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 ad-

vice 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[1]. Therefore, we

[1] http://www.mhlw.go.jp/wp/hakusyo/kousei/14/

(a)	(b)
朝食。 小松菜、人参、みかん、バナナ、牛乳でスムージー。 パン。 ゆで卵。 珈琲 昼食。 おでん。 お好み焼き。 そばロール。 同席した人達とシェア。 夕食。 昼食が、ヘビーだったのでお腹すかず。 りんごとアイス。 (English translation) Breakfast Smoothie made of milk, banana, orange, carrot, and Japanese mustard spinach Bread Boiled egg Coffee Lunch Oden (traditional Japanese food) Okonomiyaki (traditional Japanese food) Soba-roll (modern Japanese food) Shared with those present at lunch Dinner I was not hungry because of my large lunch. Apple and ice cream	筋肉痛がやっと治ってきた。 治りきる前にもう一度トレーニングすると筋肉がつきやすいと言われた気がする。 少し曖昧・・・！ 今日は一駅歩きした後、家でトレーニングをしようとしたがやはり体力が持たずそのままダウンしちまった！！ 晩ご飯も、コンビニで買ってきたかつ丼をペロリ！ ダイエット。 先は長い・・・・・・。 (English translation) Sore muscles are healing. I have heard that it is easy to generate muscle when the muscle is exercised before the pain has healed. Somewhat ambiguous ...! After walking to the next station, I tried to do some exercise at home. But I was very tired, so I collapsed!! For dinner, katsu-don (traditional Japanese food) bought at a convenience store, perori (yummy)! Weight reduction I still have a long way to go to lose my weight ...

Figure 1: Examples of Actual Blog Articles.

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[2][3][4]. 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 (Li and Ren 2008). Computerized advisory systems have been developed to generate concise advice on diet and exercise[5][6].

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,

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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

[6] https://play.google.com/store/apps/details?id=jp.healthplanet.healthplanetapp

(a)	(b)
筋肉痛になるとトレーニングがしっかり効いたと感じるかもしれませんね。 ただ、筋肉痛が治りきる前はどうしても余分な力が入ってしまったりするので、トレーニングには不向きかもしれません。 できれば、筋肉痛にならない程度の負荷で継続してトレーニングをするようにしていただきたいですね。 その方が体力もついてくると思います。 一駅歩くというのは良いことですね。 こちらも継続していくことにより体力もつき段々、トレーニングも続けて行えるようになると思いますよ。	その方が体力もついてくると思います。 こちらも継続していくことにより体力もつき段々、トレーニングも続けて行えるようになると思いますよ。 できれば、筋肉痛にならない程度の負荷で継続してトレーニングをするようにしていただきたいですね。 一駅歩くというのは良いことですね。 ただ、筋肉痛が治りきる前はどうしても余分な力が入ってしまったりするので、トレーニングには不向きかもしれません。 筋肉痛になるとトレーニングがしっかり効いたと感じるかもしれませんね
(English translation) You know that your training is working when your muscles ache. But training before a painful muscle has healed may be bad because you could strain it. You should follow a moderate training routine if you can. I think the training will develop your muscle strength. Walking to the next station is good for your health. Walking will also develop strength so that you can keep up with your exercise routine.	(English translation) I think the training will develop your muscle strength. Walking will also develop strength so that you can keep up with your exercise routine. You should follow a moderate training routine if you can. Walking to the next station is good for your health. But training before a painful muscle has healed may be bad because you could strain it. You know that your training is working when your muscles ache.

Figure 2: Examples of Actual Advice (Part 1). (a) Actual Advice by a Professional Trainer. (b) An Example of Randomly Shuffled Sentences. Note that All Sentences Used Are Exactly the Same as in (a), Except Orders Are Different.

Nazarian and Traum 2012; Morbini, Forbell, DeVault, Sagae, Traum and Rizzo 2012).

