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# Visualization of Slide Relations for Supporting Presentation Speech Preparation

**Tomoko KOJIRI and Naoya IWASHITA**
*Kansai University, Japan*
kojiri@kansai-u.ac.jp

**Abstract:** The objective of our research is to develop a support system for creating presentation speech, especially speech that explains relations between two slides (*complementary speech*). Complementary speech is required between slides whose relations are difficult to understand from their contents, such as texts, figures, and tables. If authors could notice relations between created slides that are recognized by audiences, they would prepare appropriate complementary speech at the right places. To make authors notice slides where complementary speech is needed, our system analyzes relations between slides based on their texts and visualizes them. Four slide relations are defined and the method for detecting these relations from the slide texts is proposed. Then, analyzed relations are arranged in two-dimensional spaces that represent sequential relation and inclusive relation of their topics. The experimental results showed that most detected slide relations were the same as what examinees understood, and visualization of slide relations was useful in creating complementary speech.

**Keywords:** presentation support, slide relations, visualization, model of audiences

## 1. Introduction

Currently, we often present our ideas using presentation tools, such as PowerPoint from Microsoft. By explaining ideas using presentation slides (*slides*), abstract topics can be represented visually. However, it is difficult to create slides that can communicate our ideas precisely to audiences, since organizing various topics that explain ideas (*topics*) in a sequential order sometimes hides relations between topics. Vanacken et al. (2011) developed a new presentation tool in which topics are represented in a network structure. In this tool, presenters explain ideas by moving topics along the network structure. However, although relations between topics can be shown by the network structure, presenters need to explain topics in a sequential order. Thus, audiences still have the possibility of losing relations between topics, which prevents them from understanding the entire scope of the ideas.

A presentation consists mainly of slides and speech. Slides represent abstract topics in a physically fixed space with visual effects, by using not only texts but also diagrams, tables or short video. As pointed out by Tufte (2004), representing ideas using slides involves drawbacks in that relations between topics are sometimes difficult to understand because topics are assigned to different slides. On the other hand, speech gives supplementary explanation of the contents of the slides. Speech is categorized into two types: one is to provide additional explanation to individual slides (*explanatory speech*) and the other is to explain the relations between slides (*complementary speech*). The latter type of speech tries to solve the drawback noted by Tufte and help audiences to grasp the entire scope of the ideas.

Various studies on supporting effective presentation have been proposed. Hanaue et al. (2011) provided automatic slides creating a tool based on elements that describe each topic prepared by a presenter. This study focused on arranging elements in slides and did not consider the order of created slides. Maeda et al. (2011) proposed a learning activity for acquiring slide creation skill, especially how to order slides that is appropriate for the audiences, and developed its support tools. In the learning activity, audiences create amended versions of presented slides and discuss the reasons for modifying them in order to consider the appropriate skill in arranging the order of the slides.

Hasegawa et al. (2012) developed a system that extracted typical patterns of slides that were created by the members of the community so as to teach appropriate slide patterns to newcomers of the community. These studies supported users in acquiring the order in which to arrange slides, but speech was not focused on. On the other hand, Okamoto et al. (2012) developed a presentation rehearsal support system in which audiences can add comments on specific points in the presentation video. The added comments were organized according to the presented slides, so the presenter can grasp the inappropriateness of their slides and explanation speech easily. However, the lack of complementary speech was not grasped by the organized view. In addition, if there was no audience, presenters were not able to use this system and were not able to create effective slides and speeches.

Our research supports presenters in creating speech, especially complementary speech. Audiences understand the entire scope of ideas based on relations between slides, which are different according to their topics. If relations between topics could be grasped easily only by contents of slides, complementary speech would not be needed. On the other hand, if relations between slides were difficult to grasp, complementary speech that explains their relations would be required. To support presenters in noticing pairs of slides in which complementary speech should be added, showing relations that audiences may understand from slides is effective. Therefore, in our research, a complementary speech creation support system is proposed in which slide relations by audiences for the given slide file are inferred and are visualized. By observing visualized slide relations, presenters are able to easily find pairs of slides where complementary speech should be created.

