Personalization by Relevance Ranking Feedback in Impression-based Retrieval for Multimedia Database

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ABSTRACT

This paper proposes an approach to personalization by relevance `ranking' feedback in impression-based retrieval for a multimedia database. Impression-based retrieval is a kind of ambiguous retrieval, and it enables a database user to find not only a known data but also an unknown data to him/her. Conventional approaches using relevance feedback technique only return a binary information: `relevant' or `not relevant', for his/her retrieval intention. In this paper, he/she returns each relevance ranking to his/her retrieval intention for top *n* data of a retrieval result. From this feedback information, an adjustment data inherent to him/her is produced, and utilized for personalization. We show its effectiveness by an evaluation using our pilot system.

Keywords: Multimedia Database, Ambiguous Retrieval, Impression-based Retrieval, Personalization.

1. INTRODUCTION

This paper advances its discussion using music data from several types of multimedia data. Hereafter, we call a music data simply as `data', and a person who retrieves a data simply as `a retrieval person'. Impression-based retrieval (e.g.[1][2]) is a kind of ambiguous retrieval. In keyword retrieval using a music title or author, a retrieval person only obtains data which he/she has already known, as a retrieval result. On the other hand, impression-based retrieval enables him/her to obtain unknown data because its retrieval condition is provided like `bright music' or `violent music'.

Typical approach in order to realize impression-based retrieval is to define a multi-dimensional space representing some impressions and to position each data to a single grid point in this space. Hereafter, we call this space as `impression space'. In case of positioning each data to the corresponding point in this space, its position varies people to people. From this reason, when a retrieval person tries to obtain a data by specifying impression values, individual difference should be investigated.

Some researchers take an approach to this personalization by the use of relevance feedback technique(e.g.[3]). However, feedback information in it only contains a binary one: `relevant' or `not relevant', to an intention of a retrieval person concerning each retrieval result.

In this paper, a retrieval person returns each ranking of relevance to his/her retrieval intention for top *n* data of a retrieval result. From this feedback information, an adjustment data inherent to him/her is produced, and utilized for personalization. We describe our pilot system, and we show that our approach is effective in a certain condition by an evaluation experiment with some subjects.

This paper is organized as follows. In the next section, we summarize some related works, point out their drawbacks, and determine the purpose of this paper. Section 3 describes our solution which returns relevance with ranking. Section 4 introduces our pilot system, and Section 5 is an evaluation using the pilot system. Finally, in Section 6, we conclude our discussion.

2. PREVIOUS WORK

This is a section of related works. Subsection 2.1 summarizes some previous works, not limiting the definition of impression space and as a general discussion. All of these works treat personalization in impression-based retrieval. Subsection 2.2 introduces an impression space which we use in this paper.

2.1 Personalization in Impression-based Retrieval

Several approaches have been proposed to personalization in impression-based retrieval for a multimedia database ([3]-[5]).

Paper [4] proposes to use a difference between a position vector of data which completely fits to a retrieval intention of a retrieval person and an actually inputted retrieval vector. Paper [5] calculates difference between average impression value for many users of each data and an impression value specified by a retrieval person for the same data. This calculation is carried out for all data included in a database. Each average difference along each impression axis is derived and utilized for personalization. Paper [3] uses relevance feedback technique. A retrieval person returns a binary information: `relevant' or `not relevant' concerning each data of a retrieval result.

However, these conventional approaches are not always perfect. Drawback in the paper [4] is that this approach assumes existence of data which completely fits to a retrieval intention of a retrieval person. The paper [5] forces a retrieval person to input impression values for all data in a database. This load is not small. Drawback in the paper [3] is as follows: since feedback information is binary, a retrieval person cannot represent difference of relevance level in detail.

Based on the above-mentioned analysis, this paper aims to propose a personalization method which satisfies all of the following three requirements:

- **(Requirement 1):** a data which completely fits to a retrieval intention of a retrieval person is not always indispensable.
- **(Requirement 2):** a retrieval person does not need to provide each impression value for all data in a database.
- **(Requirement 3):** a retrieval person can represent difference of relevant level in more detail than relevant or not.

