Ph.D. Dissertation

A Study on Supporting Presentation Preparation as Knowledge Handling Process

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ABSTRACT

This dissertation discusses computational support in presentation preparation as the knowledge handling process. Today, presentations are essential activities for transferring and sharing ideas among participants. Many presenters perform presentations by showing slides using presentation tools such as PowerPoint and Keynote. Although these tools make it easy for us to prepare slides with rich graphics and animations, criticisms have pointed out their problems from the viewpoint of understandability about the contents of slides. One of the criticism is that it is not easy to complement the semantic gaps among slides or even components such as texts and images in one slide. This is partly because presenters tend to focus on making slides rather than clarifying their intentions such as messages and stories. Furthermore, the knowledge and practices for effective presentations are not considered in traditional presentation tools. The goal of this research is to solve the problems of traditional presentation tools, and then to investigate the possibility of computational support in presentation preparation as a creative activity.

In order to achieve these goals, this dissertation presents a framework for effective support of presentation preparation. The characteristic of this research is to handle the process of presentation preparation as the knowledge handling process. The fundamental approach of this research is to build an environment in which a presenter externalizes her implicit knowledge on presentations intuitively. This approach enables to handle the knowledge computationally for effective support. In order to realize such an environment, this dissertation discusses the requirements for supporting presentation preparation as a creative activity. Additionally, this dissertation discusses what kind of knowledge should be represented and handled according to the knowledge handling model.

This research consists of three themes: (1) representation and operation for externalizing presenters' intentions on what to speak, (2) support in presentation stories based on the knowledge on how to speak, (3) automatic slide generation based on the knowledge on how to compose presentation materials.

The first research theme discusses the representation and operation on a discourse structure for supporting externalization of presenters' intentions. A discourse structure represents presenters' messages and facts and the semantic relationships among them. The proposed method consists of three features. First, the method introduces an operation of interrelating knowledge fragments by semantic relationships. This operation enables presenters to clarify their intentions on how the concepts are related to each other. Second, the method provides the holistic view of a presentation story in which multiple topics are visible at the same time. Such view helps presenters examine whether their stories are consistent by comparing multiple topics. Finally, the method introduces an operation of allocating knowledge fragments to the topics in a presentation story. This operation allows presenters to move a fragment in one topic to another intuitively. These features make it easy for a presenter to compose a consistent story of her presentation.

The second research theme proposes a method for story composition according to presenters' intentions on how to tell their stories and time constraint. The approach in this theme is to handle presenters' intentions as a presentation strategy. The proposed method partially generates a story from a knowledge fragment network, ideas that are organized in the form of a network. A presentation strategy is modeled as a policy for searching a knowledge fragment network. The policy is reflected in the procedure for selecting knowledge fragments so that the story satisfies the time specified by a presenter. The procedure has a mechanism for estimating time for explaining contents in a story based on the result of the preliminary investigation. From the examples of the story composition, the prototype system for story composition proved to generate stories reflecting the strategies.

The third research theme discusses a method for generating presentation slides from a discourse structure in Chapter 4. The method is based on the mechanism of transformation from the logical structure to the geometric structure. In order to generate slides with diagrammatic representation effectively, the proposed method constructs the logical structure from a topic frame and then finds appropriate layout templates by comparing the logical structures. The preliminary case study showed that some of the slides were successfully generated by our prototype system and had more expressiveness than the slides generated by existing methods.

The research in this dissertation has three main contributions. First, the prototype system for composing a discourse structure realized the representation and operation for authoring presentation materials effectively by introducing zooming user interfaces and semantic relationships. Second, the prototype system for composing a presentation story realized the mechanism for supporting creative activities of story composition by handling knowledge in the form of presentation strategies. Finally, the prototype system for generating a presentation slide realized automatic generation of slides with diagrammatic representation by handling knowledge in the form of layout template of slides.

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Chapter 1

INTRODUCTION

1.1 Motivations

Presentation is one of the most important means for sharing and transferring knowledge in many settings such as education and business. Presenters make speeches in order to achieve their goals. In a classroom lecture, for example, the goal is to promote understanding of concepts by students. In a group meeting and a research conference, the goal is to share ideas and encourage discussion among participants. In a business meeting and public speech, the goal is to persuade audience to take some actions. In any situation, presenters devise stories and materials to achieve their goal. With the development of the services on the World Wide Web, people can share the archives of oral presentations and materials. For example, TED provides a video archive of past talks in TED conferences around the world [63]. The presentation slides used in oral presentations are shared by the services such as SlideShare [58] and Prezi [45]. Furthermore, people can be audience of presentations even if they are not in the same place as presenters. For example, the live streaming service by USTREAM enables us to watch live presentations at a distant place [68].

Presenters utilize various kinds of materials with a view to delivering their ideas effectively. Such materials include presentation slides, overhead transparencies, posters, handouts, blackboards, etc. Before a computer software for preparing and performing presentations was developed, many presenters used overhead transparencies and photographic slides as visual aids. Although a presentation system PowerPoint [33] is widely used today, its earlier versions, PowerPoint 1.0 (released in 1987) and PowerPoint 2.0 (released in 1988 and 1990), were for producing transparency sheets [15]. Currently, PowerPoint allows many presenters to prepare slides easily and perform presentations by showing slides on large screens.

Presentation slides play an important role to promote understanding of what presenters talk about. Presenters often make presentation slides when they prepare for their presentation. Most slides are prepared by using presentation tools such as Microsoft PowerPoint [33], Apple Keynote [8] and OpenOffice Impress [43]. Many books have been published for instructing how to prepare presentation slides [3][14][47][48][50]. Although these tools make it easy for us to prepare slides with rich graphics and animations, criticisms have pointed out their problems from the viewpoint of understandability about the contents of slides [15][44][66][67]. For example, Tufte argued that it is not easy to complement the semantic gaps among slides or even components such as texts and images in one slide [67]. This is partly because presenters tend to focus on making slides rather than considering their messages and stories. Traditional presentation tools do not have a function for providing the view of the overall presentation story. This prevents presenters from comparing multiple slides and thereby checking if the presentation story is consistent during the process of preparation [30]. Another reason is that most presenters use the formats of slides set up by presentation tools, and thereby rely on the way of phrase headlines with bullet lists. Traditional presentation tools do not have the function for specifying semantic relationships among slides and components explicitly. Because the semantic relationships among the phrases are implicit, the slides with such formats tend to make the discussion point and the flow of reasoning unclear [2].

This dissertation addresses these problems by developing a system that enables presenters to externalize their implicit knowledge and handles the knowledge for better presentations. Some researches have developed software agents which automatically perform presentation [6][26]. For example, an agent in EgoChat performs presentations based on a small piece of content called a knowledge card [26]. Although such software agents are expected to make us free from performing presentations, the burdens of authoring contents for presentations will increase. In addition, skills for presentations play an important role in communication among people [46]. Therefore, this research aims to support the activity of presenters without relying on the technologies of autonomous presentation agents.

Among the various kinds of activities related to presentations such as preparation, rehearsal, performance and reflection, this dissertation focuses on the process of presentation preparation.

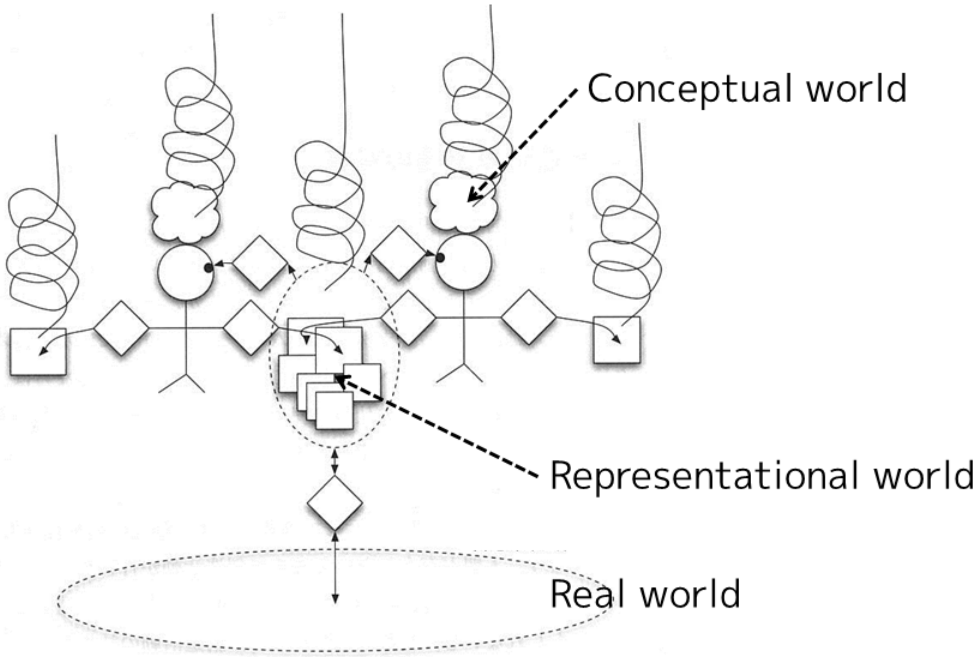


Figure 1.1: Three types of worlds from the viewpoint of creativity support (illustrated in [22])

Since presenters' behaviors such as body languages and voice intonations are essential for good presentations [49], Kurihara et al. developed a system for checking the behavior of presenters [28]. The system, which is called Presentation Sensei, promotes reflection on the performance of presenters by providing feedbacks for them. On the other hand, presenters' messages and stories are the primal factors determining whether their presentations are successful.

This dissertation addresses the support of presentation preparation from the viewpoint of creative activity support. This is because the process of presentation preparation has the following aspects of creative activities.

- Presenters create persuasive messages and stories in order to give motivation and inspiration to their audience.
- Presenters create visual materials such as slides and posters in order to promote the understanding of their audience.
- Presenters consider how to perform in presentations in order to affect their audience.

From the viewpoint of computational support of creative activities, Hori argued that the process of creative activities takes place through the interactions among three worlds as illustrated in Figure 1.1: conceptual world, representational world and real world [21][22]. Conceptual world corresponds to human mind where internal representations exist. Representational world consists of external representations on which a person can operate directly. Real world consists of external representations on which a person can have indirect operation. Effective support for presentation preparation requires handling the representations between conceptual world and representational world. Therefore, this research introduces a *presentation scenario* as external representation in representational world. A scenario represents the intention of a presenter on what to speak and how to convey it in a presentation. In order to address the problems of existing presentation tools, this research aims to support the composition of scenarios and other activities in presentation preparation by handling the scenarios as the explicit intentions of presenters.

1.2 Research Overview

The research discussed in this dissertation is conducted on the background of the knowledge handling model proposed by Watanabe [72][73]. The knowledge handling model aims to explain the process of individual learning as illustrated in Figure 1.2. While SECI model [39] considers creative activities in organizations, the knowledge handling model focuses on individual learning activities. The knowledge handling model defines the states of knowledge, and formalizes a learning activity as the sequence of state transitions of knowledge segments triggered by operations. A knowledge segment is in one of the three states: *inside of in-world*, *outside of in-world* and *out-world*. Inside of in-world corresponds to the conceptual world in Fig. 1.1. Outside of in-world and out-world correspond to the representational world and the real world, respectively. The knowledge handling model specifies four types of operations on knowledge segments: *acquisition*, *presentation*, *reproduction* and *refinement*. According to the knowledge handling model, a system for supporting creative activities must have functions corresponding to refinement on knowledge segments. The objective of this research is to clarify how the knowledge segments in *outside of in-world* should be represented. In addition, this dissertation investigates what kind of operations should be substituted for part of the thinking process as computational functions on knowledge segments in order to support presentation preparation effectively.