Currently, our system focuses on research presentations in computer science. The users of the system are presenters who finished preparing slides but are not able to add sufficient complementary speech.

## 2. Approach

### *2.1 Slide Relations*

Slides correspond to topics that explain the idea to be communicated, so slide relations are determined by relations between their topics. Figure 1 shows the topic structure. Presentation consists of various topics that have sequential relation, and each topic consists of sub-topics. Sub-topics also have sequential relation and inclusive relation. Sequential relation indicates that one topic/sub-topic moves to the next new topic/sub-topic, and inclusive relation shows that one sub-topic is going to be explained in detail by the next sub-topic. Currently, we assume that one slide consists of one sub-topic; thus, slide relations indicate relations between sub-topics in former and latter slides.

Based on the topic structure, four slide relations are defined (Figure 2). Here, we assume that slides for sub-topics are arranged by number, i.e. from 1 to 7.

- *Refinement relation*: This is when sub-topics of slides are in an inclusive relation, and the sub-topic of the former slide includes the sub-topic of the latter slide, e.g. slides 1 to 2 in Figure 2. In this relation, new methods or words tend to be proposed in the former slide and the latter gives detailed explanations. Words in the former slide often appear as part of the title in the latter slide. Slides 2 to 3 in Figure 3a are examples of slides in the refinement relation.
- *Sub-topic transition relation*: This is when sub-topics of slides are in a sequential relation, and the former slide corresponds to the former sub-topic and the latter slide is the latter sub-topic, e.g. slides 2 to 3 in Figure 2. In this relation, main contents are similar in both slides, so they tend to have similar titles. Slides 4 to 5 in Figure 3b are examples of slides in sub-topic transition relation.
- *Topic transition relation*: This is when topics that sub-topics of slides belong to are in a sequential relation, and the former slide corresponds to the sub-topic in the former topic and the latter is the sub-topic in the latter topic, e.g. slides 3 to 4 in Figure 2. In this relation, the title of the latter slide is not related to the contents of the former slide. The presentation of computer science research often consists of typical topics, such as *background, objective, approach, experiment, conclusion.* These topics often appear independently of the former topic. Thus, if such words are used as a part of the title of the latter slide, topics are considered to be changed between slides. Slides 1 to 2 in Figure 3a are examples of slides in topic transition relation.

- *Upper-sub-topic transition relation*: This is when slide *A* and the former slide are in the refinement relation, and slide *A* and the latter slide are in the sub-topic transition relation, e.g. slides 6 to 7 in Figure 2. This relation cannot be grasped by the contents in the latter and former slides, since they do not have direct relation. Thus, this slide relation is difficult for audiences to understand without any complementary speech.

