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Visualization of Topics and Logical Development Based on Reader's Understanding for Reading Support

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Abstract: When reading editorials, understanding the meaning of sentences and their relations is essential for grasping topics and their logical structures. If inter-sentence relations are not understood correctly, the topics and logical structures derived from them will not follow the structure of the editorials. That is, the derived topics do not correspond to those of the editorials' paragraphs. The derived logical development does not conclude the main opinion. This study supports the accurate understanding of inter-sentence relations by notifying readers of inaccurate topics and the logical development derived by their understanding. Our developed system visualizes the correspondence between paragraphs and derived topics as well as the reverse flow of the logic from the opinions to investigate whether all sentences are constituents of the opinions.

Keywords: Reading support system, logical structure, visualization, inter-sentence relations

1. Introduction

When reading editorials, readers must first understand the meaning of each sentence and the relations among all sentences. Based on the relations, they grasp the topics, the logical structure, and the opinion. Understanding inter-sentence relations is essential for grasping opinions. This paper supports readers who are struggling to read inter-sentence relations correctly to understand topics and their logical structure or to grasp the ideas.

As support for improving reading understanding skills, Fukunaga et al. developed a system in which readers underlined the parts of a text that express important topics and receive feedback based on a comparison of the underlined parts and the correct answers (Fukunaga et al., 2005). This system demonstrates the accuracy of the understood topics without providing a method of accurate understanding.

Fukumoto et al. argued that inter-sentence relations must be correctly understood to grasp the opinions of editorial texts (Fukumoto & Tsujii, 1994). For improving the reading understand of inter-sentence relations, Mochizuki et al. provided an environment in which the relations between sentences are organized to promote structural understanding (Tsubakimoto et al., 2008). They exploited the organization of inter-sentence relations to derive opinions without supporting the understanding of correct inter-sentence relations.

Our study promotes an accurate understanding of inter-sentence relations. We develop a system that visualizes logical structure and distributes topics in paragraphs that can be inferred from the inputted inter-sentence relations understood by readers. By monitoring the visualization, readers are expected to revise their interpretations of inter-sentence relations based on the visualized information and derive an accurate understanding.

2. Reading Understand Support System

Readers start at the level of sentences and grasp the writer's opinion in the following process:

1. Understand the sentences and their inter-sentence relations;
2. Grasp the topics;
3. Compose a logical structure from the relations among the topics;
4. Derive the opinion from its logical structure.

In step 1, readers understand the meaning of sentences based on words, grammar, and the inter-sentence relations based on the conjunctions. In step 2, they grasp topics based on the inter-sentence relations. They also grasp the logical structure of topics based on the inter-sentence relations in step 3. Logic is developed in such a way to lead them to derive a writer's opinion in step 4. Among these steps, step 1 is essential, since steps 2 to 4 are based on the results of step 1. If readers are unable to correctly read the inter-sentence relations, they will not correctly understand the topics and logical structure. Hence, the opinion will not be understood.

If topics are not grasped accurately, paragraphs may not correspond to the topics. If the logical relations are not grasped sufficiently, some topics may not lead to the opinions derived by readers. If readers notice such conflicts, they may read the sentences carefully and find appropriate inter-sentence relations. This study proposes a reading support system of inter-sentence relations that gives awareness of the inaccuracy of the understood inter-sentence relations. Our system visualizes the topics and logical structures that can be recognized based on the inter-sentence relations understood by readers and encourages them to recognize the inaccuracy by themselves.

Figure 1 overviews the system, which has an editorial database that stores such texts to show to readers. Readers select a file name from the database and start their reading practice. The system has two interfaces. One is an inter-sentence relation input interface where readers can input the inter-sentence relations that they read from the editorials. This system provides three types of relations: causal, generalization/ specification, and supplemental. The inputted inter-sentence relations are stored in the learning-log database. The other interface is visualization. It grasps the topics and logical structures that can be inferred from the inputted inter-sentence relations and presented to readers based on requests.

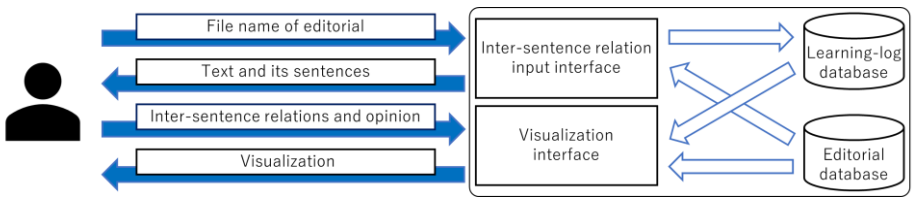

Figure 1. System overview.

3. Visualization Interface

The visualization interface shows the topics, the logical structure, and logical development that can be grasped by the inter-sentence relations understood by the reader. It provides two visualization forms: the logical development visualization and the topic division visualization.