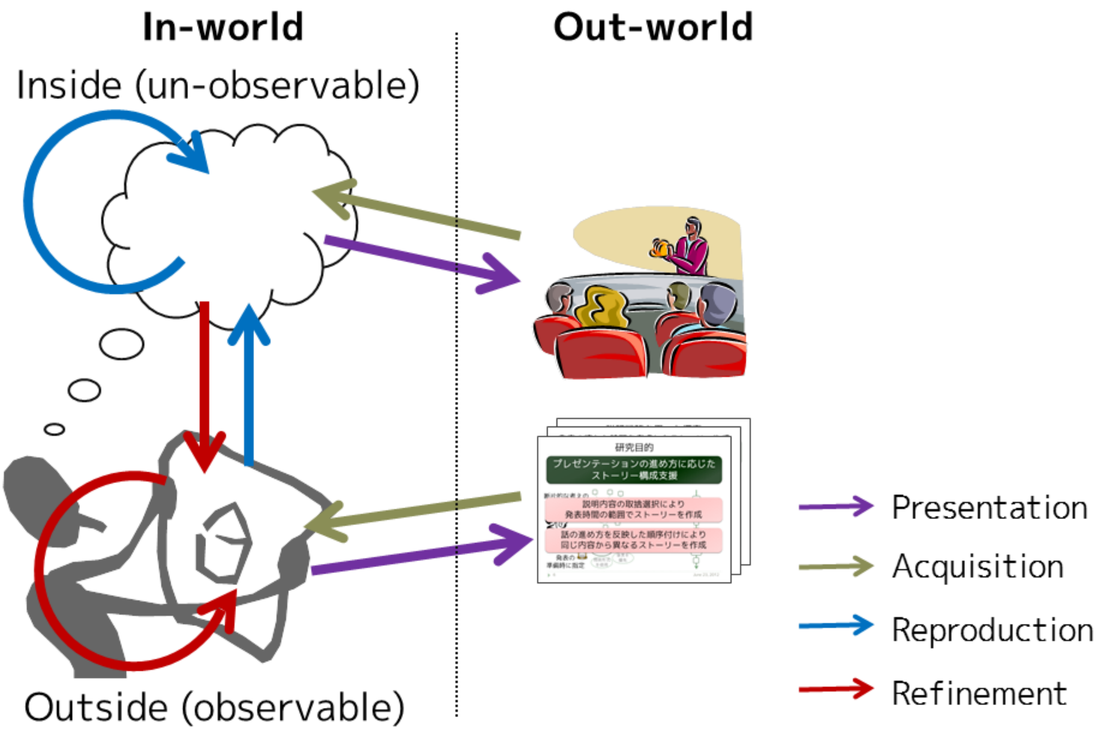


Figure 1.2: Knowledge handling model for explaining learning activity (illustrated in [72])

As described in the previous section, this research aims to develop a system for supporting presentation preparation that handles a scenario for presentations. From the viewpoint of handling external representation, the process of presentation preparation is divided into three main phases. First, presenters collect the pieces of knowledge in order to organize their ideas. Then, presenters compose scenarios by clarifying their messages and constructing the stories. Finally, presenters assemble materials such as slides and posters by preparing diagrams, images and videos.

In order to achieve the support for "better presentations", this dissertation addresses three research themes for each phase in presentation preparation described above. Here, "better presentations" refer to the presentations whose messages and stories are clear and promote understanding by their audience. Table 1.1 summarizes the research themes in this dissertation. Each of the themes is described as follows.

Externalization and organization of idea fragments The first theme focuses on the phase of externalizing and organizing small pieces of ideas. This phase corresponds to the operations of acquisition and refinement in the knowledge handling model. In order to perform

Table 1.1: Research themes

Theme	Operations	Approach
Externalization of knowledge fragments for organizing ideas	acquisition, refinement	Development of an interface for specifying semantic relationships between ideas
Story construction support from organized ideas	refinement	Collecting and ordering knowledge segments based on presentation strategy
Automatic Generation of slides from organized ideas	refinement, presentation	Comparison of semantic structure with layout templates of slides

persuasive presentation, presenters must fill in the gaps among the contents on slides while talking. However, presenters often make slides without clarifying the implicit semantic connectivity among the components on slides. Also, the presenters making slides with traditional presentation tools tend to focus on the detail without looking at the whole story of their presentations. In order to address this problem, an interface for specifying semantic relationship between knowledge fragments is introduced. This interface aims to encourage presenters to clarify their implicit knowledge on how to associate different ideas with each other. Additionally, the techniques of zooming and panning are introduced in the interface. This makes it easier for presenters to examine the consistency of their stories, because it becomes easy to switch the views between overview and detail. Therefore, presenters are able to focus on clarifying their message and story.

Story composition support based on presentation strategies The second theme focuses on the composition of presentation stories. This phase corresponds to the operations of refinement in the knowledge handling model. Traditional presentation tools do not have enough functionality for composing stories and slide decks that reflect presentation strategies and time constraints. In order to address this problem, a presentation strategy is introduced as a knowledge for story composition. A presentation strategy is represented as a policy for selecting and ordering knowledge fragments. Also, the mechanism for estimating the time for explaining the content of a knowledge fragment is introduced. This makes easier for presenters to construct stories according to their strategies and time constraints.

Automatic slide generation based on layout templates The third theme focuses on the phase of composing presentation slides. This phase corresponds to the operation of presentation in the knowledge handling model. Most of the existing methods for automatic slide generation considers only the standard format of bullet point lists prepared in traditional presentation tools. However, the slides with such format do not always clarify the important point described in them. In order to address this problem, a layout template is introduced as a knowledge for generating slides. A layout template is a typical pattern of allocating slide components for diagrammatic representation. The template is represented as the precondition for applying it and the allocation procedure of slide components. In the proposed method, the appropriate layout template is selected by comparing the semantic relationships among components with the precondition of the template. Then, slides are generated according to the allocation procedure specified in the template. This mechanism makes it possible to generate slides with diagrammatic representation as prepared in SmartArts of PowerPoint.

1.3 Organization

This dissertation consists of three research themes and organized into seven chapters. Figure 1.3 illustrates the correspondence of the research themes to the phases in the process of presentation preparation.

Chapter 2 overviews the related works on three fields: computational support for creative activities, automatic generation of presentation slides, composition support of presentation materials.

Chapter 3 presents the overall framework of the research themes in this dissertation. This chapter discusses the process of presentation preparation from the viewpoint of knowledge handling process. Then, the requirements for supporting presentation preparation are presented. On the basis of the requirements, the concept of a presentation scenario is introduced, and its role in the process of presentation preparation is discussed. Finally, the approach is presented for each of the research themes.

Chapter 4 presents the first research theme on externalizing and organizing fragments of ideas. This chapter provides the representation of organized ideas and the operations on externalized

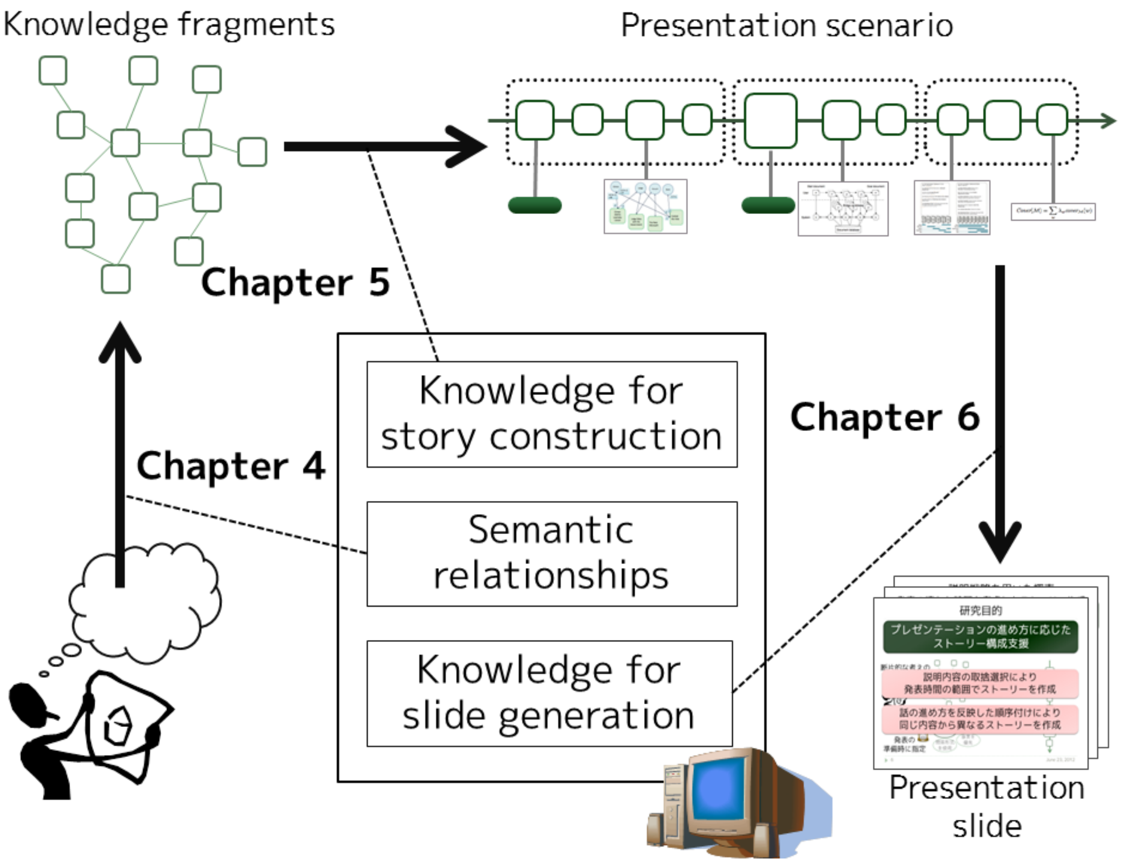


Figure 1.3: Overview of the systems in this dissertation

idea fragments in order to organize them effectively. First, the model of external representation as part of a presentation scenario is defined. Also, the types of semantic relationships, which will be referred to in the subsequent chapters, among knowledge fragments are introduced. Then, a prototype system for organizing knowledge fragments is presented. This chapter discusses the functionality of the system in supporting an earlier phase of presentation preparation.

Chapter 5 presents the second research theme on supporting story construction. This chapter provides a method for supporting composition of presentation story by considering a presentation strategy and time constraints. A presentation strategy is formalized as a policy for searching on a network of idea fragments. According to the presentation strategy, idea fragments that are necessary for a story are selected. Also, the explanation time of an idea fragment is estimated on the basis its content. Finally, this chapter presents a prototype system for story composition, and then shows that the system generates different stories from different strategies.

Chapter 6 presents the third research theme on automatic generation of presentation slides. This chapter provides a method for generating presentation slides based on layout templates of slides. The logical structure of a presentation slide is introduced, and a layout template is defined as a pair of logical structure and procedure for allocating slide components. By comparing the logical structure derived from the semantic relationships with the one defined in a layout template, it is possible to select appropriate template for the given semantic relationship. Finally, this chapter presents the examples of layout templates and the slides generated by the system.

Chapter 7 summarizes this dissertation and discusses the contributions of this research. Finally, this chapter presents the future direction of the research.

Chapter 2

RELATED WORK

This research is categorized as the development of a system for computational support of creative activities. Also, this research addresses the support for composition of presentation materials as documents. This chapter reviews the existing works that are related to the research themes in this dissertation. Finally, this chapter discusses the differences of the research in this dissertation from the existing works.

2.1 Computational Support for Creative Activities

A number of systems have been developed in order to support the process of externalizing and organizing pieces of ideas. Outline processors including Inspiration [24] and OmniOutliner [42] are examples of such systems. Although most of the systems are used for organizing ideas, their outputs have not been utilized directly in composing products such as documents and presentation materials. Exceptions are the systems for writing passages [54][55], planning events [4], composing music [5] and requirement acquisition in software development [62]. FLY [20] visualizes a deck of slides in the form similar to a mind-map [11]. While FLY provides a holistic view of a presentation, presenters using FLY have to prepare slides in advance.

Some systems are based on the concept of semantic authoring [19] and others are based on the technique of idea organization called the KJ method [25][60]. In the KJ method, participants write their ideas on many pieces of papers, and then organize them through spatial arrangement and hierarchical grouping. Then, participants illustrate diagrams or passages about the ideas based on the result of the previous steps.

In order to support idea generation in the KJ method, KJ Editor [41] and D-ABDUCTOR [61] have the functions for editing, manipulating and grouping idea fragments semi-automatically on a computer. VITE provides a user function to intuitively arrange and manipulate structured data [23]. In VITE, the data set is represented as a set of small pieces of hypertext. In addition, a user can express relation between data items by visually configuring them on her own way. From the viewpoint of personal knowledge management, the systems introducing the concept of spatial hypertext such as Popcorn [12] and iMapping [17] have been developed. iMapping is a system for organizing and managing personal semantic knowledge. iMapping was developed based on the approach of combining visualization techniques and semantic technologies. The user of the system is able to specify the semantic relation in her knowledge explicitly with a zooming interface. Although these systems are not used for generating slides automatically, their output can be used for supporting composition of presentation slides.

2.2 Automatic Generation of Presentation Slides

Some researches have attempted to generate slides automatically from existing resources such as paper manuscripts using techniques of text summarization. Miyamoto et al. proposed a method for generating slides from a research paper in the TeX format [35]. In this method, sentences that have parallel relations are extracted for generating slides in an itemized format using conjunctive words and phrases. Shibata et al. proposed a method for generating slides by constructing discourse structure from a text segment [56]. In this method, a clause and a sentence are considered as a unit that forms a discourse structure. The discourse structure is constructed by detecting coherence relations between clauses and sentences using cue phrases, word/phrase chain, and similarity between sentences. The coherence relations are used for computing the depth of indentation in a slide for each clause and sentence. Utiyama et al. proposed a method for generating slides from a text segment with annotations called the GDA tagset [69]. In this method, parse-tree bracketing (morphological and syntactic information of words and phrases), semantic relation, and coreference in the tagset are considered for generating slides. The semantic relation includes rhetorical relation such as cause, concession and elaboration.