2.2 Impression Space as Basis of this Research

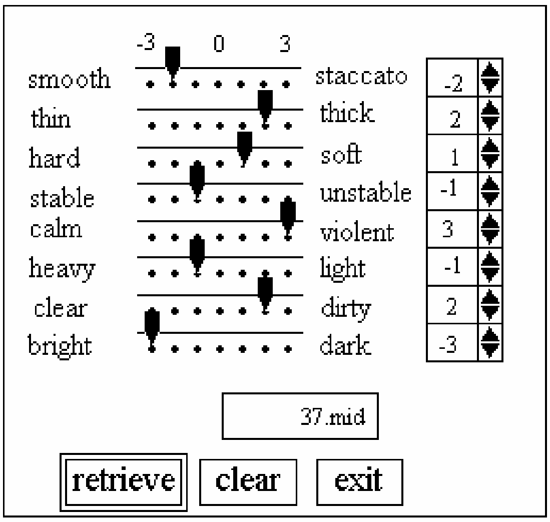

Fig.1 Retrieval Interface in Paper [6].

As a basis of our discussion, this research adopts a music impression space proposed in paper [6]. This space is composed, based on *semantic differential (SD)* technique[7].

In Fig. 1, `Smooth' versus `staccato' or `thin' versus `thick' is opposite impressions. Its degree is represented by either value of seven levels from minus three to plus three. Each data is placed on the corresponding grid point in this multi-dimensional space according to its impression value.

A retrieval operation can be carried out by specifying each value of eight impression axes. This set of impression values constructs a retrieval vector. Its retrieval result is produced by *similar search* technique[8]. Strictly, we should apply `factor analysis technique' in order to reduce the dimension and make each axis orthogonal mutually. However, this paper mainly pays attention to a discussion of personalization and simplifies its discussion.

In the paper [6], individual difference in impression is not investigated.

3. SOLUTION

Now we propose our solution. Our approach provides each relevance ranking (k=1,2,3,…,n) to top n (e.g. n=5) data in a retrieval result. Let $\boldsymbol{P_k}$ be a position vector of the data whose relevance ranking is k, in impression space. Let w_k be a weight depending upon ranking k. Let $\boldsymbol{RV_r}$ be a retrieval vector actually inputted by a retrieval person. We infer a true retrieval vector $\boldsymbol{RV_t}$ which fits to his/her retrieval intention by next formula:

$$RV_t = \frac{\sum_{k=1}^{n} w_k P_k}{\sum_{k=1}^{n} w_k} \quad (1).$$

We have lots of possibility concerning how to provide w_k. As a trial, let w_k be,

$$w_k = n - k + 1 \quad (2).$$

Our impression space is actually multi-dimensional. However, if we simplify it to two dimensions, a meaning of $\boldsymbol{RV_t}$ is shown in Fig. 2.

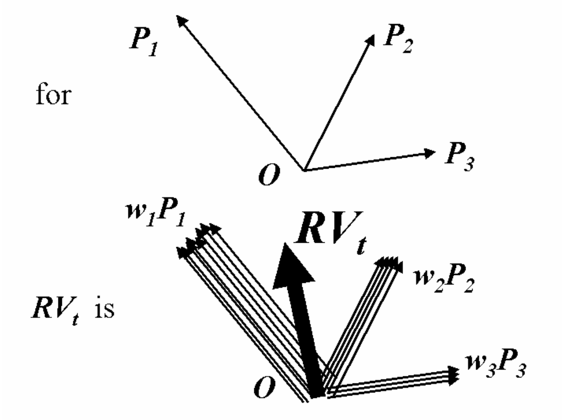

Fig. 2 Meaning of a True Retrieval Vector $\boldsymbol{RV_t}$ Which Fits to a Retrieval Intention of a Retrieval Person.