The logical development visualization shows the logical structure that can be grasped by readers and the logic toward an opinion. The logical structure is the relations among topics. This study defines a logical structure map to express the logical structure. Figure 2 shows the configuration of a logical structure map. Nodes correspond to sub-topics, and links show the relations among topics. The vertical axis represents the level of the details of the sub-topics, and the horizontal axis represents the logical development. Since the sentences of the supplemental relations indicate identical sub-topics, these sentences are gathered to form one node. Sentences without supplemental relations indicate that they themselves represent sub-topics, so they form nodes on their own. Links show either causal relations or generalization/specification relations between two sub-topics. For sub-topics that are connected by causal relations, the result topics are arranged as right nodes along the horizontal axis, and the links are directed from the cause to result nodes. Specialized sub-topics may belong to topics that resemble abstract ones, so they are arranged as the lower node along the vertical axis and generalized topics as the upper node, and the links are directed from the lower to upper nodes.

Figure 3 shows another example of a logical structure map. Since the causal relation between topics 1 and 3 is missing, there are two chunks. Such structure indicates that, according to the understanding of readers, more than one logical structure exists in the target editorial.

Logical development should be designed to derive an opinion to which all topics should have a path. Therefore, it is useful to check whether all topics are included in all the paths from an opinion. Our interface creates pictures showing like an animation for following the link in a reverse direction from the opinion node by adding red to each node. Figure 4 shows some of pictures when topic 7 is read as an opinion. First, topic 7 is colored, and then its detailed topics are colored (Figure 4a). Next, the cause of topic 7, such as topic and its detailed topics, are colored (Figure 4b). In the same way, topics 1 and 2 are colored (Figure 4c). Since all the topics are successfully colored in Figure 5, this logical structure is probably appropriate. If some nodes become uncolored, the inter-sentence relations correspond to the uncolored topics may be grasped inaccurately.

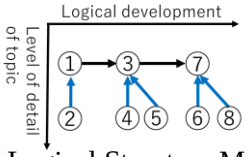

Figure 2. Example of Logical Structure Map.

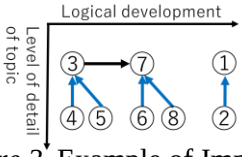

Figure 3. Example of Improper Logical Structure

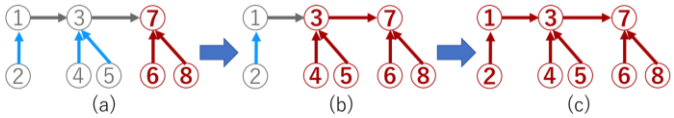

Figure 4. Example of Coloring Nodes from Opinion along Reverse Direction of Logical.

On the other hand, the topic division visualization shows the distribution of the topics for each paragraph. Figure 5a shows how the sentences are arranged by paragraphs whose colors are assigned for individual topics. Since specialized nodes may represent the same topics with their upper nodes, sentences that belong to the same sub-trees are assigned the same color. If the same color is distributed over several paragraphs, or if a paragraph is changed within a topic, as shown in Figure 5b, it can be suggestive that the reader's understanding of the topic may be inaccurate.

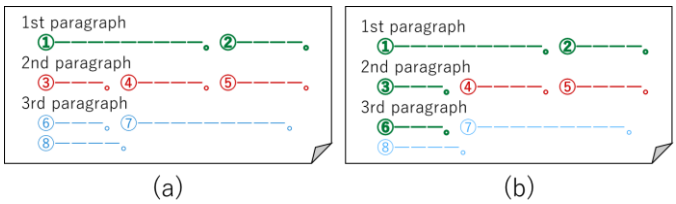

Figure 5. Imagination of Topic Division Visualization.

4. Conclusion

We developed a system that supports readers to understand the inter-sentence relations for the purpose of accurate understanding the opinions of the editorials. Our system visualizes the logical developments and the distribution of topics based on reader understandings of inter-sentence relations to make them aware of their misunderstandings and to revise their understanding of the opinions and its reasons.

In this study, we support the detection of mistakes in inter-sentence relations, but we do not support the correction of the understanding of inter-sentence relations. As a future work, it is necessary to propose a method to support correction by feedback on mistakes in inter-sentence relations.

References

Fukunaga, Y., Hirashima, T., & Takeuchi, A. (2005). Implementation and Effectiveness of a Feedback Feature in Underlining to Promote Reading Comprehension of e-Learning Instructional Materials. *In Proceedings of International Conference on Computers in Education*, pp. 101-108.

Fukumoto, F., & Tsujii, J. (1994). Automatic Recognition of Verbal Polysemy. *In Proceedings of The 15th International Conference on Computational Linguistics*, Volume 2, pp. 762-768.

Tsubakimoto, M., Mochizuki, T., Nishimori, T. et al. (2008). The Impact of Making a Concept Map for Constructive Reading with the Critical Reading Support Software "eJournalPlus." *In E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education*, pp. 506-514.