Although these methods generate slides based on semantic relationships, the slides follow the standard format of bullet-point lists in traditional presentation tools. In order to promote the understanding of the slide contents, it is necessary to allocate components such as texts and images diagrammatically so as to represent the discourse structure effectively on slides.

2.3 Composition Support of Presentation Slides

Yasumura, et al. proposed a method for supporting composition of slides in XHTML format from a research paper manuscript written in the TeX format [77]. Their system takes a paper manuscript as an input and computes the number of slides for each section in the paper, then selects the appropriate layout template for each topic such as a section and a subsection. The layout templates are applied to specific type of topic and specific combination of components. This system extracts the components such as texts, images and mathematical expressions by computing their importance. On the other hand, the system does not extract the relationships among the components. Therefore, the expressiveness of semantic relationships in a slide is limited.

From the viewpoint of reusing existing slides, some systems attempted to support assembling slides for a new presentation [13][53]. Their systems provide interactive interfaces that visualize multiple presentations with their alignments computed on the basis of the similarities among slides. Outline Wizard is a system to support composing presentation slides using the technique of outline-based search [10]. Outline Wizard has a repository of existing slides with its outline extracted from their hierarchical structure. In composing presentation, the slides are retrieved from the repository so as to match the outline specified by a presenter. These systems make it easy to compose a presentation from existing slides. On the other hand, these systems do not support the thinking process of a presenter in order to make her story persuasive and consistent. That is because they do not handle the semantic relationships between contents or topics in a presentation.

Wang et al. attempts to support slide composition for classroom presentations [70]. They extract the skeleton of a presentation from a textbook based on the correspondence between past slides and the contents of textbooks. The skeleton represents a hierarchical structure of keywords and helps presenters to compose slides. While their method supports creation of slides, their format still follows the standard bullet-point list.

Some systems enable a presenter to prepare presentation contents in order to perform a presentation flexibly by switching the sequence of slides during his/her presentation intuitively. Palette is a presentation tool that has a paper-based interface [37]. In Palette, a presenter can control a slide show by using index cards printed with slide contents. Customizable Presentation provides functions of grouping slides and specifying multiple paths on slide transition [36]. NextSlidePlease also assists presenters in performing presentations based on time constraints [59]. The system allows presenters to specify the priorities of slides and the time for explanation. During presentations, the system selects and presents appropriate slides based on the remaining time. While these systems realize flexible presentations, presenters have to make slides in advance in order to use them. Therefore, presenters still tend to pay less attention to stories than slides.

2.4 Interfaces in Authoring Support of Presentation Materials

Some systems adopt zooming user interfaces (ZUIs) in order for presenters to grasp the topic structure and stories. The basic approach is to add the functionality of zooming to the two-dimensional plane on which presentation materials are composed and presented. Both a presenter and audience can focus on a specific topic and look over the whole story by zooming in and out. CounterPoint has a function of arranging slides prepared with PowerPoint on a two-dimensional plane and expressing topic transition by animations such as zooming and panning [16]. FLY [30] and Prezi [45] also provide ZUIs and specify views of presentation data by taking "snapshots" on a two-dimensional plane at arbitrary location and scale. These systems make it easy for a presenter to provide the overview of a story for her audience. On the other hand, the interrelationships among topics and components are not always clear because they cannot be specified explicitly.

In order to make slide composition easier, some researches introduced pen interfaces to the process of authoring presentation materials. Kotodama is a system for authoring presentation materials with a pen interface [27]. The system also provides a two dimensional zoomable plane as implemented in CounterPoint. SketchPoint also introduced a pen interface for supporting composition of materials for informal presentations [29]. While these systems reduce the burden of authoring contents, the semantic relationships among the contents are not handled unless they are explicitly specified by presenters.

2.5 Summary

This chapter reviewed the systems and methods related to idea organization, automatic generation of slides and authoring support of presentation materials.

From the viewpoint of supporting creative activities, many systems have introduced a visualization technique by arranging elements on a two-dimensional plane. These systems arranges the elements by statistical mapping of the similarities among them. While these systems do not interpret the external representations explicitly, this research attempts to interpret them using explicit knowledge. Specifically, the proposed method introduces a presentation strategy as knowledge for story composition. Although some of the systems based on the KJ-method support the process of constructing a story by ordering pieces of ideas, these systems do not handle the knowledge on how to construct a story. This research attempts to support the process of story composition by constructing multiple stories from the same collection of knowledge fragments.

From the viewpoint of slide composition, existing works on generating slides do not prepare the layout templates of slides in which the semantic relationships among slide components are embedded explicitly. The layout templates in these works are prepared based on the types of components to be included in slides (e.g., the template for a bullet list and the template with a graph). Therefore, the generated slides do not always convey the interrelationships among concepts in slides to the audience. On the other hand, this research attempts to generate slides according to templates with its inherent semantic construction. By considering semantic relationships as preconditions for applying a template, it becomes possible to transform the semantic relationships among slide components into the slide with an appropriate layout.

Chapter 3

FRAMEWORK

This chapter discusses the process of presentation preparation from the viewpoint of the knowledge handling model [72][73]. The knowledge handling model described in Chapter 1 enables to model a creative activity as a sequence of operations on knowledge segments. This dissertation investigates the representation that corresponds to the knowledge segment in the state of *outside of in-world* in the knowledge handling model. Additionally, this dissertation discusses what operations on such knowledge segments are substituted for computational functions in order to support presentation preparation.

3.1 Process in Presentation Preparation

The process of presentation preparation consists of three phases as illustrated in Figure 3.1. First, a presenter externalizes ideas for a presentation and organizes them by associating them with each other. Second, a presenter composes a scenario by grouping the ideas into a set of topics and composing a blueprint for presentation materials. Finally, a presenter makes a presentation material by allocating visual components on sheets for the material.

For each of the phase described above, this research introduces external representation which can be manipulated by a presenter. The product of the first phase is represented as a network structure in which a node corresponds to a piece of idea. The piece is called a *knowledge fragment* in this dissertation. The product of the second phase is called a *presentation scenario.* A presentation scenario represents intentions of a presenter on what to speak and how to deliver her idea. The product of the third phase is a presentation material. This research assumes that a presentation

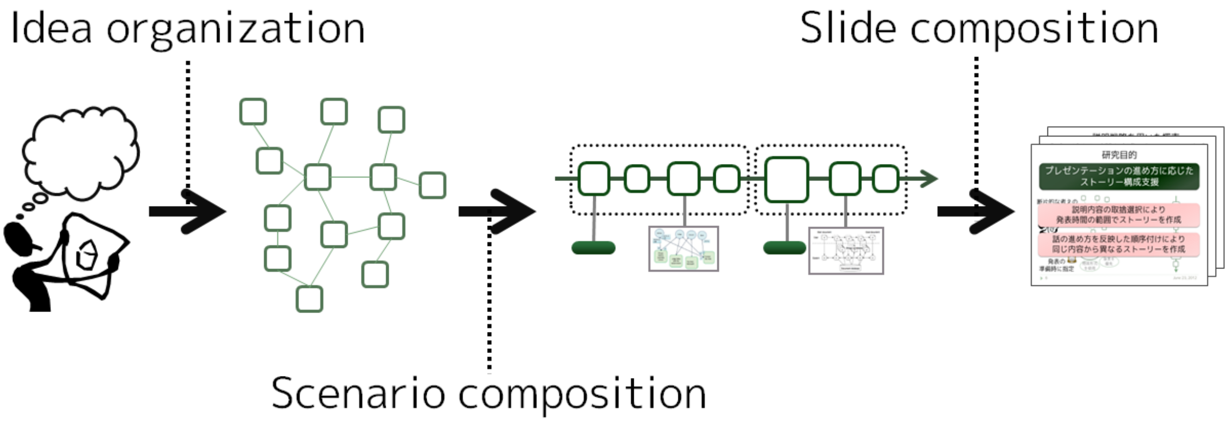


Figure 3.1: Process of presentation preparation

material is composed on the basis of a presentation scenario. The advantage of introducing these representations is that various styles of presentations can be composed from the same contents. For example, different stories can be composed from the same topic according to the background of the audience or time constraints. Another advantage is that the knowledge for composing the product fron that in the previous phase can be handled computationally as illustrated in Figure 3.2. In composing a presentation scenario, the knowledge for composing a persuasive story is applied to the network of ideas. Additionally, the knowledge for composing an understandable slide is applied to the presentation scenario. By handling these knowledges explicitly, this research attempts to support the process of presentation preparation for "better presentations".

3.2 Representation of Presentation Scenarios

Traditional presentation tools are not suitable for a presenter to organize ideas and construct a story in the process of preparation. This is because the thought of a presenter on what and how to speak is not always clear in an early stage of presentation preparation. Since a presentation scenario is composed through a process of structuring presenter's idea fragments, it is quite difficult for her to express her thought in the form of presentation slides. Also, it is more important for a presenter to consider semantic relation among topics or among items within each topic than to consider the appearance of presentation slides and method for visualizing her thought. However,

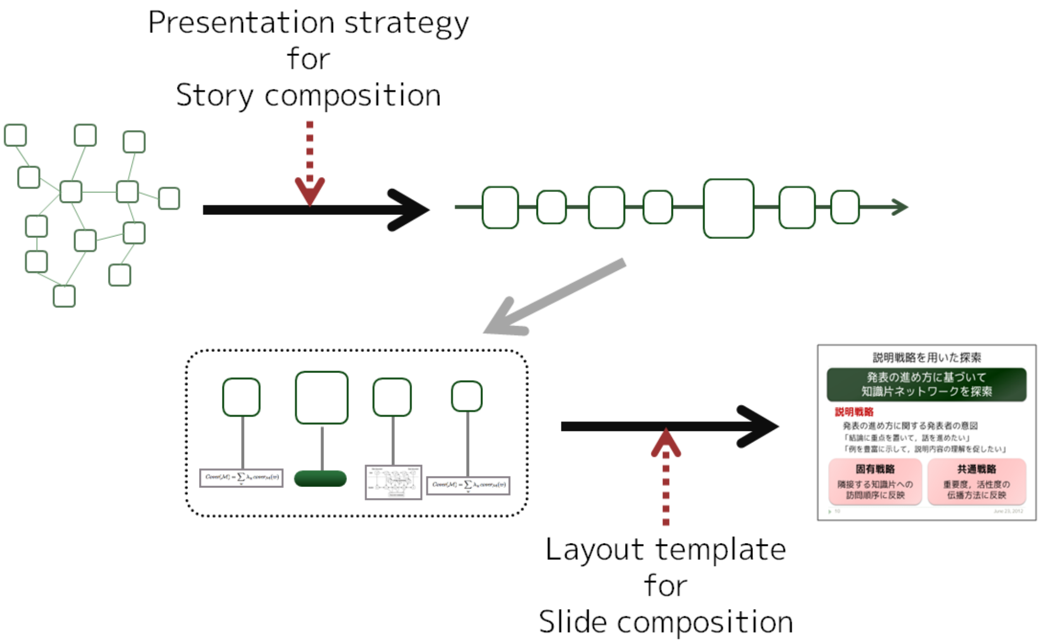


Figure 3.2: Knowledge for production bridging representations

a presenter cannot specify such relationships on traditional presentation tools. This makes it difficult for a presenter to confirm if topics or items are related to each other appropriately.

In order to solve the problem in an early stage of presentation preparation, this research introduces a *presentation scenario*. A presentation scenario represents presenters' intentions on their presentations. Figure 3.3 illustrates the representation of a presentation scenario in the framework of this research. A presentation scenario is composed of *knowledge fragments*, *slide components*, *topic frames* and *story*. A knowledge fragment corresponds to a piece of idea written on a sticky note in a real world. A slide component is a visual element that constitutes a presentation material such as text and image. A presentation scenario is composed by associating knowledge fragments with slide components for each topic. This operation corresponds to determining how to deliver a presenter's message. A topic frame represents a topic in a presentation. A story is a sequence of knowledge fragments that represents how to narrate a presenter's message.

This representation a presentation scenario must have the following characteristics from the viewpoint of thinking process support:

- A scenario consists of semantic blocks and is free from physical constraints.