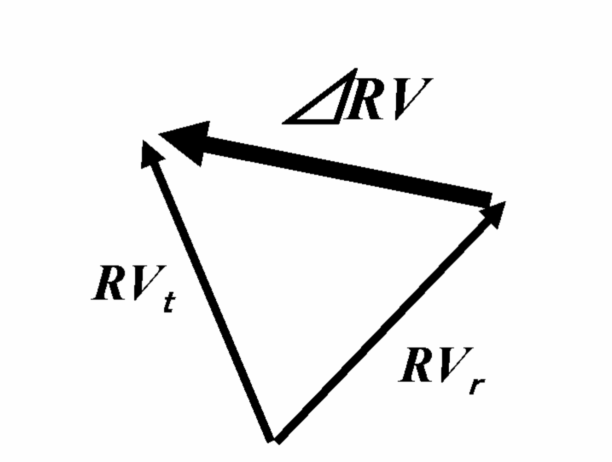

Fig. 3 Deriving Adjustment Vector $\triangle RV$ Inherent to a Retrieval Person from RV_t and Actually Inputted Retrieval Vector RV_r.

Difference between inferred RV_t and actually inputted retrieval vector RV_r is

$$\triangle RV = RV_t - RV_r \qquad (3).$$

We utilize it for his/her adjustment vector to his/her later retrieval operation(Fig. 3), and realize personalization.

If we summarize the Eq. (1)-(3),

$$\triangle RV = \frac{\sum_{k=1}^{n}(n-k+1)P_k}{\sum_{k=1}^{n}(n-k+1)} - RV_r \qquad (4).$$

4.PILOT SYSTEM

We develop our pilot system by extending the paper [6]. Concretely, we implement the following menu: a retrieval person returns each relevant ranking to top n data in a retrieval result. This feedback information produces an adjustment vector inherent to him/her. After that, when he/she carries out a retrieval operation, the adjustment vector is applied.

Fig. 4 shows an initial page for retrieval operation in our pilot system. Eight vertical blocks in the middle of the page represent eight pairs of opposite impressions. A retrieval person specifies each value of these pairs according to his/her retrieval intention, and clicks `retrieve' button on the right side.

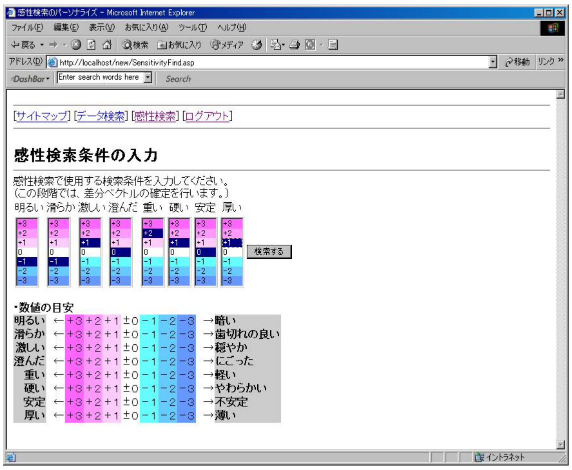

Fig. 4 Initial Page for Retrieval Operation.

Fig. 5 is a result page of the first retrieval operation. If we scan this page from the top, we can see horizontal four tables: (i) `inputted retrieval condition', (ii) `adjustment vector for personalization', (iii)`retrieval vector which adjustment vector has been applied', and (iv) `music data list as a retrieval result'. In here, (i) is the same vector inputted in the Fig. 4. Since the adjustment vector of (ii) is zero vector at the beginning, the value of (iii) is equal to (i). The most important table in our proposition is (iv). It has an input field of relevant ranking in the most right column, for each retrieval result. A retrieval person listens to music data of retrieval result, and inputs each relevant ranking to his/her retrieval intention, using these input fields. After the input operation is finished, he/she clicks the `ranking finished' button at the bottom of this page.

Fig. 5 Result Page of the First Retrieval Operation.

His/her clicking of the button brings Fig. 6, which is a result page of the second retrieval operation. It contains horizontal four tables as the same as the Fig. 5, however, (ii) is no longer zero vector. It is an adjustment vector produced by inputted relevant rankings. It is applied to the vector (i). In this way, personalized retrieval vector (iii) is calculated, and the corresponding result (iv) is obtained. Although inputted retrieval condition does not change, two retrieval results in the Fig. 5 and the Fig. 6 are different each other. The latter is the retrieval result personalized for him/her.

Fig. 6 Result Page of the Second Retrieval Operation.

We adopt Microsoft Access as a DBMS (DataBase Management System). A content of this page is dynamically produced using ASP (Active Server Pages)[9].