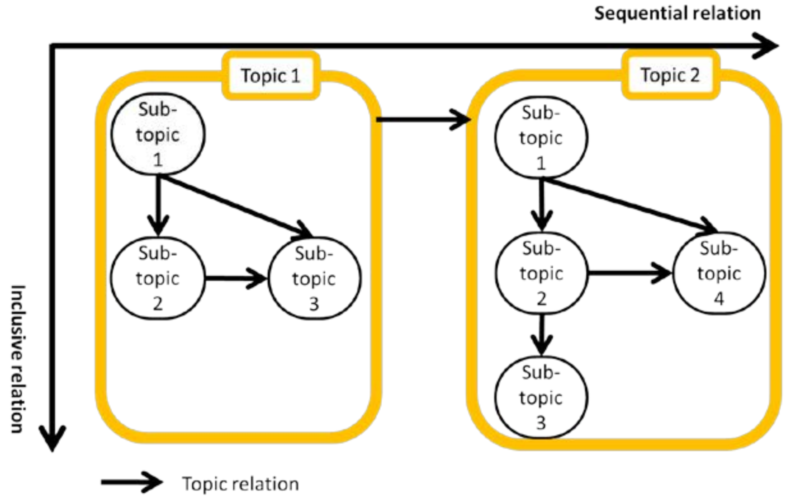



**Figure 1: Topic structure**

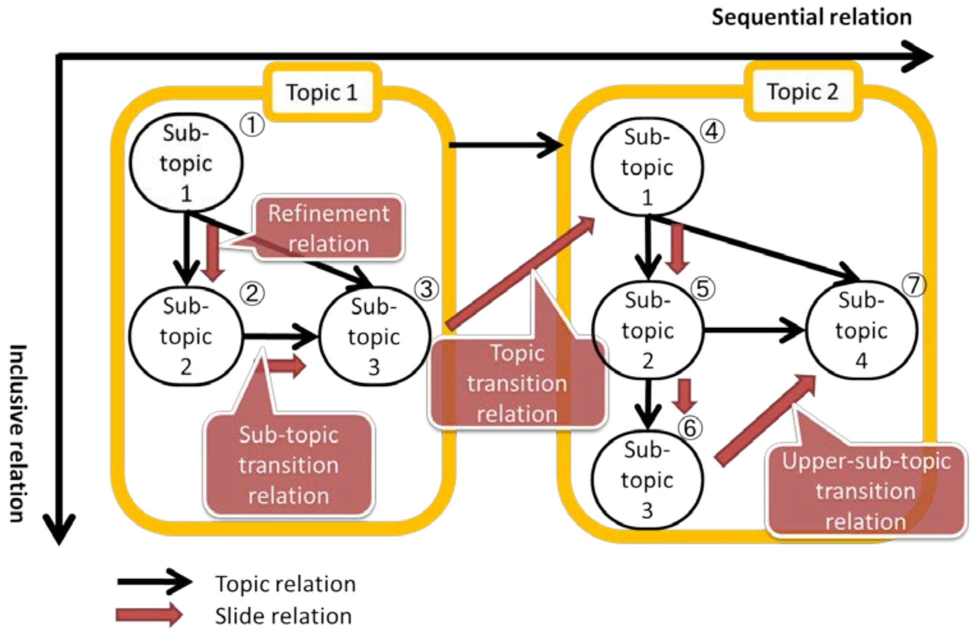
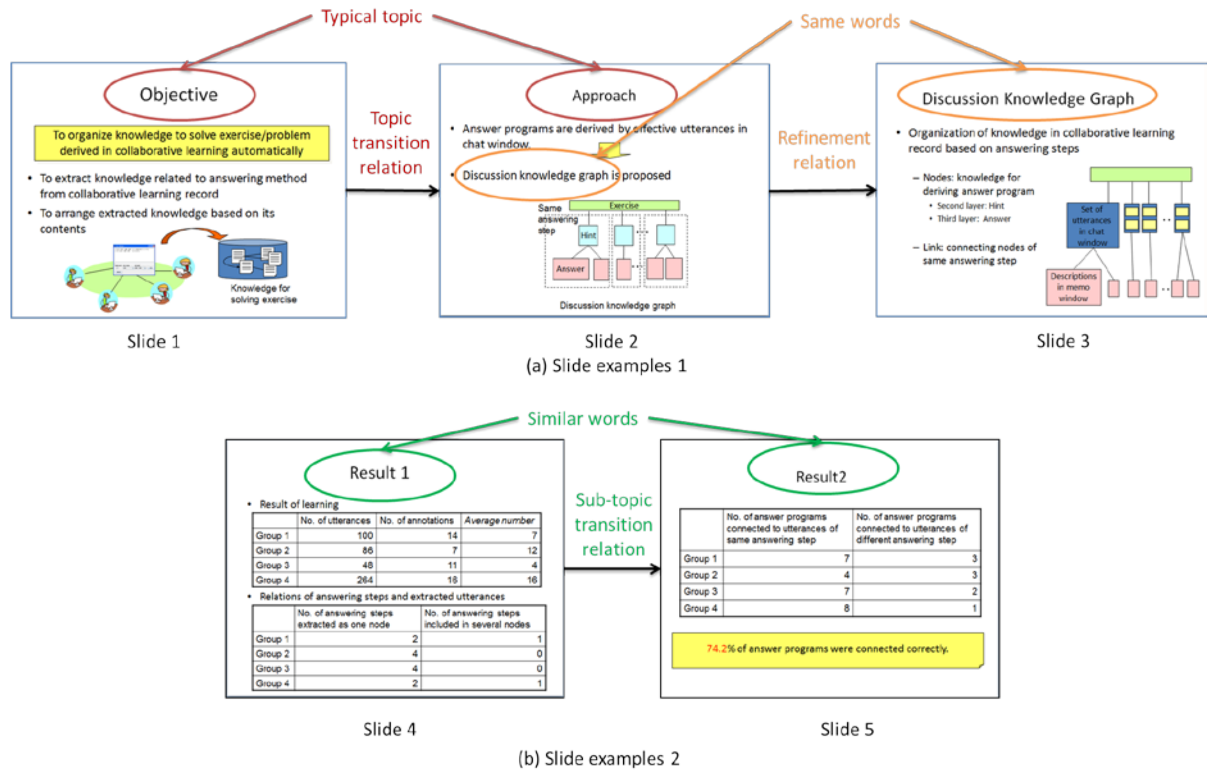