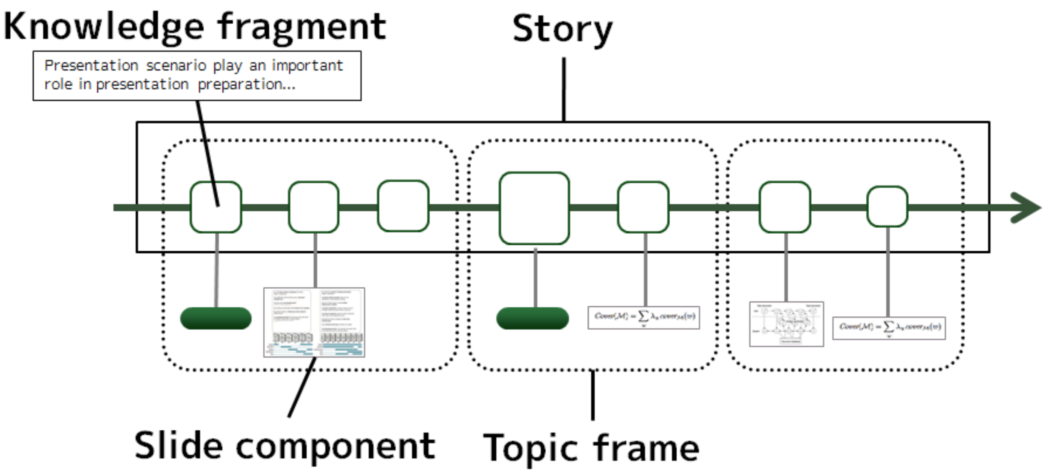


Figure 3.3: Representation of presentation scenario

- The semantic blocks are partially ordered, but not necessarily linearly ordered.
- In each topic, the concepts to be mentioned are associated with each other using semantic relationships.

A semantic block in a scenario is called a *topic frame*. A topic frame represents a topic such as a chapter and a section in documents. Topic frames are free from the physical constraints such as the sizes of slides or displays. In each topic frame, slide components such as texts and images are organized. Each text component is assumed to contain a clause or a sentence written in a natural language. In the organization process, the components are connected by semantic relationships such as "cause and effect" or "an example of." Also, a presenter can specify a relationship between topics by determining the component shared by them. Semantic relationships among topics and components are regarded as implicit knowledge on how to proceed a presentation. Therefore, a presenter is able to externalize such implicit knowledge in composing a scenario.

3.3 Presentation Strategies for Story Construction

A presentation story plays an important role in persuading audience. A persuasive story consists of clear message and sequence of concepts. In constructing presentation stories, presenters consider the sequence of concepts for conveying their messages effectively. The effective sequence depends

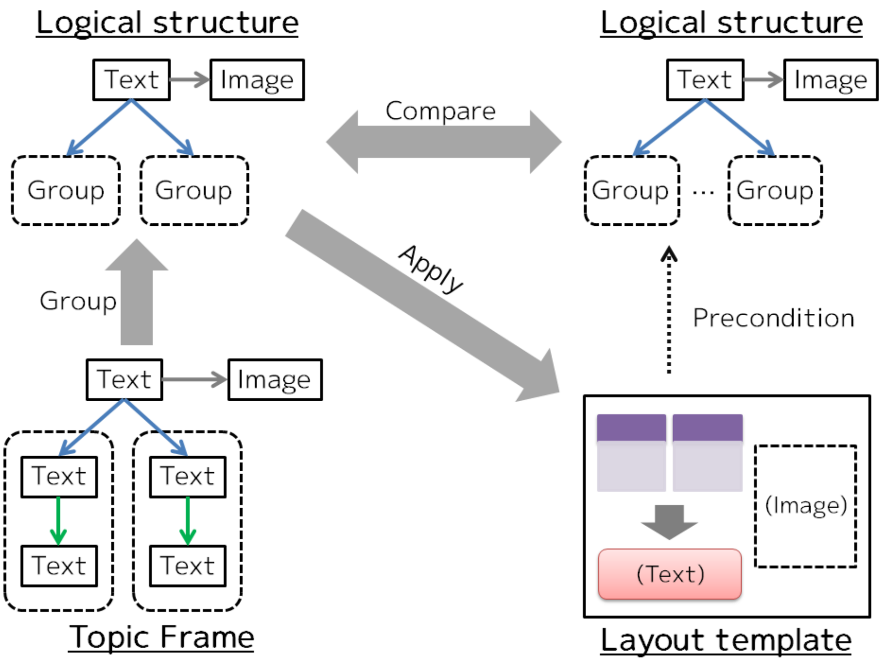


Figure 3.4: Transformation from a topic frame into a slide

on the background of audience and other situations. For example, PREP (Point-Reason-Example-Point) is an effective strategy for conveying a message logically. Presenters also select the concepts to be explained in order to perform their presentations within the specified time.

This research addresses these challenges by modeling knowledge on strategies for explaining concepts. To achieve this, the proposed method handles the knowledge fragments externalized by presenters as a network structure. In the approach, a presentation strategy is represented as a policy in searching a knowledge fragment network. Also, the presentation story must satisfy the predefined time constraint. To follow the constraint, the time for explaining the contents of knowledge fragments is estimated on the basis of their contents. The time can be estimated from the length of the character string in a knowledge fragment. Therefore, the proposed method introduces a model for calculating the explanation time and select the fragments for constituting a story within the specified time.

3.4 Layout Templates for Slide Composition

This research takes an approach of generating slides from the topic frames described above. In order to reflect the semantic relationships in generated slides, the proposed method attempts to arrange slide components diagrammatically on a slide. Presentation slides must include visual components such as images, graphs, diagrams and tables in order to promote understanding of what a presenter talks about. That is because the slides with these visual components convey the message of a presenter intuitively and the relationships among her ideas effectively. In addition, the layout of components on a slide must not be too complex [47]. Therefore, the diagrammatic representation of generated slides should be as complex as that of SmartArts in PowerPoint.

In order to reflect the structure of a topic frame in the layout on slides, a layout template is defined on the basis of the semantic relationships among slide components. Figure 3.4 illustrates the approach. A layout template of a presentation slide is a characteristic pattern of allocating slide components. The proposed method attempts to find an appropriate template for a given topic frame. To achieve this, the method formalizes the precondition for applying a layout template as the logical structure of slides. Generally, document structure is defined as the combination of a logical structure and a geometric structure [71]. A logical structure represents semantic relationships among document elements such as the title, texts, subtexts, figures, tables and footnotes. The elements have their own physical properties such as size, length, location, font style and size in texts. The semantic relationships are assigned among two or more elements: is-a, part-of, grouping, etc. A geometric structure is related to the physical positions of individual elements from a location-oriented point of view on a sheet: neighboring, left-right, upper-lower, overlapping, etc. Thus, it is important to transform the elements from a logical structure to a geometric structure. The transformation is dependent on the semantic relationships among the elements in the logical structure and the physical properties of elements, and is performed interpretatively from the upper elements in the logical structure, which is specified commonly by a tree structure.

In the proposed method, layout templates are defined as a pair of a logical structure and a geometric structure. The layout templates are used for transforming the logical structure into the geometric structure. To do this, the logical structure of slides is derived for each topic frame.

Then, appropriate templates are selected by comparing the logical structure derived from a topic frame and those defined as preconditions in templates. Finally, slides are generated by allocating slide components according to the templates. Currently, the slides are generated for each topic. This means that the relationships among topics in the scenario are not considered in generating slides. Of course, there is a case in which it is necessary to generate a slide that summarizes multiple topics. However, we focus on the generation mechanism of a slide from one topic and leave the mechanism considering relationships among topics for future work.

Chapter 4

REPRESENTATION AND OPERATION FOR A DISCOURSE STRUCTURE

4.1 Introduction

This chapter presents representation and operation for knowledge fragment network from a viewpoint of supporting externalization of presenters' intentions. Traditional presentation slides in the style of bullet lists lack in rhetorical relationships between items in the lists. This makes it difficult for audiences to successfully grasp what messages presenters are trying to convey. One of the reasons for this problem is that traditional presentation systems do not handle the semantic relationships among slides or components on slides. The components that should belong to the same topic are sometimes divided into different slides due to the physical constraints of slides. In this case, the semantic connectivities among the components are broken off. Another reason is that the working view of traditional presentation systems forces presenters to organize the contents for each slide in the deck. This view deprives presenters of the opportunity to examine the consistency of their stories.

The method proposed in this chapter addresses this problem by introducing representation and operation for handling presenters' implicit intentions. The approach consists of three parts. The first part is to introduce an operation of interrelating knowledge fragments by semantic relationships. This operation enables presenters to clarify their intentions on how the concepts are related to each other. The second part is to introduce the holistic view of a presentation story in which multiple topics are visible at the same time. Such view helps presenters examine whether their stories are consistent by comparing multiple topics. The third part is to introduce an operation of allocating knowledge fragments to the topics in a presentation story. This operation allows presenters to move a fragment in one topic to another intuitively.

This chapter presents a knowledge fragment network and a discourse structure as the externalized representations to be manipulated by presenters. A discourse structure consists of the semantic blocks representing topics in a presentation stories and relationships among the blocks. Such a semantic block is called a *topic frame*. In a topic frame, knowledge fragments are organized rhetorically. A discourse structure is composed through the process of producing knowledge fragments within a topic frame and relating topic frames to each other. This chapter presents a prototype system for externalizing and organizing knowledge fragments in the form of a discourse structure.

This chapter is organized as follows. Section 4.2 discusses the approach to support composition of a discourse structure. Then, Section 4.3 introduces a model of a discourse structure and its composition process. Section 4.4 presents the implementation of a system for discourse structure composition. Finally, Section 4.5 summarizes this chapter.

4.2 Approach

Traditional presentation tools manage the data on components such as texts and images with a slide as a unit. Namely, the components are grouped according to the physical constraints of slides instead of the semantic blocks such as topics. Such data structure is suitable to make slides and perform presentations. However, it is not suitable to consider a story in the early stage of presentation preparation. This is because the thought of a presenter on what and how to speak is obscure in such a stage. Since a discourse structure is composed through the process of structuring knowledge fragments, it is quite difficult for presenters to express their thoughts in the form of presentation slides.

The proposed method addresses this problem by introducing representation and operations for a discourse structure based on the concept of spatial hypertext [32][57]. Spatial hypertext refers to a representation of a hypertext as arrangement of document pieces on a two-dimensional plane. This representation is effective for an early stage of creative activities because it can express transient relationships and vagueness. Based on this concept, the proposed method introduces the representation of a discourse structure by which presenters can grasp the holistic view of their presentation stories. Specifically, a discourse structure is visualized on a two-dimensional plane on which multiple topics are visualized. Such view enables presenters to allocate knowledge fragments to topics and examine the consistency among the topics in their presentations.

In addition, presenters preparing for presentations must consider semantic relationships among topics or among items within each topic, rather than the appearance of presentation slides and technique for visualizing their thoughts. Traditional presentation tools prevent presenters from composing scenarios because of the characteristics of data structure they handle. Firstly, the components of presentation slides are divided into blocks according to the physical constraints such as the sizes of slides or displays. Secondly, presentation slides are arranged in a linearly ordered sequence. This makes presenters abandon consideration of stories in alternative sequences of topics and forces them to perform presentations in a fixed sequence of slides. Finally, semantic relationships among topics or items within a topic are not specified. This makes it difficult for presenters to confirm if topics or items are related to each other appropriately.

In composing a discourse structure, representation of externalized intentions affects the cognitive process of a presenter [40][78]. Also, such representation should be edited and manipulated intuitively [75][76]. Therefore, spatial arrangement of idea fragments is effective to support composition of a discourse structure. In addition, it is necessary for presenters to specify semantic relationships between ideas. Therefore, a discourse structure is represented as a network in which a node and a link correspond to a slide component and a semantic relationship between components, respectively. By allowing a presenter to specify relationships between components, it becomes possible to capture and handle presenters' intentions on their presentations.

On the basis of the discussion described above, data structure of a discourse structure must have the following characteristics:

- A discourse structure consists of semantic blocks that are free from physical constraints.

- Topics are partially ordered, but not necessarily linearly ordered.

- In each topic, the concepts to be mentioned are associated with each other using semantic relationships.

A discourse structure is considered as a set of partially ordered set of topics. Topics are related to each other by the concept shared by them. Items such as a character string and a figure are organized in each topic.

The proposed method introduces a topic frame for satisfying the characteristics described above. A topic frame represents a semantic block of one topic such as a chapter and a section in documents. Topic frames are free from the physical constraints such as the sizes of slides or displays. In each topic frame, presenters externalize knowledge fragments in the form of character strings or figures, etc., and then organize them. In the organization process, presenters relates the fragments rhetorically. Rhetorical relation between knowledge fragments is regarded as implicit knowledge on how to proceed a presentation. Therefore, presenters are able to externalize such implicit knowledge in composing topic frames. Moreover, a system for presentation preparation can acquire information about relation between knowledge fragments and then apply the information to supporting composition of a new scenario.

4.3 Definitions

This section gives the formal definitions of a knowledge fragment, a knowledge fragment network. These definitions are referred to in the subsequent chapters. Then, we define a model of a discourse structure and introduce operations on it.