5. EVALUATION

5.1 Method

Taking into account actual load of a retrieval person, we set the value of variable *n* which is the number of data returning a relevant ranking, to five in this evaluation. Subjects of experiment are twenty-two students in Faculty of Software and Information Science, Iwate Prefectural University. We enter 270 data of Japanese popular music in our impression space.

Following the evaluation method in the paper [3] and [4], we examine our approach to have ability of personalization. That is, a subject beforehand selects a data to be retrieved, using keyword retrieval such as music title or author. This data is called `target data'. We cause a subject to input an impression value of the target data according to his/her feeling. We apply our approach: `relevance ranking feedback' repeatedly, and confirm the target data to move to the relevance ranking 1. Its concrete procedure is as follows:

(Step1): A subject selects 5 data from the impression space by keyword retrieval such as music title or author. Hereafter, we call these 5 data simply as `target data set'.

(Step2): First, he/she selects a single data from the target data set as a target one. In here, we do not show him/her its impression value.

(Step3): We cause him/her to input an impression value of the target data according to his/her feeling.

(Step4): Based on the inputted values, a retrieval vector is constructed. It brings him/her a retrieval result which contains top 5 data fitting to the retrieval condition by similar search.

(Step5): [**Case 1:** the case in which the target data does not appear in the relevance ranking 1]:

He/she returns each relevant ranking of the 5 data in the retrieval result. Inputted ranking is processed according to the Eq. (4) proposed in the previous section. He/she retrieves at the same retrieval condition as the (Step3) once more. After that, we go back to the (Step4).

[**Case 2:** the case in which the target data appears in the relevance ranking 1]:

We proceed to (Step6).

(Step6): We measure and record how many times he/she has been required to repeat the (Step5) in order to bring the target data to the relevance ranking 1.

(Step7): He/She selects another data from the target data set in the (Step1) and goes to the (Step3). If we finish the (Step6) concerning all data in the target data set, quantitative evaluation with him/her is over.

After we have finished the above quantitative evaluation, we ask him/her some questions in the form of questionnaire. It is a subjective evaluation concerning our system.

5.2 Result

We have obtained the following result;

[**Case 1:** the case in which top 5 of the first retrieval result contains the target data]:

Iterative applying of our approach has brought the target data to relevance ranking 1 at 100 % rate (Table 1).

[**Case 2:** the case in which top 5 of the first retrieval result does not contain the target data]:

It is only 2.15 % rate data that have been brought to relevance ranking 1 by the iteration.

Table 1: Number of Feedback Times Required in Order to Bring a Target Data to Relevance Ranking 1 in Case (i).

Number of Feedback Times	Ratio of Data
1	23.50%
2	47.10%
3	23.50%
4	5.90%

In addition, the result of a subjective evaluation is as follows; half or more subjects have evaluated that returning a satisfaction level to a retrieval result by relevance ranking is effective.

6. CONCLUDING REMARKS

In this paper, we have proposed an approach to personalization by relevance ranking feedback in impression-based retrieval for a multimedia database. We have carried out an evaluation experiment using some music data under the following restriction: a retrieval person returns relevance rankings of top 5 data in a retrieval result. As a result, our approach has been effective if the following condition is satisfied: top 5 of a first retrieval result for a retrieval condition contains a data which most strongly fits to a retrieval intention of a retrieval person.

Comparing to the conventional approaches, our approach is superior in the sense that it has all of the desirable three features in quality aspect, as follows. First, it does not assume the existence of data which completely fits to a retrieval intention of a retrieval person. Second, it does not force a retrieval person to input impression values for all data in a database. Third, a retrieval person can represent difference of relevance level by providing ranking.

We are planning several future works: (i) investigating countermeasure in case that above-mentioned condition for our approach to be effective is not satisfied, (ii) evaluation of the case in which we change the value of variable n, which is the number of data which a retrieval person returns relevance rankings, (iii) modification of the Eq. (2) in Section 3, which determines a weight w_k depending upon a relevance ranking k, (iv) relative quantitative evaluation of our approach to others, and (v) investigating effectiveness in the case we use an image as a data.

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