Recommendation and Diagnosis Services for Presentation Semantics

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Abstract: The main topic in this paper is how to effectively help research group members share and reuse presentation documents. The key idea is to propose a presentation semantics framework, which represents semantic roles of and relations among presentation slides with metadata. We then discuss a machine learning technique for analyzing the semantics roles and relationships automatically from the repository of the documents accumulated in the research group. This paper also demonstrates interactive Web services that recommend the metadata to be attached to the documents newly made, and that diagnose the presentation semantics of the documents.

Keywords: Presentation Semantics, Metadata Recommendation, Semantics Diagnosis

1. Introduction

In our daily research activities, a large volume of contents is generated and used by researchers and students in a research group. In particular, presentation documents are well-organized ones representing not only research findings but also presentation heuristics followed by the research group members [1]. Especially, novice researchers could promote developing their presentation skills by sharing such documents accumulated in the group.

However, the presentation documents are usually managed by their presenters and are not always shared by the research group. Moreover, information of presentation semantics to be shared and reused is implicitly embedded in objects like slides of the documents. It is accordingly difficult for the novices to select necessary slides for making new documents and to reflect on their own documents by means of semantic structures obtained from a large volume of past documents accumulated in the their group.

In order to resolve such issues, we have proposed a framework of the presentation semantics, which represents semantic information included in presentation documents with metadata [6]. On the other hand, it is complicated for the research group members to append suitable semantic metadata to the documents since such task often requires defining group standards for sharing them effectively. The main issue addressed in this paper is accordingly how to analyze the semantics roles and relationships automatically from the repository of the documents accumulated in the group, which is applied to metadata recommendation and to semantics diagnosis.

2. Presentation Documents with Metadata

In this paper, the presentation semantics framework provides a metadata model for representing semantic structures embedded in the presentation documents [7]. This framework consists of four types of metadata as shown in Figure 1.

Slide metadata represent the semantic roles of each slide included in a presentation document. Examples of the slide metadata are "*Cover*", "*Overview*", "*Purpose*", "*Architecture*", "*Results*", etc. Segment metadata also represent a sequence of the slide metadata in the document. We have defined four kinds of segment metadata, "*Introduction*", "*Theory & Idea*", "*System*", and "*Evaluation*", each of which includes related slide metadata. For example, the segment "*Theory & Idea*" includes "*Purpose*", "*Approach*", and "*Model*". Relation metadata represent sequential or hierarchical relationships among the slide metadata and segment metadata. An example of the sequential metadata is a sequence

of "*Cover*", "*Overview*", "*Table of Contents*", and "*Background*", which often appears in the documents. The other example of the hierarchical metadata is a parent-child relationship between the slide metadata. For example, "*Background*" has two children metadata "*Research Targets*" and "*Issues Addressed*". File metadata represent some attributes about the presentation contexts such as "*Target*", "*Presentation Time*", etc..

In general, sharing the presentation documents is not so easy since such the presentation semantics are often embedded in the documents. Attaching the metadata to the documents is also a time-consuming and complicated task for the research group members as follows: (1) the same slide could be often attached with the different metadata that have the same meaning, (2) it is difficult to detect the slide metadata from the slide contents, and (3) it is also difficult to detect the segment and relation metadata from the slide sequence.
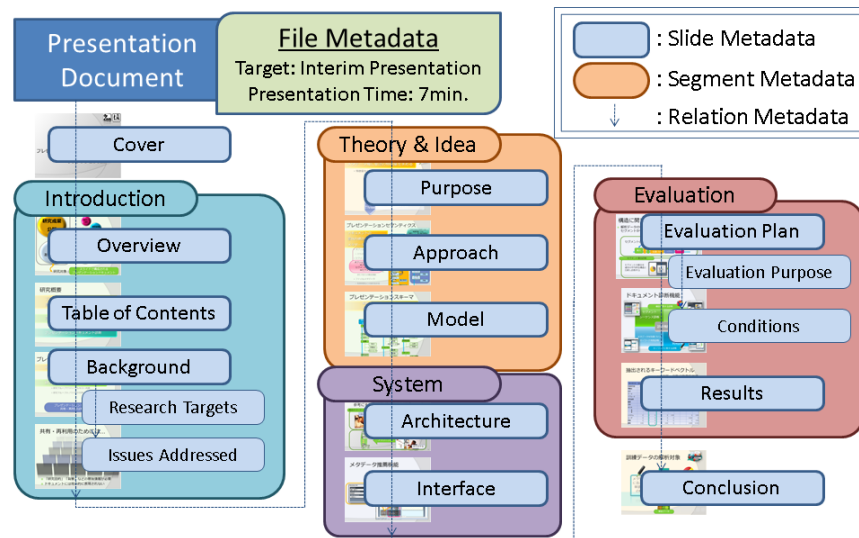

Figure 1. Presentation Semantics Framework

3. Web Services with Presentation Semantics Analysis

The essential requirement for resolving the above difficulties is to recommend the presentation semantics as the metadata. In this paper, we accordingly propose a machine learning technique to conduct semantic analysis of the presentation documents. We also describe two interactive Web services for metadata recommendation and semantics diagnosis, which have been implemented with ASP.NET 3.5 and Silverlight 3 [5] to run like desktop applications on the major web browsers such as Internet Explorer and FireFox.