4.3.1 Knowledge Fragment Network

A knowledge fragment is an element that represents a piece of knowledge externalized by a presenter. A knowledge fragment corresponds to a sticky note and a flash card in real world. A knowledge fragment f is defined follows:

$$\begin{aligned} f &= (id, type, content), \\ type &\in \{text, image\}. \end{aligned}$$

Table 4.1: Semantic relationships between knowledge fragments and their meanings

Name	Description	Direction
caused-by	f_{src} is a reason of f_{dst}.	cause→effect
assumed-by	f_{src} assumes f_{dst}.	assumption→statement
paraphrased-by	f_{src} paraphrases f_{dst}.	paraphrase→statement
criticized-by	f_{src} criticizes f_{dst}.	criticism→statement
compared-with	f_{src} is compared with f_{dst}.	one item→another item
exemplified-by	f_{src} is an example of f_{dst}.	example→statement
detailed-by	f_{src} is a detail explanation of f_{dst}.	detail→statement
specialized-by	f_{src} is a specialization of f_{dst}.	specific case→general case
supplemented-by	f_{src} supplements f_{dst}.	supplement→statement
questioned-by	f_{src} poses a question to f_{dst}.	question→statement
answers-to	f_{src} answers to f_{dst}.	answer→question
illustrated-by	f_{src} is an illustration of f_{dst}.	illustration→statement
followed-by	f_{src} comes before f_{dst}.	previous item→next item
related-to	f_{src} is related to f_{dst}.	one item→another item

Here, *id* is an identifier, *type* is the type of f and *content* refers to the entity of f. If the *type* of a knowledge fragment is *text*, its *content* is a character string. Also, if the *type* of a knowledge fragment is *image*, its *content* represents a corresponding image.

A knowledge fragment network G is defined as follows:

$$\begin{aligned} G &= (F, L), \\ L &= \{(f_{\text{src}}, f_{\text{dst}}, r) | f_{\text{src}}, f_{\text{dst}} \in F\} \end{aligned}$$

Here, F is a set of knowledge fragments. L is a set of links between knowledge fragments, and r refers to a type of a semantic relationship between knowledge fragments. The semantic relationships considered are listed in Table 4.1. The types semantic relationships are determined according to the the Rhetorical Structure Theory [31].

4.3.2 Discourse Structure

Figure 4.1 illustrates the model of discourse structure. A discourse structure is represented as a three-layered structure: a skeleton layer, a topic frame layer, and a component layer. In Fig. 4.1, circles in a skeleton layer and a topic frame layer denote topic frames. Rectangles in a topic

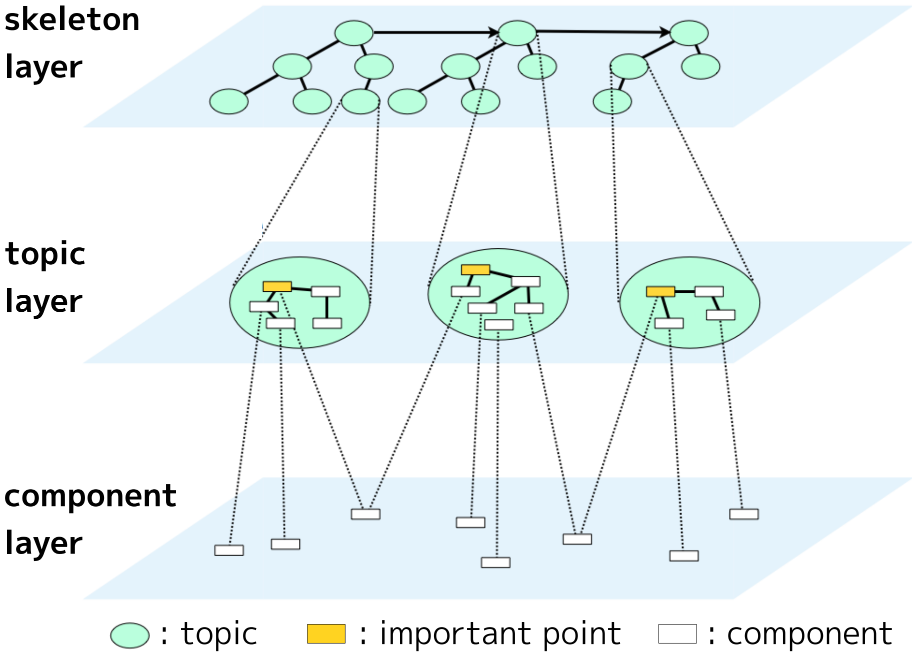


Figure 4.1: Three-layered model of discourse structure

frame layer and a component layer denote slide components. The colored rectangle represents the component that corresponds to the most important point in each topic. Here, a slide component is considered as a knowledge fragment defined in the previous section. A discourse structure DS is defined as follows:

$$DS = (\text{Skeleton}, \text{Topics}, \text{Components}).$$

In this definition, Skeleton, Topics and Components represent a skeleton layer, a topic frame layer and a component layer, respectively.

In a component layer, slide components are stored. As described above, a slide components corresponds to a knowledge fragment. There are two differences between a slide component and a knowledge fragment. One is that a slide component can be given a role in a topic frame. The other is that a slide component has information of sizes when allocated on presentation materials.

The data structure in this layer is defined as follows:

$$\begin{aligned} \text{Components} &= \{c\}, \\ c &= (id, content, type, size), \\ type &\in \{text, image\}. \end{aligned}$$

In these expressions, *id* represents an identifier of a component. *Content* and *type* represent the component itself and its type specified by *id*, respectively. If the *type* of a component is *text*, its *content* is a character string. If the *type* of a component is *image*, its *content* represents a corresponding image. In the definition, *type* takes one of the only two values above. This is because visual components such as an image, a table, a graph and a diagram are similar in the sense that they occupy a larger region on a slide than a text component. Another reason is that we focus on the relationships among components rather than the types of the components. The *size* of a component represents its horizontal length and vertical length. The value of *size* is assigned to the components whose *type* is *image*.

In a topic frame layer, topic frames are stored. A topic frame is composed of its name, and the slide components and semantic relationships among them. The data structure in a topic frame layer is defined as follows:

$$\begin{aligned} \text{Topics} &= \{t\}, \\ t &= (id, name, C_t, L_t), \\ C_t &= \{(c, role) | c \in \text{Components}\}, \\ L_t &= \{(c_{src}, c_{dst}, type) | c_{src}, c_{dst} \in C_t\}, \\ role &\in \{title, point, normal\}. \end{aligned}$$

In each topic frame, *id* represents its identifier. C_t is a set of references to slide components in a component layer. The *role* of a component represents its role in a topic frame. The component whose *role* is *title* corresponds to the title of a topic. The component whose *role* is *point* represents the important point in a topic. This attribute is reflected in the logical structure of slides. L_t is a set of links between components included in the topic frame t. *Type* represents a type of semantic relationships between components as listed in Table 4.1.

A skeleton is a graph structure of topic frames that constitute a presentation story. The data structure in a skeleton layer is specified as follows:

$$\begin{aligned} \text{Skeleton} &= (T, L), \\ T &= \{t | t \in \text{Topics}\}, \\ L &= \{(t_{src}, t_{dst}, type, C_l) | t_{src}, t_{dst} \in T \wedge C_l \subset C_{t_{src}} \cup C_{t_{dst}} \wedge C_l \neq \phi\}. \end{aligned}$$

In these expressions, T is a set of topic frames. Namely, T is a subset of Topics. L is a set of relationships between topic frames in a skeleton layer. t_{src} and t_{dst} are references to topic frames in a topic frame layer. $Type$ represents a type of relationship between topic frames. This indicates the abstract relationship between topics such as sequential relation and hierarchical relation. Such relationship play a role in helping a presenter to grasp the overall structure of topics in a presentation. C_l is a set of slide components that are shared by two topics t_{src} and t_{dst}. This definition implies that a presenter has to relate topics each other by allocating at least one common component to them. Since C_l indicates more detailed relationship between topics than *type*, it plays a role in helping presenters to examine the coherence among multiple topics.

4.3.3 Operations on a Discourse Structure

The composition process of a discourse structure is divided into two phases: topic frame construction and skeleton construction.

A topic frame is constructed by the following operations:

- Create a new topic frame,
- Add/Remove components to/from topic frames,
- Assign roles to components,
- Connect two components within a topic frame.

The operation of connecting components is realized by specifying the type of semantic relationship between them. Since each topic must have a message to be emphasized, we introduce a constraint that the role *point* must be assigned to at least one of the slide components for each topic frame.

The skeleton of a discourse structure is constructed by connecting topic frames. In this phase, topic frames are connected to construct a partially ordered set of topics. In the proposed method, two topic frames are connected if they share one or more components. That is because the topics that are related to each other should share some concepts.

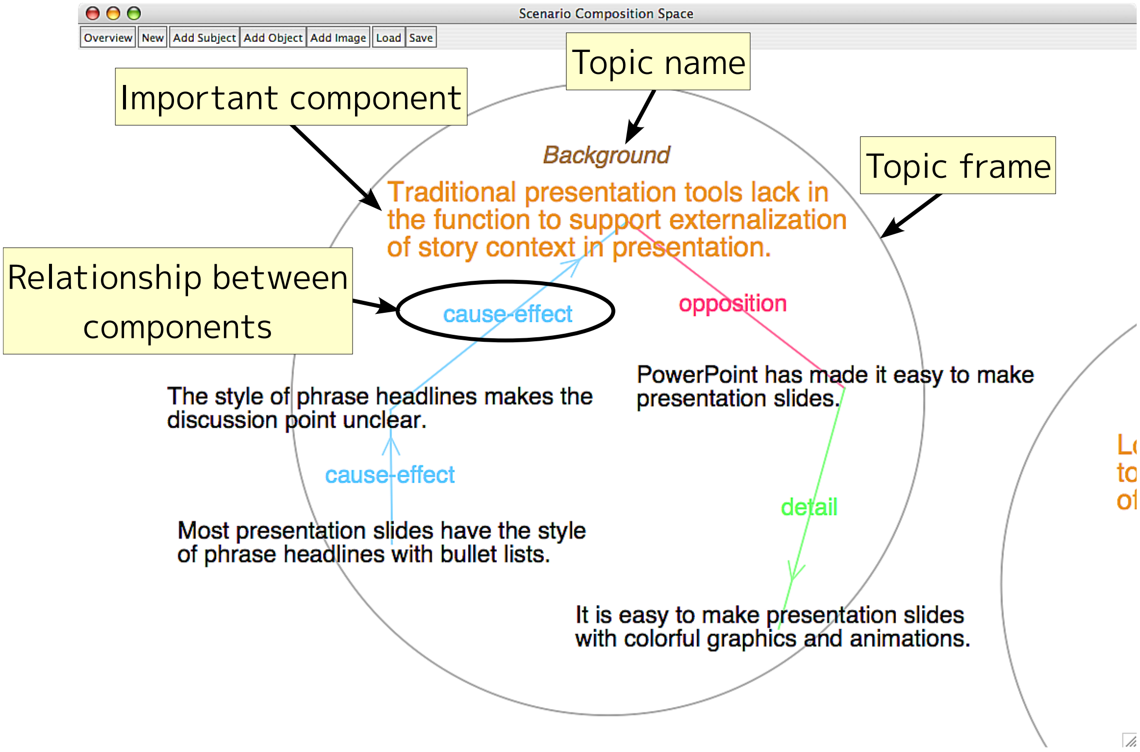
A topic frame represents a semantic block such as a chapter, a section, etc. In books or research papers, there are two types of relations between chapters or sections: sequential relation (predecessor-successor) and hierarchical relation (section-subsection). Therefore, the type of relationships between topic frames is either sequential or hierarchical.

In order to realize the operations described above, a discourse structure is visualized in the form of a network. In the level of a skeleton, a topic frame is represented as a node and the relationship between topics is represented as a link. In the level of a topic frame, a slide component is represented as a node and the semantic relationship between them is represented as a link between the slide components. The level of a topic frame also has information on the links between topic frames. In both levels, whether a link is directed is determined according to the type of a relationship.