**Figure 2: Topic structure and slide relation**

## *2.2 Overview of Complementary Speech Creation Support System*

Contents of the slides are insufficient to understand the detail of the topics. Complementary speech is needed between slides whose relations cannot be grasped only by the contents of the slides. Such slides are in upper-sub-topic transition relation or in one of the other three relations, but their contents are insufficient to grasp their relations correctly. As focused as error-based simulation researches (Hirashima et al. (1998), Kajimoto et al. (2002)), to show insufficiency of presenters' slides promotes them of notice the slides that complementary speech is needed. Thus, to visualize the relations that audiences can grasp from the slide contents, our complementary speech creation support system infers the slide relations from their contents. By visualizing the relations, presenters can learn which slides require complementary speech.

Figure 4 illustrates the system architecture. Presenters input their slide file into the system. Text in input slides is decomposed into words by the *lexical analyzer*, and relations between slides are analyzed based on their words by the *mechanism for detecting slide detection*. The visualization interface represents relations between slides graphically. After presenters modify slide relation and input complementary speech, visualization of slide relations is updated by the *mechanism for modifying slide relation*. When the visualized relations satisfy the presenter's intention, appropriate speech is prepared.




F **Figure 3: Slide examples and slide relation**

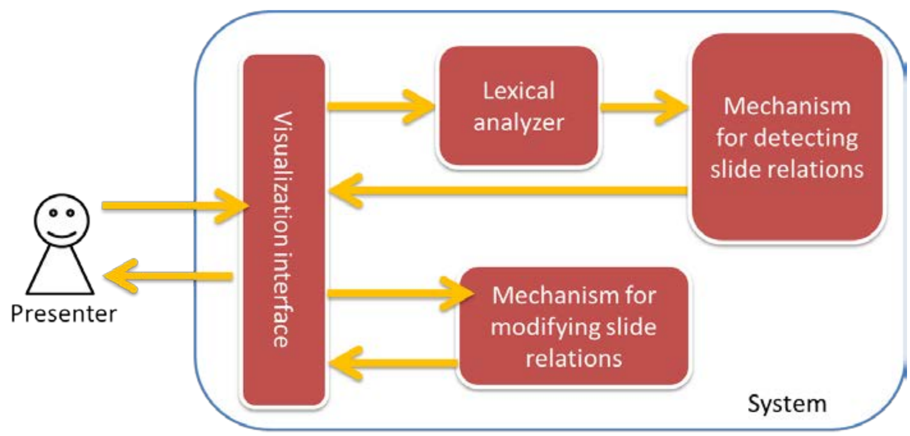
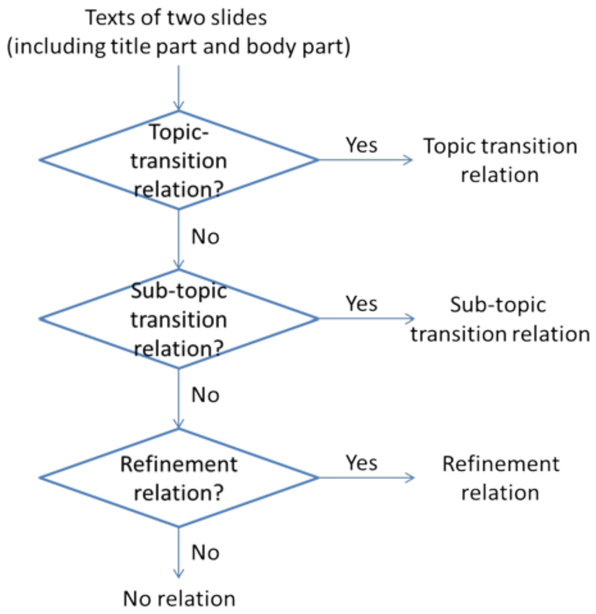



