Toward an Advice Agent for Diet and Exercise Based on Diary Texts

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Abstract
Many people are interested in the prevention of disease and health-enhancing activities. In Japan, most of these people are anxious about some health-related issue such as decreased strength, stress, and chronic diseases. To improve one’s health, it is very important to manage diet and exercise. Various systems give advice on information easily captured by sensors, including body weight and exercise time. Considering that such health activities are likely to be recorded as text, we are developing a system to generate human-like advice for diet and exercise based on health related blog articles. When a user posts a blog article reporting his/her diet and/or exercise activities, the system posts advice for the article. The system extracts health information (diet and exercise) from blog articles using machine learning-based models that are trained on pairs of blog and advice articles. Herein, we report the current status and future work of our research. In the first phase, we created a corpus consisting of blog articles on health and advice on some of these, as the knowledge resource for the health advice system. To date, 1402 blog articles and 386 advice articles have been created. We are currently annotating the articles to extract health-related information.

Introduction
Many people are interested in health activities. In Japan, the Ministry of Health, Labour and Welfare has stated that the number of people interested in the prevention of disease and health promotion activities is increasing; most of these are anxious about some aspect of health such as decreased strength, stress, or chronic diseases. Therefore, we
can assume that society has much need for technologies supporting health activities.

Because many people are interested in their health, various services have been developed. As paid advisory services run by people, many health clubs provide individual consultations. Although such services provide good verbal advice on diet and exercise, there are some problems such as time constraints and high consultation fees. Moreover, as in face-to-face counseling, some people are hesitant to voice their personal experiences. Computerized advisory systems have been developed to generate concise advice on diet and exercise.

Such systems use information that is easily captured by sensors, such as body weight and exercise time. Although these systems are available anytime, anywhere, and at no cost, they can provide only brief messages such as ideal menus and charts.

There are many other studies of systems that support health activities using text messages. However, there is almost no research on systems using verbal communication like the ELIZA system (Weizenbaum 1966), which is one of the best-known pioneering systems. As an example of one of the very few dialogue systems for health, there is a project to develop a system that focuses on mental healthcare for soldiers (Morbini, DeVault, Sagae, Gerten, 6).

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2 http://www.konamisportsclub.jp/fitness/1on1/
3 http://www.ogsports.co.jp/start/program.html
4 http://www.nas-club.co.jp/program/gym/option/index.html
5 http://www.konamisportsclub.jp/appli/caloriecise/index.html
In this study, we focus on diet and exercise as information about health and report on the development of a system to generate human-like advice on such information based on health-related blog articles. Our study aims to provide motivation for health-related activities.

**Method**

It is not easy to generate health advice from blog articles written ungrammatically, mainly because of the three problems listed below:

- **Identification of Information about Health**
  
  A system giving health advice must identify the information in the blog article needed to provide such advice. In particular, the system should be designed considering that blog articles typically comprise ungrammatical text. That is, sentences in blog articles are not well formed like those appearing in newspapers. Therefore, in blog articles, ellipses are frequently used, and even simple sentences may be divided into a few sentences. Moreover, in Japanese articles, onomatopoeia is often used to represent a blog author’s behavior. Some examples are shown in Figure 1. In Figure 1(a), the first sentence represents the time for eating (that is, morning), while the following sentences enumerate the foods eaten by the author. However, in the text, there is no expression for “I ate”. Similarly, in Figure 1(b), the onomatopoeia “ペロリ (perori)” is used to express “I gobbled it up”. Considering the above, blog-specific formats (which are similar to spoken language) must be considered when extracting health information from blog articles.

- **Knowledge**
  
  Various types of knowledge must be stored as data to compare the author’s state of health (diet and exercise) extracted from blog articles with the ideal state. The knowledge is also used to suggest improvements for health activities. Therefore, we must investigate the knowledge used by managerial dieticians and exercise trainers.

- **Consistency**
  
  Although an advice text generally comprises two or more sentences, all the sentences may not refer to the same part of the article. To create a natural advice text, the system must consistently arrange the sentences in an appropriate sequence. For example, although the text in Figure 2(a) is easily understandable, this is not the case for that in Figure 2(b). In addition, the system must also remove redundant sentences and information.
Considering the above, we propose the method described in Figure 3. In this method, we construct a corpus of blog articles on health by creating both the blog articles and suitable advice articles for these. Information about health activities described in the blog articles is annotated to allow our system to extract information of the blog authors’ health activities. The system learns correspondence relationships between the health activities in the text and advice on the activities using the annotated corpus. The system uses the results of this learning as the knowledge resource for generating health (diet and exercise) advice on unseen articles. The output advice texts are presented after arranging the advice sentences consistently.

Current State

We have created 1402 blog articles written by people concerned with health and 3867 advice articles written by managerial dieticians and exercise trainers to construct a corpus for use as the knowledge resource. All these articles are written in Japanese. For blog articles, the average number of sentences is 6.74, and the average number of characters in each sentence is 31.49. For advice articles, the average number of sentences is 3.00, and the average number of characters in each sentence is 31.48. Research on annotating information about the execution of diet and exercise activities in the articles is in progress.

Annotating Blog Articles

Because authors often describe not only activities executed but also those not executed, extraction of diet and exercise activities executed by blog authors requires more than the extraction of names of diets and exercises. To describe whether activities have been executed, we often use straightforward expressions such as “I ate” and “I resisted eating” as well as negations such as “I didn’t jog” and “I couldn’t resist eating snacks”. To do this, we also use euphemistic expressions such as “I should have resisted eating snacks” and “I really must jog tomorrow”. Such expressions recognizing authors’ or speakers’ episodes are known as modalities (Masuoka 1991; 2000). In addition to food and exercise names, modalities play an important role in extracting diet and exercise activities executed by authors of blog articles.