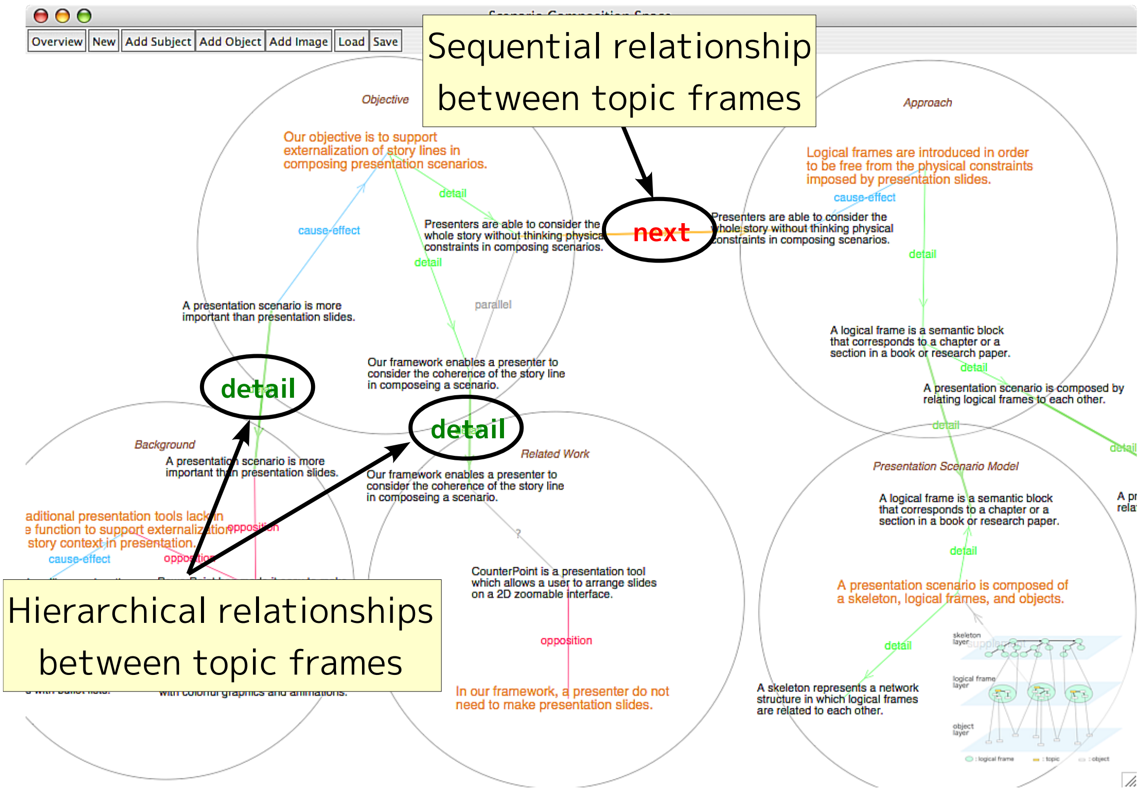
4.4 Implementation

This section presents a system for composing a discourse structure. The system is for editing slide components and specifying semantic relationships among them. The interface is implemented using Piccolo [9], a Java library for developing a zoomable user interface.

In composing a discourse structure, presenters should consider the consistency both between topics and within one topic. Therefore, it is effective to offer a function to change the working view of a discourse structure easily and intuitively. To achieve this, we introduced the technique of zooming and panning in our interface. Figure 4.2 shows the screenshots of the interface. With this interface, presenters can change their working views by zooming and panning. In the local view shown in Fig. 4.2(a), presenters are able to see the detail of a specific topic frame. In the global view shown in Fig. 4.2(b), presenters are able to see the whole presentation. In these figures, the area inside a circle corresponds to a topic frame. Semantic relationships between components are represented as a link with a label. For example, a text component “Traditional presentation



(a) Local view of a topic



(b) Global view of topics

Figure 4.2: Screenshots of the system for discourse structure composition

tools lack in the function to support externalization of story context in presentation." in Fig. 4.2(a) is connected to a text component "The style of phrase headlines makes the discussion point unclear." with a link that represents the relationship "cause-effect". In Fig. 4.2(b), the topic frame "Objective" (one at the upper left side) is connected to the two topic frames "Background", and "Related Work" (ones at the lower left side) with hierarchical relation. On the other hand, the topic frame "Objective" is connected to the topic frame "Approach" (one at the upper right) with sequential relation.

In addition to zooming functions, the system provides a presenter with the operational functions as follows:

Add a topic frame This operation is done by specifying the name and the important point of a topic using a dialog window.

Add a component This operation is done by specifying the content of a component using a dialog window.

Connect a component to another one in a topic frame This is done by dragging and dropping a component near the one that a presenter wants to connect to. Figure 4.3 shows an example. When a component is moved near to another component in a topic frame, a dotted line appears between them as shown in Fig. 4.3(a). The line indicates a candidate component to be related with the one moved by a presenter. After that, the type of relationship can be specified using a dialog window. When a presenter specifies the type of relationship, the visualization of a discourse structure is updated as shown in Fig. 4.3(b).

Connect a topic frame to another one This is done by dragging and dropping a component in one topic frame to another topic frame that a presenter wants to connect. Figure 4.4 shows an example. When a presenter moves a component from one topic frame to another as shown in Fig. 4.4(a), the system asks her whether the topics will be connected by the component or the component is removed from a topic frame using a dialog window. When a presenter selects the first option, she specifies the relationship between the two topic frames and the relationship between the components using a dialog window. Finally, the visualization of a discourse structure is updated as shown in Fig. 4.4(b).

Create a detailed topic from an existing one This is done by moving a component in a topic out of the topic frame. Figure 4.5 shows an example. When a presenter moves a component from the topic frame it belongs to as shown in Fig. 4.5(a), the system asks her whether a topic frame will be created from the component or the component is removed from the topic frame. When a presenter selects the first option, she specifies the name of a new topic. Then, a new topic frame that has the component whose *role* is *point* is added to a discourse structure as shown in Fig. 4.5(b).

Since the prototype system provides the functions described above, it is possible for presenters to compose a discourse structure through intuitive manipulation on topic frames and slide components. Also, presenters can specify the semantic relationships between components, while they cannot do it using traditional presentation tools. Moreover, zooming and panning functions enable presenters to look at multiple topic frames at the same time. Therefore, the system helps presenters to consider the consistency among the topics in a discourse structure.

Section 4.2 discussed that the representation of a discourse structure must be suitable for an early stage of presentation preparation. Especially, the representation must have the following characteristics:

- A set of partially ordered topics,
- Semantic relationships between items specified by a presenter, and
- Multiple topic frames on the working view for intuitive allocation of components.

The prototype system has the functions for a presenter to compose a discourse structure with the characteristics described above. Specifically, the system has the following functions to support composition of a discourse structure by a presenter:

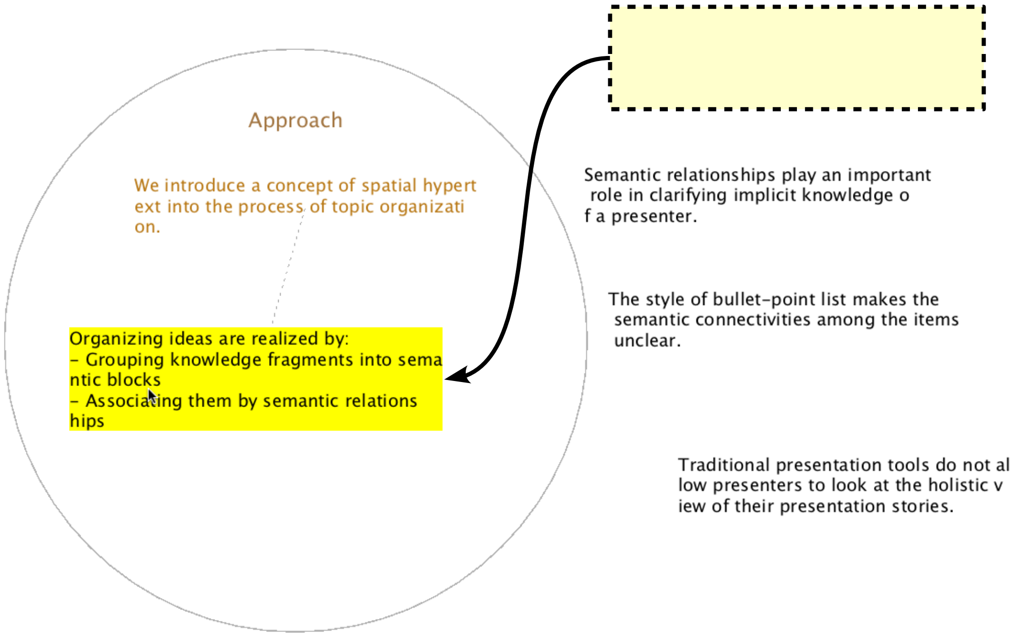
- Zooming and panning for switching a working view smoothly,
- Specifying sequential/hierarchical relation between topics, and
- Specifying semantic relationships between slide components in each topic.

The first function enables a presenter to switch her working view between overview and detail. This makes it easy for a presenter to consider a presentation story and confirm if topics are connected with each other appropriately. The second function is realized by sharing a text component with the topics to be connected. This makes it easy for a presenter to understand how topics are related to each other. The third function is realized by moving a component near to the one to be connected and then selecting a type of relationship. Since moving components and topic frames are achieved by dragging them, a presenter is able to specify relationships between topics or components within a topic intuitively in the system.

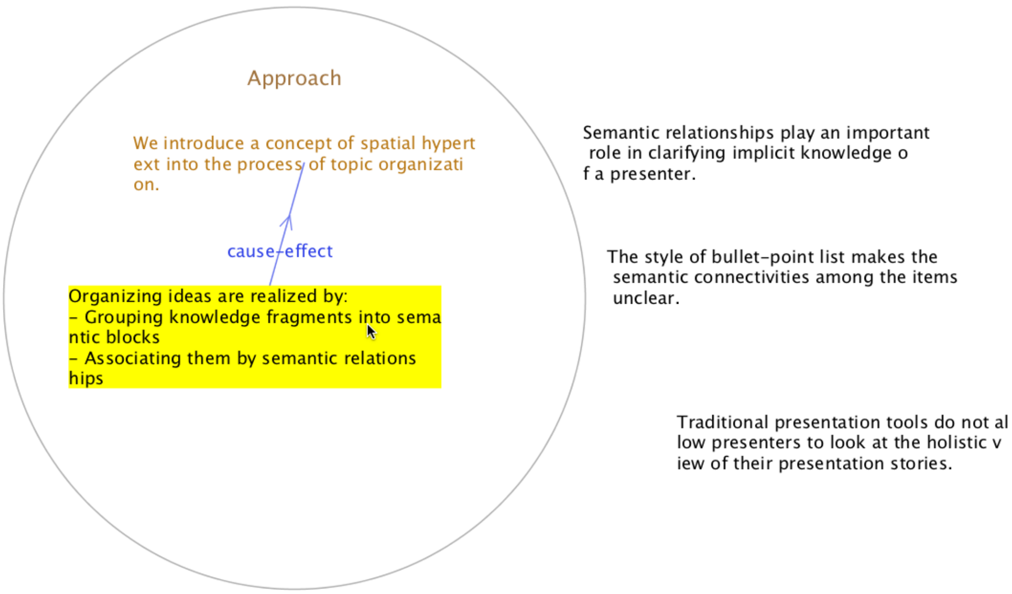
4.5 Summary

This chapter presented a prototype system for supporting externalization of the intentions on a presentation. By introducing a concept of topic frame, a model of a discourse structure is defined. Based on this model, the system for composing a discourse structure is developed. The system has the following features. First, presenters are able to externalize their implicit intentions on the semantic relationships between their ideas. Second, presenters are able to change the working view smoothly through the functions of zooming and panning. Our system provides the holistic view of a presentation story in which multiple topics are visible at the same time. Finally, we introduce an operation of allocating knowledge fragments to the topics in a presentation story. This operation allows presenters to move a fragment in one topic to another intuitively. These features are expected to promote the thinking process of presenters.

The representation of a semantic relationship in the prototype system does not consider the sequence of topics in a presentation. Therefore, the next chapter discusses the method for composing a presentation story from the knowledge fragments externalized by a presenter.