**Figure 4: System architecture**

## 3. Visualization of Slide Relations

### 3.1 Detection of Slide Relations

The system detects three relations, such as refinement relation, topic transition relation and sub-topic transition relation, from text in slides. First, text is divided into title part and body part. Then, it is decomposed into words using a lexical analyzer. Slide relations are detected using meaningful words in slides, such as nouns, verbs, adverbs, and adjectives.




F **Figure 5: Steps of detecting slide relations**

Figure 5 illustrates the steps for detecting slide relations. When texts of two slides, such as former and latter slides, are input, firstly system checks if two slides are in topic-transition relation. Slides in topic-transition relation are determined by the existence of words in titles that represent a typical topic. As for the typical topics in the computer science field, *background, related research, objective, approach, experiment, result, conclusion, consideration* and *future work* are defined. If one of these words is included in the title of the latter slide, the slide and its former slide are in topic-transition relation. In case two slides are not in a topic-transition relation, sub-topic transition relation is checked. Topics in slides are similar in the slides that are in sub-topic transition relation. The titles of such slides may be similar. Thus, words in their titles are compared and if more than one word is the same, they are inferred to be in sub-topic transition relation. It two slides are not in sub-topic transition relation, they are checked if they are in refinement relation. In slides in refinement relation, a word in the former slide tends to be explained in the latter slide. Therefore, if words in the former slide are included in the title of the latter slide, these slides are determined to have a refinement relation. If not, no relation is inferred by these slides.

### 3.2 Visualization Method

Slides are visualized in a way such that their relations are easily and intuitively understood by presenters. Refinement relation corresponds to the inclusive relation of topics, and topic transition relation and sub-topic transition relation are the parts of sequential relations. In our system, topics are mapped to the two-dimensional space where the horizontal axis corresponds to the sequential order of topics, and the vertical axis represents the details of the explanation. For example, explanation becomes more detailed as slides' positions get lower in the two-dimensional space.

Let us explain the concrete method for arranging slides. The first slide is allocated at the left topic position. Then, according to the detected relations with the former slides, each slide is allocated to the two-dimensional space. Figure 6 illustrates the allocation method of slides according to the detected slide relations. If the slide has refinement relation with the former slide, the slide is put in a lower position than the former slide, and the two slides are connected by a yellow line (Figure 6a). If the slide is in sub-topic transition relation with the former slide, it is allocated to the position right of the former slide, and they are connected by a green line (Figure 6b). If the slide is in topic-transition relation, it is allocated to the position to the right and top of the former slide because the latter slide is the first slide of the new topic (Figure 6c). These slides are connected by a red line. To grasp the change of topic easily, a dashed vertical line is depicted between two slides. If slide relations are not detected, an X mark is inserted between two slides (Figure6d).

