of Systems Engineering, Okayama Prefectural University, 111 Kuboki, Soja, Okayama, Japan
[2] Department of Nutritional Science, Okayama Prefectural University, 111 Kuboki, Soja, Okayama, Japan
[a)] tajima@cse.oka-pu.ac.jp

2. Japanese Food Guide Spinning Top

Japanese Food Guide Spinning Top[1] is an illustrated tool for daily food choice. This tool is provided by Japanese Ministry of Agriculture, Forestry and Fisheries. In the following, we call this tool the Guide for short. This guidance consists of the following components.

[Spinning Top]

The illustration expresses the balance of daily food. It represents the quantity image of daily eating. This spinning top is divided into following three dishes and three items.

(1) Grain dishes
This dish provides carbohydrates. For example, rice, bread, noodles and so on.

(2) Vegetable dishes
This dish provides vitamins, minerals or dietary fiber. For example, vegetables, tubers, corms, bulbs, mushrooms, seaweeds and so on.

(3) Fish and Meat dishes
This dish provides proteins. For example, meat, eggs, fishes, beans and so on.

(4) Milk
This item provides calcium. Milk and dairy products are classified into this item.

(5) Fruits
Any fruits are classified into this item.

(6) Sweets
We can also take little sweets.

These dishes and items are called the "class" in the Guide. Every class contain some example figures of foods. The center axis of the spinning top represents water. Healthy life can be kept since we make the spinning top rounding and standing.

[Target SV(serving) values]

The SV value (which means SerVing value) is the target quantity for every class in the Guide. One SV means about one meal. Target values are set as follows.

- Grain dishes : 5 to 7 SV
  Here, 1 SV is about 40g of carbohydrates. Thus 5 to 7 SV per day means 200g to 280g carbohydrates to eat per day. In Japan, rice is served by a rice bowl which contains about 100g, and 100g of rice contains about 40g carbohydrates, then a regular size of rice bowl serves 1 SV.
- Vegetable dishes : 5 to 6 SV
  Here, 1 SV is about 70g of foods' net weight in this class.
- Fish and Meat dishes : 3 to 5 SV
  Here, 1 SV is about 6g of protein. It is hard to find the net weight of protein which is contained in a food. Thus, there are some examples to count this SV value. An egg dish has 1 SV. A fish dish has 2 SV. A meat dish has 3 SV. This is very rough counting method, but easy counting is prior to accuracy.
- Milk : 2 SV
  Here, 1 SV is about 100mg of calcium. When we use this tool, we regard a cup of milk as 1 SV.
- Fruits : 2 SV
  Here, 1 SV is about 100g of foods' net weight. In many case, we count 1 piece of fruit as 1 SV.
- Sweets does not have SV value, because little quantity is allowed to eat per day.

[Examples of dishes and SV value]
This area represents examples of dishes and example SV values of dishes. There are some figures of foods and whose SV values. The SV values are aimed to balance the quantity of daily eating but finding precise values is difficult for every dishes. Thus, such illustrated guide of dishes are useful to find rough SV values. Such roughness is more important to use this tool continuously.

With this illustrated tool, we can count the total SV values for each meal or the total value of every day. We can take balanced meals by aiming the SV values of each dishes or items at the target values.

3. Classification of Recipes

3.1 Rakuten recipes

Rakuten Recipe is one of the most popular recipe website in Japan. And there are repositories of recipes for research or study use[5] called Rakuten data. There are following compositions.

[Recipe Title] : This title is set by the user who submit the recipe to Rakuten recipe site. So, it tends to more impressive word will be written by the author.

[Photos] : This photo is the dish after cooking. This is taken by the author of this recipe and usually dish quantity is as same as the following ingredients list.

[Ingredients List] : The list of ingredients also provided by the author of this recipe. Every entry of the list consists of a ingredient's name and its quantity. These name and quantity are also provided by the author of this recipe.

[Cooking Procedure] : Cooking procedure consists of the text of the process and its photo. Some steps does not have a photo and only text description is remained.

[Comments] : In this site, user can add a comment to the recipe which is called "making report" (in Japanese "Tsukurepo").

[Categories] : Every recipe has its three categories, that is big category, middle category and small category. The big category has the following nine names:

- Grain dish
- Side dish
- Snacks
- Takeout foods
- Sauce or Jam
- Drinks
- Season foods
- Local foods
- Special purpose

Middle and small categories are defined for every big category. For example, the middle category for Snacks is as follows.

- Snacks/Cakes
- Snacks/Foreign snacks
- Snacks/Japanese snacks
- Snacks/Others

Small category is defined for every middle category, then there are 733 small categories. The total number of middle categories is 61.

There are about 410 thousand recipes in Rakuten data.

3.2 Making correct classification

Using the category labels, we make a correct data of the Guide. The correct data is hand made and the following is how to make the correct data.