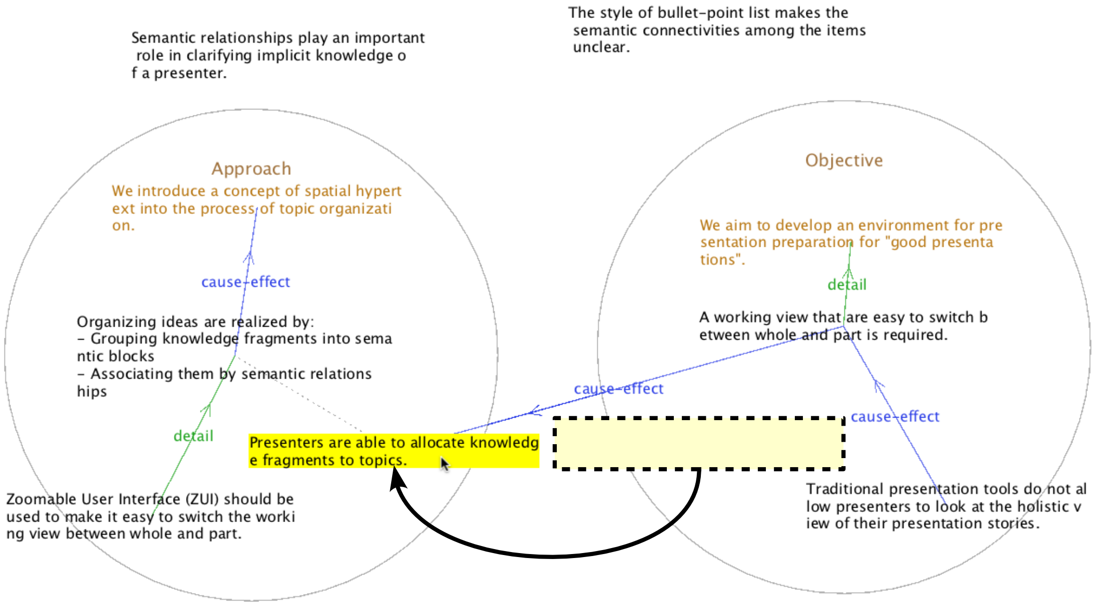


(a) Moving a fragment into a topic frame

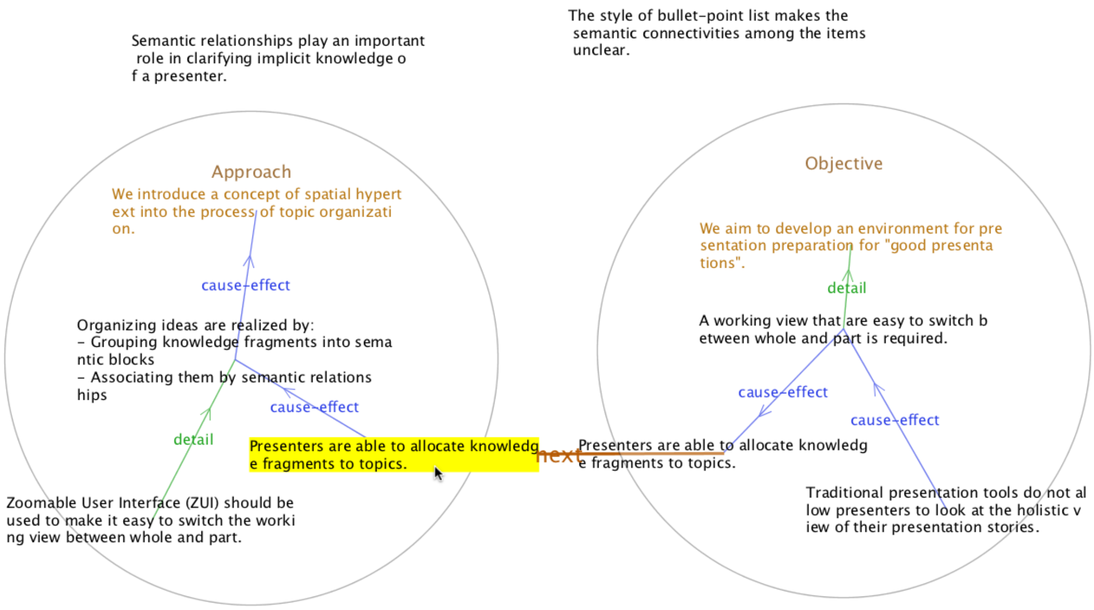


(b) A topic frame after specifying the semantic relationship between two fragments

Figure 4.3: Operation of allocating a knowledge fragment to a topic frame

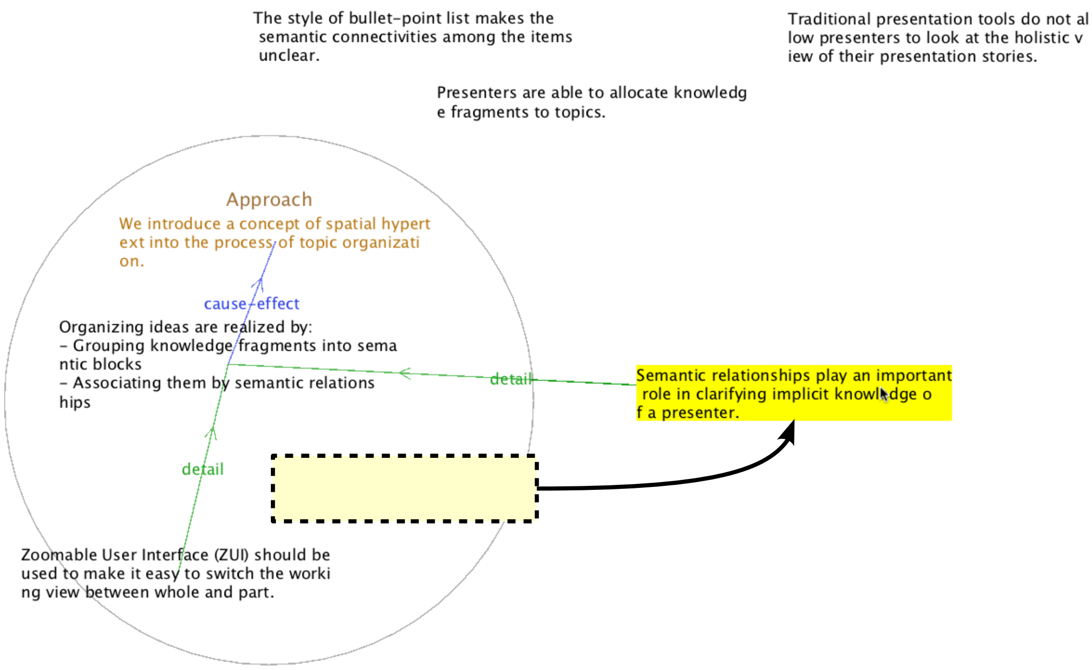


(a) Moving a fragment in a topic frame to another topic frame

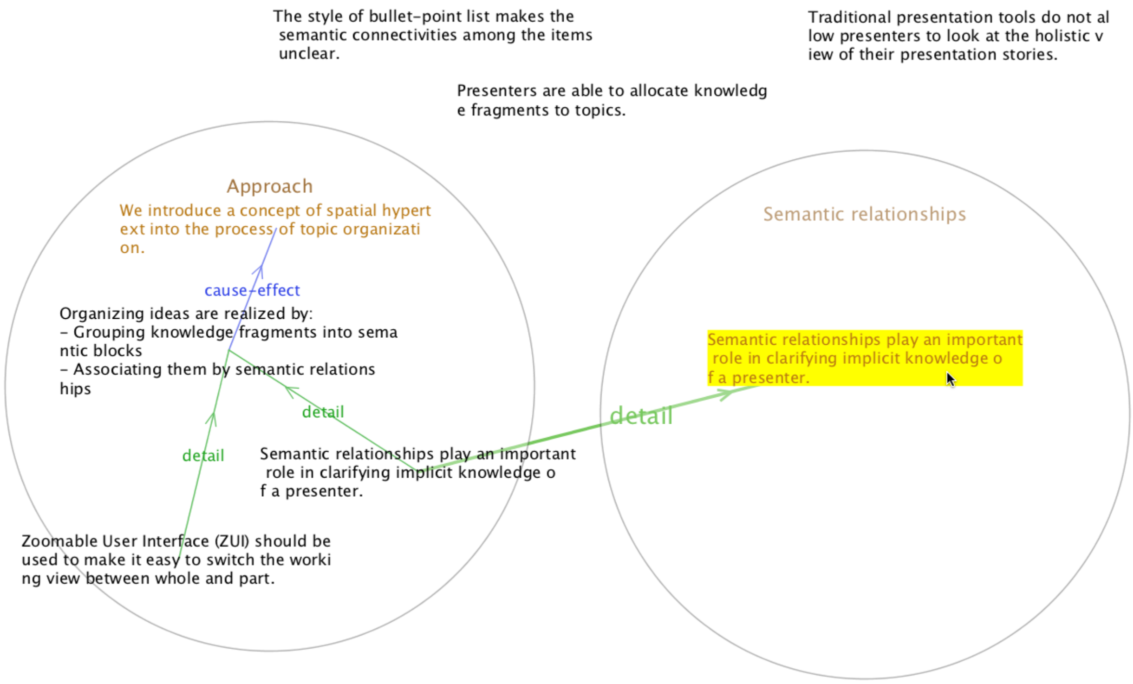


(b) Topic frames connected by a shared fragment

Figure 4.4: Operation of connecting two topic frames



(a) Moving a fragment out of a topic frame



(b) Topic frames related by a hierarchical relationship

Figure 4.5: Operation of adding a detail topic frame

Chapter 5

STORY COMPOSITION BASED ON PRESENTATION STRATEGIES

5.1 Introduction

This chapter presents a method for supporting composition of a presentation story. In presentation, a story plays an important role in persuading audience as well as a message. A story consists of facts, messages and their sequence. Whether a story is effective and persuasive depends on the situation such as the background knowledge of audience and time constraints. The objective in this chapter is to support composition of presentation stories according to multiple situations. Although facts and messages are essential for a persuasive story, this chapter focuses on how to order them in composing a story.

The idea of the proposed method is to introduce a presentation strategy and translate it into the policy of searching a knowledge fragment network. Namely, a presentation story is represented as a search path on a given knowledge fragment network. The proposed method contains a mechanism of selecting and ordering the fragments according to a strategy specified by a presenter. This mechanism allows a presenter to compose a story from a few fragments specified as important ones by her. Also, time constraint is an important factor to determine what to speak in a presentation. Therefore, the proposed method selects the knowledge fragments to be included in a story so that the story will satisfy the time constraint. The mechanism of selection is realized by estimating the time for explanation on the basis of the contents of knowledge fragments.

This chapter is organized as follows. Section 5.2 discusses the approach and the interaction design in story composition. Section 5.3 explains how to handle a presentation strategy in the

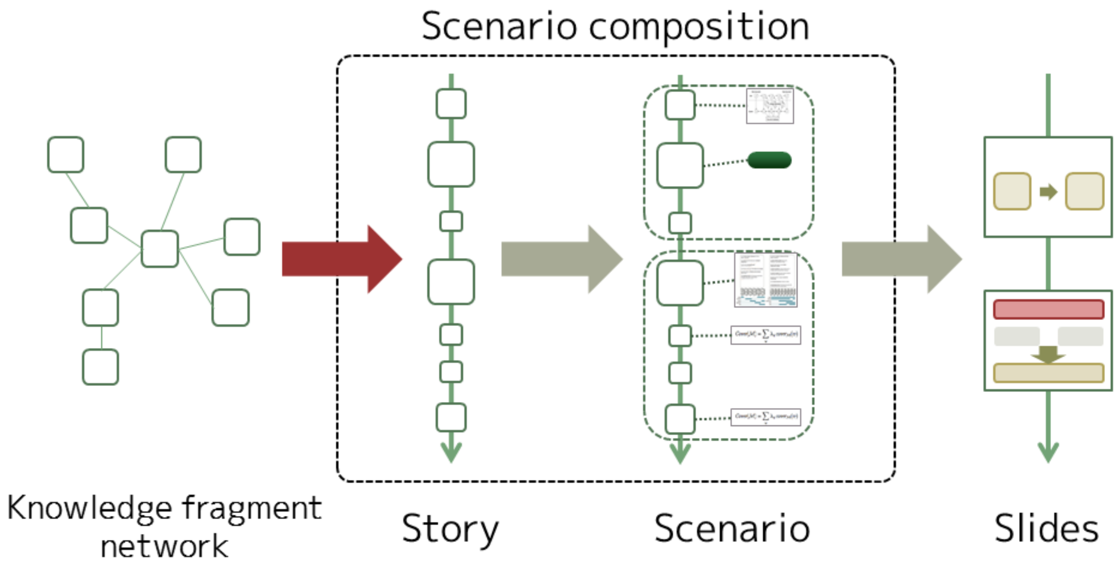


Figure 5.1: The process of scenario composition

proposed method. Section 5.4 presents the mechanism of constructing a presentation story. Section 5.5 describes how to introduce time constraint into story composition process. Then, Section 5.6 presents the prototype system for story composition and an example of story composition. Finally, Section 5.7 summarizes this chapter.

5.2 Approach

This section discusses the process for composing a presentation story and the approach to story composition support. The proposed method assumes that a presenter composes a story from a knowledge fragment network defined in the previous chapter. A presenter externalizes knowledge fragments and organizes them in the form of a knowledge fragment network through her daily activity. The proposed method also assumes that all the knowledge fragments are texts. Namely, only the knowledge fragments whose *type* is *text* are considered in this chapter. The reason for this assumption is that a presenter tends to come up with keywords and phrases before constructing her presentation story. Furthermore, story composition usually precedes slide composition. The knowledge fragments in a phase of story composition should be in the form of a text rather than visual elements such as pictures and diagrams.