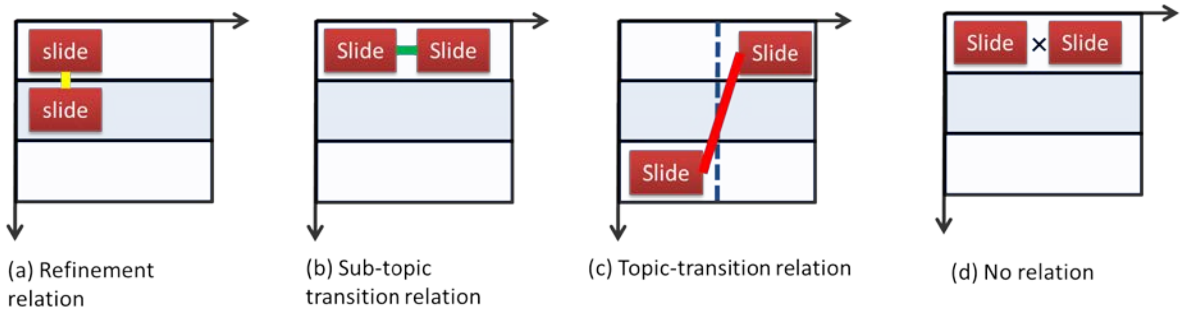



**Figure 6: Visualization method for each relation**

## 4. Prototype System

We have developed a prototype system that automatically analyzes the relation between slides of an inputted file and visualizes their relations. The system is implemented by C#. MeCab (2009) is applied as a lexical analyzer. Available presentation slides are newer than PowerPoint Office 2007.

Figure 7 shows the system interface. When the PowerPoint file is selected by the s*lide selection button*, the system opens the file, analyzes the relations between slides and shows the result in the *visualization area of slide relation*. In this area, slides are represented by blue squares and their page numbers are attached to the square. When the square is clicked or the page number is selected from the *list of slides*, its contents appear in the *slide contents area*.

Complementary speech can be created from the *complementary speech creation area*. In the area, slide relations between the currently selected slide and its next slide can be re-defined manually by selecting an appropriate one from the list. From the list, refinement relation, topic-transition relation, sub-topic transition relation, and upper-sub-topic transition relation can be selected. When the relation is selected, *complementary speech creation form* appears (Figure 8). When the complementary speech is inputted, slide relations shown in the *visualization area of slide relation* are updated based on the selected relation, and inputted speech appears in the *complementary speech area*. In the case where the upper-sub-topic transition relation is selected, the *level input form* emerges to indicate the level of the next slide (Figure 9).