(1) If the big category is identical to a class in the Guide, then all recipes in the big category is marked by the class name in the Guide. For example, the big category "Grain dish" can obviously be classified into "Grain dishes" class in the Guide.

(2) If the big category can not be decided into one class in the Guide then, using middle category, we try to select a class in the Guide. For example, recipes with the middle category of "Snacks/Cakes" are classified into "Sweets" class in the Guide.

(3) If we can not decide one class by the above step then, using the small category, we try to select a class in the Guide.

(4) If we can not decide one class using small category then all recipes with the small category is classified int "Others" class.

With the above process, we can classify all recipes in Rakuten data into classes of the Guide.

Table 1 shows the number of recipes of each class in the Guide.

3.3 Classification method

Classification is done by Support Vector Machine(SVM for short)[4] in our experiments. The kernel is not used (=linear) and soft margin parameter is found by preliminary experiment.

The input vector of the SVM has the size of the vocabulary of

learning data. It means that each element of an input vector is identical to a word of learning data. All texts in learning data are morphological analyzed by mecab[6]. The value of each element of an input vector is TF-IDF value where a recipe is a document.

For multi-label classification, we use one-versus-rest method with SVM. In this setting, we make n SVMs for n-class classification. Then, it is selected that the class whose SVM has the longest distance from the hyperplane. With this condition, we evaluate the performance of the classification method.

4. Experiments and Results

At first, we make input vectors from restricted morphemes. For the texts of cooking process and the table of ingredients, we restrict the following morphemes. The input vectors are constructed from one of these combinations.

- verb
- noun
- noun + verb
- noun + verb + adjective

Evaluation is done by 5-fold cross validation. All results are the average of these 5 tests. Table 2 shows the accuracy of the output of one-versus-rest method. Here, accuracy is calculated by the following equation.

$$accuracy = \frac{correct\ inferred\ recipes}{all\ test\ recipes}$$

"correct inferred recipes" is the number of recipes whose correct class corresponds to the inferred class.

Bigger size of input vector marks high performance from this result. Especially, the accuracy becomes over 70% when the size is bigger than 20000.

Next, we show the performance of each SVM which is two values classifier. In one-versus-rest method, there are 7 SVMs for each class of the Guide. Each of them classifies that the input recipe is in the class or not. In the previous experiment, we select the final class by the distance from the hyperplane. In the next tables, we show the performance of each SVM. Table 3, 4 and 5 show precision, recall and F-value of each SVMs, respectively.

Here, precision, recall and F-value is calculated by the following equations.

$$precision = \frac{correct\ inferred\ recipes(each\ class)}{positive\ inferred\ recipes}$$

$$recall = \frac{correct\ inferred\ recipes(each\ class)}{positive\ labeled\ recipes}$$

$$F = 2/((1/recall) + (1/precision))$$

In this experiment, we are concerned with one target class. "correct inferred recipes(each class)" is the number of recipes which is correct inferred on the target class. "positive inferred recipes" is the number of recipes such that the SVM for the target class outputs the positive label. "positive labeled recipes" is the number of recipes whose correct class is the target class. For example, assume that the target class is Grain and every test data contains even numbers of Grain recipes, then "positive labeled recipes" for one test is 18287 (= 91436 / 5).

From these results, we find 0.56 F-value average when input vectors are made from noun, verb and adjective. The performances of Milk and Fruits are low because of few examples.

Next, we restrict text areas to construct input vectors. The following restrictions are evaluated.

- ingredients
- (cooking) process
- ingredients + (recipe) title
- process + title
- ingredients + process
- ingredients + process + title

Table 6 shows the accuracy of every condition. Obviously, text conditions which contain the recipe title get high performance than the others. From this, the recipe title name is useful for automatic classification even though upload users can select words in the title freely.

Table 7, 8 and 9 show precision, recall and F-value of each SVMs, respectively.

From these results, recipe title is also important to decide classes. Almost all conditions, if they contains the recipe title, the F-value is higher than that in the condition without the recipe title. Only on the condition that "ingredients + process + title" for Fruits, the F-value is smaller than that on "ingredients + process" for Fruits. This is also because of lack of learning examples.

5. Conclusions

We have shown a classification method for a recipe to a class on Japanese Food Guide Spinning Top. This is done by SVMs with one-versus-rest. The accuracy is about 0.7 to 0.8 and the title of the recipe is important to classify. For the future work, inferring SV value for a recipe is remaining. We can make the automatic food guide system if we can combining them.