3.1 Machine Learning for Semantic Structure Analysis

Presentation slides often include typical keywords that afford clues for identifying the metadata. It is accordingly possible to obtain the slide metadata from the typical keywords in the slides to analyze the presentation semantics. Considering such typical keywords, we use the machine learning technique to identify the relationships between the slide metadata and typical keywords included in the slides from the documents as training data that are attached in advance with the metadata and that are accumulated in our research group. Such relationships identified can be used to detect the presentation semantics of the documents produced in the group. Detail steps for the keyword vector calculation are as follows:

A) Noun words are extracted by using MeCab (Japanese language morphological analyzer) [3] from each slide of the presentation document with metadata in advance.

B) The keyword vector of the slide metadata is represented by the following formula,

$$V_i = \left(w_{i,1}, w_{i,2}, \cdots, w_{i,j}, \cdots, w_{i,m} \right) \tag{1}$$

where $w_{i,j}$ is the weight score of the word $j\left(1 \le j \le m\right)$ in the slide metadata $i\ (1 \le i \le l)$. Each $w_{i,j}$ is calculated by the following formula expanded $tf\text{-}idf$ approach.

$$w_{i,j} = tf_{i,j} \cdot imf_j \tag{2}$$

where $tf_{i,j}$ is summation of the score for the word j included in the slide metadata i of all the documents attached. imf_j is inverse metadata frequency of the word j as shown in the following formula.

$$imf_j = \log_{10} \frac{l}{mf_j} \tag{3}$$

where l is the total number of the slide metadata, and mf_j is the number of the slide metadata including keyword j.

C) Each weight score in the keyword vector is normalized by each slide metadata.

D) This technique then calculates to what extent each metadata appears at the normalized position in the sequence of the metadata from the training data. It counts the number of the slides included in each segment metadata and calculates averages and standard deviations of the allocation rate of every segment metadata from the documents.

3.2 Recommendation Service for Slide Metadata

Using the results of the presentation semantics analysis described above, this Web service recommends the slide metadata to be attached to presentation documents. The aim of this service is to help the research group members attach the slide metadata to the documents they produce. The first step towards identifying appropriate slide metadata from the typical keywords included in the slide is to calculate the keyword vector of each slide in the same way as the machine learning technique does. The second step is to calculate degree of similarity between the target slide k and the slide metadata i by means of the following formula as inner product of each keyword vector.

$$Sim(k,i) = V_k \cdot V_i \tag{4}$$

where V_k and V_i are the keyword vectors of the slide k and the slide metadata i, respectively. V_i is also calculated in the presentation semantics analysis. The next step is to calculate the normalized appearance position of each slide in the same way as the training data. The candidates of the slide metadata are ranked in a descending order of the normalized appearance frequency as shown in "Order of Normalized Appearance Frequency" in Figure 2. Following these orders, this service extracts common metadata candidates and sorts them by multiplying the keyword vector similarity and normalize appearance frequency, which are recommended as appropriate metadata of the target slide. The rests of the candidates are ordered behind the common metadata candidates.
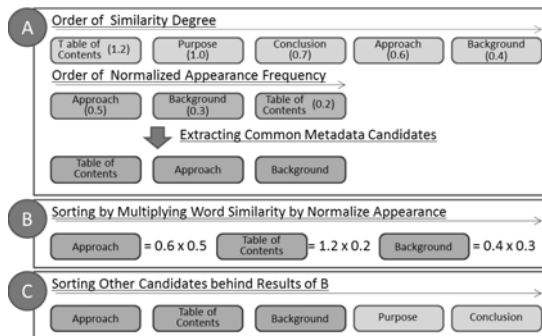

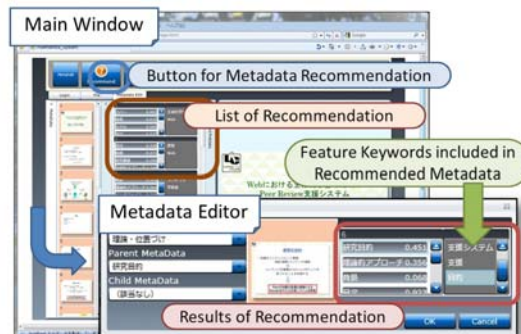Figure 2. Recommendation Algorithm   Figure 3. Recommendation Service

The service for the metadata recommendation estimates the slide metadata corresponding to the target slide as shown in Figure 3. After uploading PowerPoint 2007 format (.pptx) [3] file as the presentation document, a research group member can attach the slide metadata to

each slide included in the document by means of the recommendation function. When he/she pushes the button for metadata recommendation, Metadata Editor shows the results of the recommendation at the right side of the slide thumbnail. The metadata selected are stored with the document to the Web server.