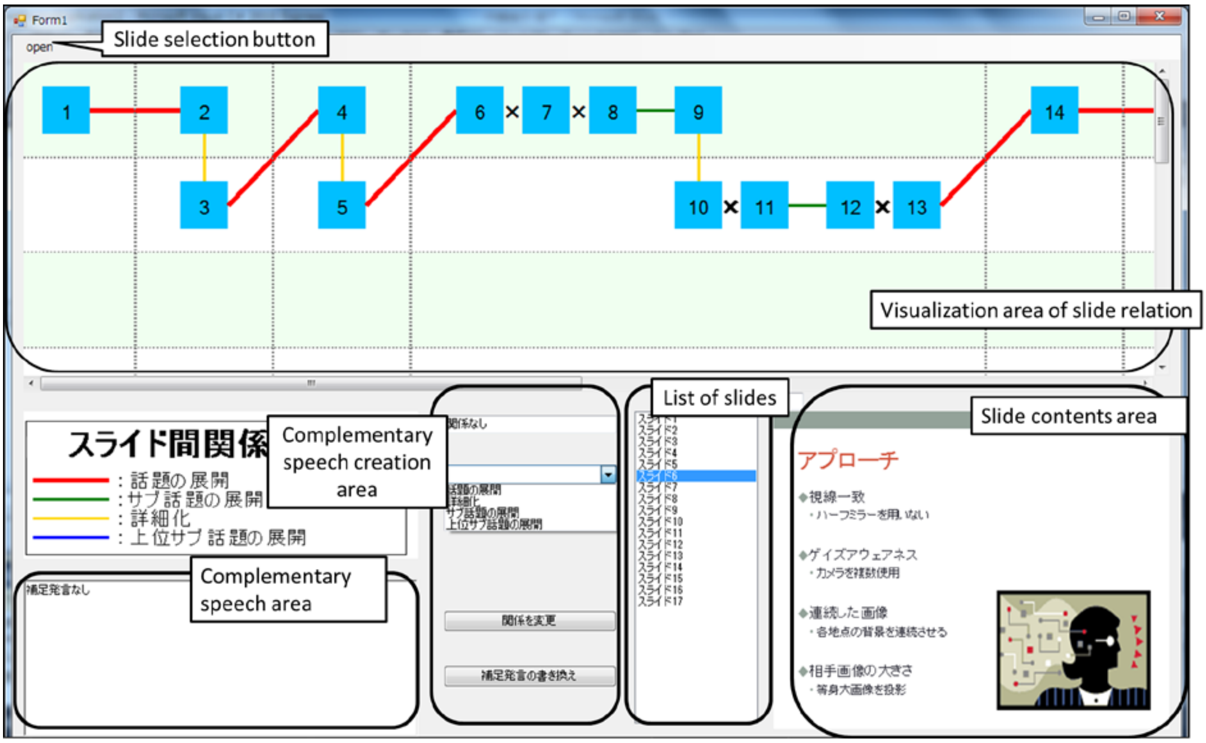



Figure 7: Interface of prototype system


Figure 8: Complementary speech creation form

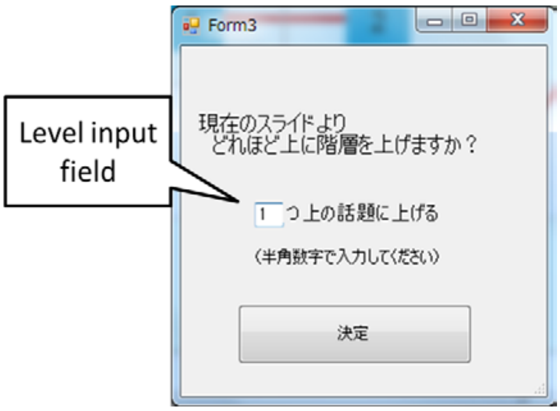



Figure 9: Level input form

## 5. Experiment

We have evaluated the validity of the detected slide relations and usability of the prototype system. Examinees were eight students in our university (*A – H*), all of whom were engaged in the research field of computer science. They did not have much experience creating slides.

### *5.1 Validity of Detected Slide Relations*

The objective of this experiment was to evaluate whether the slide relations detected by the system were appropriate. In the experiment, first, three slide relations that we have defined were explained to examinees. Then, they were asked to select three relations or no relation between slides in the given slide file. Each examinee selected relations for another examinee's file, namely, examinee *A* checked examinee *B*'s file and examinee *B* evaluated examinee *C*'s file, and so on. All slide files consisted of around 10 slides. In each file, all figures were removed and were replaced with their titles.

Selected relations were compared with those detected by the system, and precision and recall rates were calculated. Precision and recall rates were derived by the following equations.

$$Precision = \frac{\text{The number of slides to which examinees and system assigned the same relation}}{\text{The number of slides to which system assigned one of three relations}}$$

$$Recall = \frac{\text{The number of slides to which examinees and system assigned the same relation}}{\text{The number of slides to which examinees assigned one of three relations}}$$

The precision and recall rates of examinees' answers are shown in Table 1. Precision rates were 1.00 for three examinees and larger than 0.67 for all examinees. Therefore, the relations detected by the system were almost the same as what ordinary audiences could recognize. The disagreements between the system and examinees occurred mostly between topic transition relation and sub-topic transition relation. For example, for slides whose titles were "experiment" and "result", the system determined topic transition relation since both words are seemed to represent new topics, but examinees thought they were sub-topic transition relation because "experiment" and "result" usually appeared together. Currently, the words that characterize new topics are defined by authors heuristically. The words that constitute a new topic may be different according to the audience. Thus, we should investigate the words that are recognized as new by most audiences.