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.
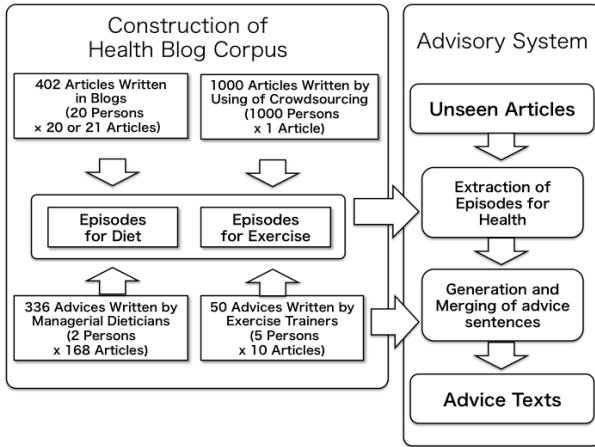
Figure 3: Proposed Method.

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 386[7] 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

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[7] 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.

Tag	Meaning
fi	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="abstract"* is specified. If the attribute is not specified, the noun phrase is an actual food (e.g., bread).
fe	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="negative"* is specified; otherwise if he/she ate food, no attribute is specified.
ei	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="abstract"* is specified. If the attribute is not specified, the noun phrase represents an actual exercise (e.g., jogging).
ee	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="negative"* is specified. If he/she exercised, no attribute is specified.
q	Quantity. Phrases describing the quantity of food the author ate or exercises he/she did.
t	Time. Phrases describing times when the author ate food or when he/she exercised.

Table 1: Tags Used to Annotate Blog Articles.

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-

<t id="t1">今日の</t></t><t id="t2"><fi value="abstract" id="f1">朝ごはんは</fi></t>、<fi id="f2">ごはんと</fi><fi id="f3">味噌汁。</fi><fe f="f1,f2,f3" t="t1,t2"/>
<t id="t3">お昼は</t><fi id="f4">サンドイッチを</fi><q id="q1">2つ</q><fe f="f4" q="q1" t="t3">食べた。</fe>
<t id="t4">夜は</t><q id="q2">30分の</q><ei id="e1">ジョギングと、</ei><ei id="e2">腕立て伏せ</ei><q id="q3">50回。</q><ee e="e1,e2" q="q2,q3" t="t4"/>

(English translation)
<fi id="f2">Rice</fi> <fi id="f3">and miso soup</fi>
<t id="t2"><fi value="abstract" id="f1">for my breakfast</fi></t><t id="t1">today</t>.<fe f="f1,f2,f3" t="t1,t2"/>
<fe f="f4" q="q1" t="t3">I ate</fe> <q id="q1">2</q> <fi id="f4">sandwiches</fi> <t id="t3">for lunch.</t>
<ei id="e1">Jogging</ei><q id="q2">for 30 minutes</q> <q id="q3">and 50</q> <ei id="e2">push-ups</ei><t id="t4">in the evening</t>.<ee e="e1,e2" q="q2,q3" t="t4"/>

Figure 4: Example of an Annotated Blog Article.

Tag	Meaning
pos	Clauses or sentences describing good evaluation of authors' activities.
neg	Clauses or sentences describing poor evaluation of authors' activities.
neutral	Clauses or sentences that do not correspond to either pos-tag or neg-tag, such as general knowledge, questions, agreements, proverbs.
Attribute	Meaning
future	Clauses or sentences describing suggestions and improvements for the future.

Table 2: Tags for Annotating Advice Sentences.

そうですね。
朝食を摂る習慣はとてもよいと思います。
野菜もたっぷりつかわれてよいですね。
この調子で頑張ってくださいね。

(English translation)
I think so.
It is a very good habit to eat breakfast.
It is also good to eat many vegetables.
Keep up the good work.

Figure 5: Example of an Annotated Advice Article (Part 2).

<neutral>そうですね。</neutral>
<pos>朝食を摂る習慣はとてもよいと思います。</pos>
<pos>野菜もたっぷりつかわれてよいですね。</pos>
<pos future="true">この調子で頑張ってくださいね。</pos>

(English translation)
<neutral>I think so.</neutral>
<pos>It is a very good habit to eat breakfast.</pos>
<pos>It is also good to eat many vegetables.</pos>
<pos future="true">Keep up the good work.</pos>

Figure 6: Annotated Advices Shown in Figure 5.

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, because advice is usually based on the adviser's evaluation, it is inevitable that subjective categories are used.

Figure 7: Screenshot of Our System.

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, *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.

Dictionary of Names of Foods

We do not always use the correct names of foods. For example, although "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.

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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