References

[1] N. Yoshiike, F. Hyashi, Y. Takemi, K. Mizoguchi and F. Seino, A new food guide in Japan : the Japanese Food Guide Spinning Top, Nutr. Rev. vol.65, no.4, pp.149–154, 2007.
[2] R. Takahashi, S. Oyama, H. Ohshima and K. Tanaka, Measuring relevancy of modifiers in the recipe names on the user-generated recipe websites, IEICE Trans. (in Japanese), vol.J94-A, no.7, pp.467–475, 2011.
[3] Y. Shidochi, I. Ide, T. Takahashi and H. Murase, Finding replaceable materials by cooking recipe mining, IEICE Trans. (in Japanese), vol.J94-A, no.7, pp.532–535, 2011.
[4] N. Cristianini and J. S. Taylor, An introduction to support vector machines and other kernel-based learning methods, Cambridge Univ. Press, 2000.
[5] The Rakuten Data Release provided by Rakuten, Inc.
[6] MeCab: Yet Another Part-of-Speech and Morphological Analyzer : http://mecab.googlecode.com/svn/trunk/mecab/doc/index.html

Table 1 The number of recipes for each class in Japanese Food Guide Spinning Top

Grain dishes	Vegetable dishes	Fish and Meat dishes	Milk	Fruits	Sweets	Others
91436	134187	96967	3817	2143	44609	37819

Table 2 Accuracy of restricted morphemes

morphemes	input vector size	accuracy
verb	4961	0.5864
noun	21830	0.7658
noun + verb	25003	0.7722
noun + verb + adj	25410	0.7726

Table 3 Precision with restricted morphemes

morphemes	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
verb	0.6293	0.5580	0.5778	0.4262	0.0000	0.6470	0.4944
noun	0.8480	0.7383	0.7439	0.6100	0.4036	0.7708	0.6714
noun + verb	0.8531	0.7476	0.7506	0.5820	0.4181	0.7767	0.6682
noun + verb + adj	0.8534	0.7485	0.7509	0.5939	0.4148	0.7770	0.6685

Table 4 Recall with restricted morphemes

morphemes	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
verb	0.6316	0.7719	0.4966	0.0030	0.0000	0.6364	0.0950
noun	0.8631	0.8560	0.7466	0.1349	0.0437	0.8731	0.2370
noun + verb	0.8690	0.8586	0.7550	0.1524	0.0533	0.8744	0.2583
noun + verb + adj	0.8688	0.8596	0.7557	0.1533	0.0567	0.8743	0.2595

Table 5 F-value with restricted morphemes

morphemes	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
verb	0.6304	0.6477	0.5341	0.0059	0.0000	0.6416	0.1409
noun	0.8555	0.7928	0.7452	0.2203	0.0787	0.8187	0.3502
noun + verb	0.8610	0.7992	0.7527	0.2406	0.0940	0.8227	0.3723
noun + verb + adj	0.8610	0.8002	0.7532	0.2428	0.0995	0.8228	0.3737

Table 6 Accuracy of text restriction

text	input vector size	accuracy
ingredients	29377	0.7502
process	25410	0.7726
ingredients + process	53332	0.7885
process + title	34809	0.8119
ingredients + title	44251	0.8217
ingredients + process + title	61079	0.8090

Table 7 Precision with text restriction

text	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
ingredients	0.8590	0.7184	0.7213	0.4624	0.3488	0.7504	0.5911
process	0.8534	0.7485	0.7509	0.5939	0.4184	0.7770	0.6685
ingredients + title	0.8829	0.8178	0.7981	0.6330	0.4745	0.8179	0.7270
process + title	0.8726	0.8031	0.7915	0.6682	0.4607	0.8099	0.7194
ingredients + process	0.8667	0.7678	0.7641	0.6150	0.4415	0.7890	0.6936
ingredients + process + title	0.8723	0.8024	0.7842	0.6585	0.4356	0.8038	0.7175

Table 8 Recall with text restriction

text	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
ingredients	0.8426	0.8552	0.7371	0.0974	0.0508	0.8777	0.1424
process	0.8688	0.8596	0.7557	0.1533	0.0567	0.8743	0.2595
ingredients + title	0.9159	0.8718	0.8083	0.2743	0.1116	0.8983	0.4553
process + title	0.9087	0.8677	0.7903	0.2493	0.0595	0.8992	0.4317
ingredients + process	0.8901	0.8651	0.7756	0.1866	0.0554	0.8925	0.2843
ingredients + process + title	0.9032	0.8658	0.7896	0.2131	0.0495	0.8978	0.4271

Table 9 F-value with text restriction

text	Grain	Vegetable	Fish and Meat	Milk	Fruits	Sweets	Others
ingredients	0.8507	0.7808	0.7290	0.1601	0.0884	0.8091	0.2292
process	0.8610	0.8002	0.7532	0.2428	0.0995	0.8228	0.3737
ingredients + title	0.8991	0.8439	0.8031	0.3809	0.1798	0.8562	0.5597
process + title	0.8902	0.8341	0.7909	0.3624	0.1048	0.8522	0.5392
ingredients + process	0.8782	0.8135	0.7697	0.2848	0.0983	0.8376	0.4030
ingredients + process + title	0.8875	0.8329	0.7868	0.3206	0.0880	0.8482	0.5352