**Table 1: Precision and recall rates of detected slide relations**

| Examinee | Precision | Recall |
|---|---|---|
| A | 1.00 | 0.75 |
| B | 0.67 | 0.67 |
| C | 1.00 | 0.60 |
| D | 0.89 | 0.73 |
| E | 1.00 | 0.67 |
| F | 0.67 | 0.67 |
| G | 0.89 | 0.62 |
| H | 0.83 | 0.63 |

On the other hand, recalls were more than 0.60 for all examinees, so the system could recognize most relations that examinees understood. Most relations that the system could not extract were sub-topic transition relation. Currently, the system detects the sub-topic transition relation only from the number of identical words in titles. The system is not able to understand synonyms or words that represent similar meaning. For example, examinees recognized that "background" and "problem" indicate the problem to be solved in the presented research and assigned the sub-topic transition relation between these slides. However, the system could not find any relation because they do not contain the same words. To cope with this drawback, we need to introduce a dictionary into the system that defines words with similar meaning.

### *5.2 Usability of Prototype System for Complementary Speech Creation*

The objective of this experiment was to evaluate the usability of the prototype system for creating complementary speech. Examinees were asked to create complementary speech using the prototype system. Then, they were asked to answer questionnaires related to the visualization, creation of complementary speech, and usability of the system.

Tables 2 and 3 show the questionnaire results. They were asked to select one of four choices, 1 being the worst and 4 the best. Table 2 evaluates the understandability of the visualization methods for each slide relation. The questionnaire asks if the visualization methods were intuitive and effective for understanding the relations. Based on the result, examinees could grasp the refinement relation, topic-transition relation, and sub-topic transition relation easily. However, they had difficulty understanding the upper-sub-topic transition relation. Some examinees recommended that it would be more understandable if two slides that have sequential relations were connected by a line, rather than those that have upper-sub-topic relation. We need to revise the visualization method for the upper-sub-topic relation according to this opinion.

**Table 2: Questionnaire results about understandability of visualization methods**

| Relation | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Refinement relation | 0 | 0 | 1 | 7 |
| Sub-topic transition relation | 0 | 1 | 5 | 2 |
| Topic transition relation | 0 | 0 | 4 | 4 |
| Upper-sub-topic transition relation | 3 | 4 | 1 | 0 |

**Table 3: Questionnaire results about complementary speech creation and system usability**

| Questionnaire items | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. Visualization of slide relations helps you in determining target slides to create complementary speech? | 0 | 0 | 2 | 6 |
| 2. Visualization of slide relations helps you in creating complementary speech? | 0 | 2 | 3 | 3 |
| 3. Was the system easy to use? | 0 | 2 | 1 | 3 |

Items 1 and 2 in Table 3 asked about the effectiveness of the system for creating complementary speech. Based on the results, most examinees were able to create complementary speech based on the visualization of the slide relations. Many examinees commented that they were able to create complementary speech easily because they could grasp the slides that audiences may find difficult to understand by the visualization of slide relations.

According to item 3 in Table 3, the usability of the system was not good. Currently, the contents of only one slide can be viewed in the slide content area. However, in considering complementary speech, the contents of the former slide and the latter slide should be examined. Therefore, some examinees commented that it would become more useful if contents of two slides were displayed at the same time. Thus, we should re-design the interface so as to view contents of two slides simultaneously.

## 6. Conclusion

In our research, a complementary speech creation support system has been developed that makes presenters notice slides that need speech by showing slide relations that can be grasped by audiences. Four slide relations were defined and methods for extracting three of them were proposed. In addition, visualization methods that can represent slide relations intuitively were introduced. Experimental results using our prototype system proved that our system could detect slide relations that are almost the same as human audiences. Moreover, the prototype system was effective in creating complementary speech.

Currently, our system introduces a very simple approach in detecting slide relations, such as the coincidences of words. This approach has a limitation in that the system could not grasp words of the same meaning as shown in the experimental result. To cope with this drawback, synonyms should be introduced in considering the similarity of topics.

Current our system utilizes only texts information. However, slide relations also can be grasped by figures or tables. We should develop the method for analyzing figures or tables to grasp slide relations more accurately.

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