Although considering what the authors ate and what exercise they did is important, information about the time and amount of activities is also important. For example, even if a diet were well balanced, it would be detrimental to your health if you ate enough for three people every time. Fur-

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<table>
<thead>
<tr>
<th>Tag</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>fi</td>
<td>Food items. Noun phrases describing foods (including medicines) have tags. Each tag has an attribute “value”, which shows whether the food is an abstract concept. If the noun phrase is abstract (e.g., breakfast), value=&quot;abstract&quot; is specified. If the attribute is not specified, the noun phrase is an actual food (e.g., bread).</td>
</tr>
<tr>
<td>fe</td>
<td>Food events. Phrases describing episodes when the author ate food are tagged. The tag has an attribute “fact”, which denotes whether the author ate food. If he/she did not eat food, fact=&quot;negative&quot; is specified; otherwise if he/she ate food, no attribute is specified.</td>
</tr>
<tr>
<td>ei</td>
<td>Exercise items. Noun phrases describing exercise have tags. The tag has an attribute “value”, which denotes whether the exercise is an abstract concept. If the noun phrase is abstract (e.g., exercise), value=&quot;abstract&quot; is specified. If the attribute is not specified, the noun phrase represents an actual exercise (e.g., jogging).</td>
</tr>
<tr>
<td>ee</td>
<td>Exercise events. Phrases describing episodes when the author exercised. The tag has an attribute “fact”, which denotes whether the author exercised. If he/she did not exercise, fact=&quot;negative&quot; is specified. If he/she exercised, no attribute is specified.</td>
</tr>
<tr>
<td>q</td>
<td>Quantity. Phrases describing the quantity of food the author ate or exercises he/she did.</td>
</tr>
<tr>
<td>t</td>
<td>Time. Phrases describing times when the author ate food or when he/she exercised.</td>
</tr>
</tbody>
</table>

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*This number includes 10 advices which are excluded from advices to use because they are extremely long. The average numbers described above were calculated after the exclusion.*
thermore, a well-balanced dinner eaten at 11:00 p.m. is not as good as one eaten at 6:00 p.m.

Considering the above, we use the six tags shown in Table 1 to extract information about what, when and how much the authors did. Sentences are tagged by phrases. The tags have id-attributions pointing to other tags associated with them. The id-attribution is designed to associate tags for diet and exercise activities (that is, “fe” and “ee”, respectively, in Table 1) with the other tags. The system can correctly recognize peripheral information of diet and exercise activities based on the associations. An example of an annotated blog article is shown in Figure 4. According to Figure 4, we know that the author ate miso soup for breakfast and sandwiches for lunch as diet activities based on id-attributes attached to fe-tags. Similarly, we also know that he/she went jogging and did push-ups in the evening.

Annotating Advice Articles

As shown in Figures 2 and 5, actual advice texts are composed of various types of sentences including those praising the author, those drawing the author’s attention to some issue, and those proposing improvements. Figure 5 shows that it is effective to agree or evaluate authors’ activities as the first step and to describe conclusions in the next step. In contrast, it is intuitively expected that advice texts consisting only of sentences for improvements are insufficient as advice. Therefore, it is important to analyze the roles of sentences in actual advice texts and how to compose them. There are various methods for categorizing sentences. To avoid ambiguity and duplicated advice, the method should refrain from using categories that are highly dependent on an individual’s subjectivity such as “sentences to praise” and “sentences of encouragement” unless the criterion for classification is clearly defined. However, advice is usually based on the adviser’s evaluation, it is inevitable that subjective categories are used.
As a result of our discussions, we adopted three types of tags and one attribute listed in Table 2 as categories to suppress ambiguity as much as possible. Each tag has an attribute “future”, the default value of which is “false”. Only if the extent of each tag matches the criteria for “future” listed in Table 2, \texttt{future=“true”} is specified. Although clauses in sentences are normally tagged, sentences themselves can be tagged if the extent of each tag is not clearly defined; that is, there are clauses and sentences that have two or more tags. An example of annotated advice is shown in Figure 6. In this figure, the role of the first sentence is “agree”, the second and third sentences denote good evaluations, and the last sentence suggests that the author should continue the activities in the future.

\textbf{Dictionary of Names of Foods}

We do not always use the correct names of foods. For example, “エビのチリソース (shrimp with chili sauce)” is the correct name of one Japanese food, the popular name is “エビチリ (shrimp chili)”. However, we recognize both names. Consequently, we are constructing a dictionary containing combinations of the correct names of foods and popular names for them. The current version of the dictionary has about 2,000 combinations.

\textbf{Future Works}

After applying annotations as described in sections “Annotating Blog Articles” and “Annotating Advice Articles”, we need to associate the advice sentences with sentences in the blog articles. Based on this association, the system learns to output suitable advice on various health activities. As described in section “Annotating Advice Articles”, various activities in blog articles can be classified as good or bad activities by using the association because each advice sentence has one or more tags (pos, neg, neutral). Therefore, by using many blog and advice articles, a large-scale database for determining whether activities written in blog articles are good can be constructed. Moreover, if there are various kinds of lexical patterns, a large-scale dictionary of templates to generate advice sentences can be constructed.

We are debating whether we should adopt the method proposed by Pighin et al. (Pighin, Cornolti, Alfonseca, and Filippova 2014) to find such patterns.

A screenshot of the current version of our system is shown in Figure 7. The system extracts sentences including keywords to generate advice on posted articles and outputs this advice according to the results of the extraction. We intend to improve our system so that it can dynamically generate advice based on advanced machine learning methods in the future.

As for the annotation, we intend not only to associate sentences in blog articles with those in advice articles but also to increase the number of articles. After all the annotation tasks, the articles will be published as a corpus of advice on health activities.

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\textbf{References}