3.3 Diagnosis Service for Presentation Semantics and Keywords

This service uses the results of the presentation semantics analysis to diagnose the presentation semantics and keywords embedded in the presentation documents produced by the research group members. It provides four functions as shown in Figure 4: (1) Segment sequence checker detects fragmentations of the segments estimated from the slide metadata so that the group members can notice discontinuities of the presentation sequence easily. (2) Segment balance checker detects an allocation tendency of the segment metadata by comparing the target document to average and standard deviation of the allocation rate of the training data. (3) Metadata keyword checker evaluates whether typical keywords corresponding to certain slide metadata are used in each slide. (4) Title keyword checker evaluates whether keywords including the title of the presentation are used in each segment.

Figure 4. Semantics Diagnosis Services

4. Case Studies

This section describes case studies whose purpose was to investigate whether the services enabled suitable metadata recommendation and semantics diagnosis. In these studies, we used 12 presentation documents for the interim presentation (presentation time: 7 minutes) of our research group members as training data. The main domain of these presentations was to develop self-directed learning support systems. The slide metadata were attached to all the documents by a knowledgeable researcher as correct metadata in advance.

As the case study for the recommendation service, we first chose a certain presentation document from the 12 documents, which deleted the slide metadata attached as a recommendation target. Next, we registered the other documents on the service as training data for the semantics analysis and recommended the slide metadata for the target document from the results of the analysis. We repeated such recommendation process for every document and compared the slide metadata attached by the knowledgeable researcher to the ones attached by the service. Table 1 shows the results of the accuracy of the metadata recommended which were divided into two types, (a) accuracy of first place, which represented the rate of the metadata correctly recommended in the first place, (b) accuracy of top three places, which represented the rate of the metadata correctly recommended in the top three places. In addition, we made comparison among three recommendation approaches using (1) the keyword similarity, (2) the normalized appearance position, and (3) these combination.

Table 1 indicated that the results from the combined approach (3) were more suitable for the metadata recommendation than (1) and (2). The approach (1) got poor results since there are some words which have close relationships with several slide metadata. For example, the word "task" is associated with not only "Approach of Research (i.e. target tasks)" but also "Conclusion (i.e. future tasks)". The results from (3) seemed to be improved by combining

(1) and (2) because the approach (2) roughly complemented the order of the semantic structure in which the approach (1) lacks.

As the case study for the diagnosis service, we first registered the above 12 presentation documents with metadata on the service as the training data. Then we prepared paired documents different from the training data, which two novices in our research group made. These documents were the first and final versions for the interim presentation. Assuming that the final version was more refined than the first version, we investigated the differences in each diagnosis result. Comparing the diagnostic results of the first version to the final version, problems of the segment sequence, segment balance, and title keyword in the first version were resolved through the presentation refinements.

Table 1. Accuracy Rate of Metadata Recommendation

	(1)	(2)	(3)
(a)	40.6% (78/192)	42.7% (82/192)	53.1% (102/192)
(b)	62.0% (119/192)	74.0% (142/192)	77.1% (148/192)

5. Conclusion

This paper has described the presentation support Web services with the presentation semantics framework. The key future of our presentation semantics framework is to deal not with the domain knowledge of the document [2] but with the roles of and semantic relations among objects composing the documents. Such presentation schema consequently means a presentation philosophy to be used in the research group members. We have also demonstrated the recommendation service and the diagnosis service which utilize the results of the presentation semantics analysis with the machine learning technique. The results of preliminary case studies indicated that the services would make it possible to provide the research group members with the services which manage presentation semantics.

In the near future, it will be necessary to improve the recommendation accuracy and to facilitate developing skills in producing presentation documents. Furthermore, we will evaluate effectiveness of the diagnosis service for the refinement process in a more detail.

References
[1] S. Hasegawa, A. Tanida, and A. Kashihara: A Presentation Support Service using Presentation Semantics, Proc. of the 8th IEEE International Conference on Advanced Learning Technology (ICALT2008), pp.104-105,(2008).
[2] A. Kohlhase: "Semantic PowerPoint: Content and Semantic Technology for Educational Added-Value Services in MS PowerPoint", Proc. of World Conference on Educational Multimedia, Hypermedia & Tele- communications (ED-MEDIA2007), 3576-3583, (2007).
[3] T. Kudo, K. Yamamoto, and Y. Matsumoto: Applying Conditional Random Fields to Japanese Morphological Analysis, Proc. of the 2004 Conference on Empirical Methods in Natural Language Processing (EMNLP-2004), pp.230-237, (2004).
[4] Microsoft Corporation: "PowerPoint Home Page - Microsoft Office Online"
http://office.microsoft.com/en-us/powerpoint/FX100487761033.aspx
[5] Microsoft Corporation: "The Official Microsoft Silverlight Site", http://silverlight.net/
[6] K. Saito, A.Tanida, A. Kashihara, S. Hasegawa: An Interactive Learning System for Understanding Presentation Semantics. IEICE Technical Report Educational Technology, Vol. 109, No. 453, pp. 37-42 (2010) (in Japanese).
[7] A.Tanida, S.Hasegawa, A.Kashihara: Web 2.0 Services for Presentation Planning and Presentation Reflection. Asia-Pacific Society for Computers in Education, 2008. Proc. of The 16th International Conference on Computers in Education (ICCE2008), pp. 565-572. (2008).