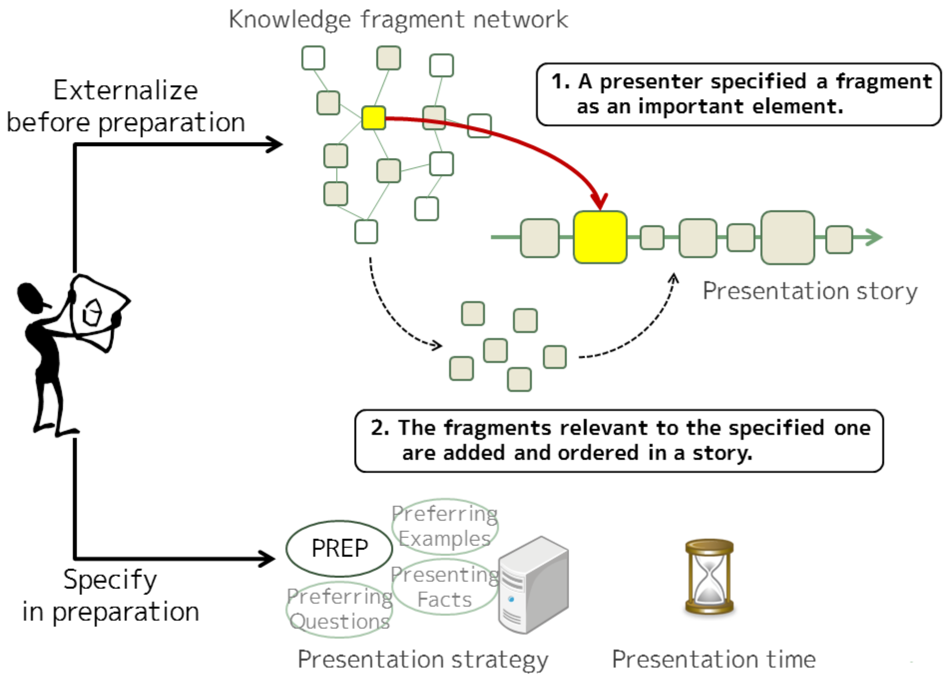


Figure 5.2: Interaction model in composing a presentation story

5.2.1 Story Construction in Scenario Composition

Scenario composition consists of two steps: constructing a presentation story and designing presentation slides. Figure 5.1 illustrates the process of scenario composition. First, a presenter constructs a story from a knowledge fragment network by picking and ordering fragments whose contents are important to her. Next, a presenter designs presentation slides by grouping knowledge fragments into topics, associating the fragments with slide components, and specifying the layout of slide components in presentation materials. The method proposed in this chapter focuses on the first step.

5.2.2 Representing Knowledge for Story Composition

A presenter usually constructs a story according to her strategy. The proposed method introduces a *presentation strategy* with a view to supporting story construction. A presentation strategy is a presenter's intentions on how to construct a persuasive story. "PREP (Point-Reason-Example-Point)", "Explain from examples" and "Use as much illustrations as possible" are examples of a presentation strategy. In the field of cognitive science, it is argued that a story grammar promotes understanding of a story [64]. A story grammar is represented as a set of production rules in similar forms to a context free grammar. This means that a story is considered as a sequence of elements that are related by semantic relationships. Since such sequence reflects the preference of the semantic relationships, a presentation strategy must specify the priorities of selecting specific semantic relationships. In order to support the composition of a persuasive story, the proposed method extracts knowledge fragments from a knowledge fragment network and order them in sequence that reflects these strategies.

The proposed method introduces an interaction model between a presenter and a system in story composition as illustrated in Figure 5.2. First, a presenter specifies a presentation strategy and time before composing a scenario. When a presenter picks a knowledge fragment that she intends to emphasize, the system selects the fragments that are relevant to the picked fragment, and then orders them in sequence according to the strategy. If additional fragments are necessary, a presenter specifies another important fragment. A presenter repeats this interaction until she judges that the story is complete. This interaction makes it easy for a presenter to construct a story.

5.2.3 Processing Flow

In order to achieve the interaction described in the previous section, it is necessary to determine how to select the knowledge fragments that should constitute a story and how to order them in sequence. Figure 5.3 illustrates the processing flow for supporting construction of presentation stories. Before composing a story, a presenter organizes ideas in the form of a knowledge fragment network. Then, a presenter determines a specific presentation strategy and an important knowledge fragment. The system searches the knowledge fragment network and assigns importance weights to fragments according to the specified strategy (Step 1). In this step, importance weights are propagated to the neighboring fragments according to the semantic relationship. Then, the system extracts the fragments with high importance and constructs a temporary story by ordering them (Step 2). Finally, the system estimates the time for explanation and removes unnecessary fragments from a temporary story if the estimated time exceeds the time specified by a presenter (Step 3). In this step, the fragments with lower importance weights are removed while the

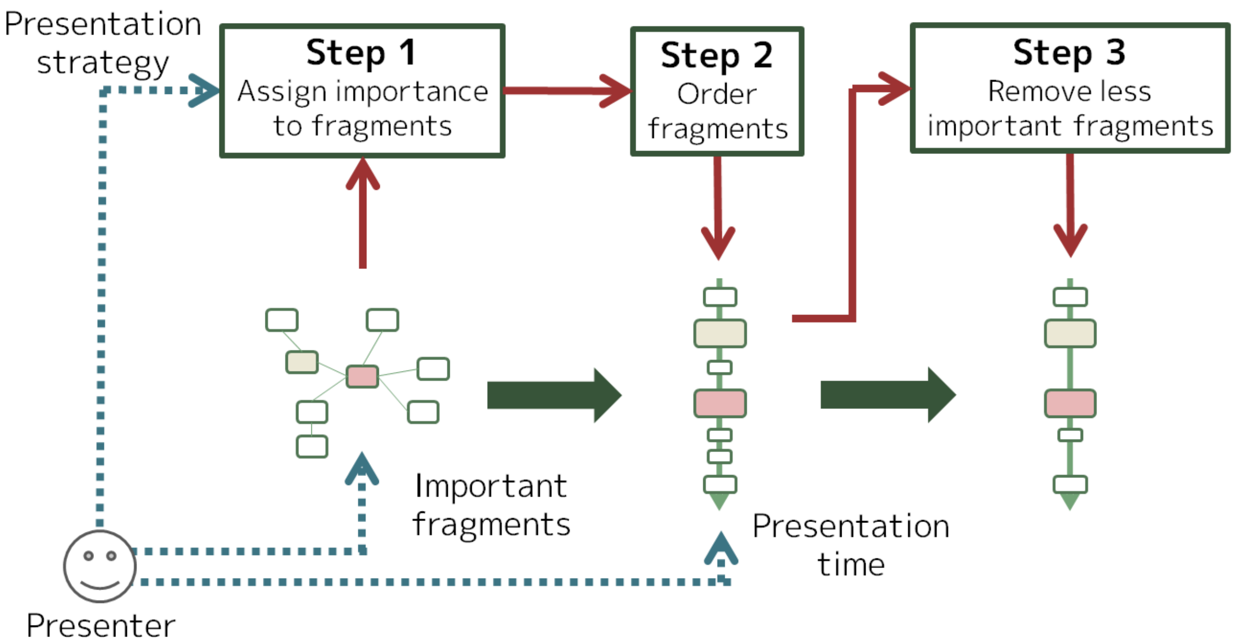


Figure 5.3: Processing flow for supporting story construction

estimated time of a temporary story exceeds the specified time.

5.3 Presentation Strategy

The proposed method translates a presentation strategy into the policy of searching in a knowledge fragment network. A presentation strategy has two aspects from the viewpoint of adaptation to the situation of presentations.

Common strategy: A general strategy common to most presentations. This type of strategy includes policies such as “the concepts related to many other concepts are more important” and “important concepts have higher priority”.

Specific strategy: A strategy that varies according to the situations such as the background knowledge of audience and time constraints. This type of strategy includes story patterns and the important concepts to be explained in detail.

Figure 5.4 illustrates the process of translating a presentation strategy into the steps to construct a story. In order to reflect the specific strategy, semantic relationships in a given knowledge

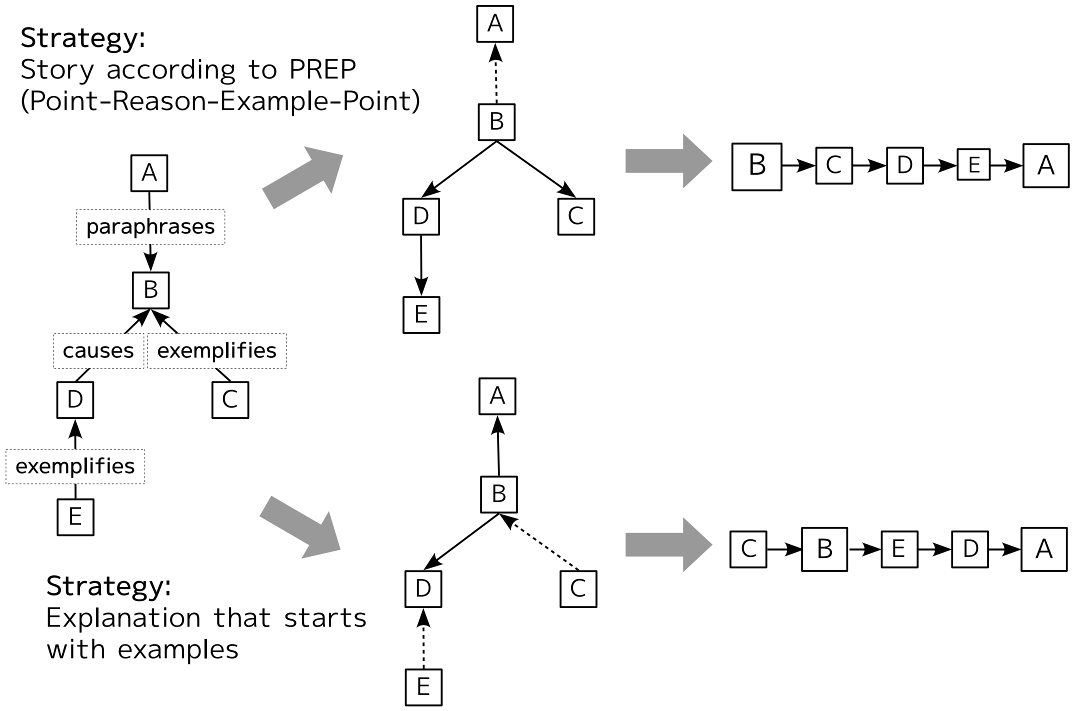


Figure 5.4: Translation of a knowledge fragment network into a presentation story according to a presentation strategy

fragment network are interpreted as sequential relation (an arrow with a dotted line) or hierarchical relation (an arrow with a solid line). Suppose that the fragment f_1 represents the reason of the fragment f_2. If a strategy is "Give higher priority to points than to reasons", the relationship between f_1 and f_2 is interpreted as a hierarchical relationship in which f_1 is subordinate to f_2. Then, the system searches the network from an important fragment according to the order of semantic relationships specified as a story pattern. The order reflects a specific strategy to the situation of a presentation. During this step, the system assigns importance weights to fragments according to the common strategy. The importance weight is used to determine the range of searching.Finally, the system constructs a story by arranging fragments in sequence according to the order of visiting and the categories of relationships.

The following subsections explain how to translate a presentation strategy into a strategy for constructing a presentation story from specific/common aspects.

5.3.1 Specific Strategy

A specific strategy S is defined as follows:

$$\begin{aligned} S &= \{(r, type, direction, priority, decay)\}, \\ type &\in \{sequential, hierarchical, undirected\}, \\ direction &\in \{same, reversed, none\}. \end{aligned}$$

In this definition, r is a semantic relationship defined in Section 4.3.1. *Type* indicates whether r is sequential, hierarchical or undirected. *Direction* specifies whether the direction of sequential/hierarchical relationship from one fragment to another is the same as that of semantic relationship r. Suppose that the knowledge fragment network $G = (F, L)$ defined in Section 4.3.1 is given. For a pair of knowledge fragments f_{src} and f_{dst} in F such that $(f_{\mathrm{src}}, f_{\mathrm{dst}}, r) \in L$ and $(r, type, direction, priority, decay) \in S$, f_{src} appears before f_{dst} in a story if $type = sequential$ and $direction = same$. Also, f_{src} is subordinate to f_{dst} in a story if $type = hierarchical$ and $direction = reversed$. If $type = undirected$, *direction* becomes *none*. *Priority* is a numeric value that indicates how important the semantic relationship r is considered in a given strategy. This value is used in searching a knowledge fragment network G. *Decay* is the decay of importance weights associated with r. This value indicates to what extent the importance of a knowledge fragment specified by a presenter spreads over G.

5.3.2 Common Strategy

In order to reflect a common strategy, the proposed method calculates a potential importance of a knowledge fragment f based on its degree centrality in G. This is because the fragments related to many fragments are considered to be more important. The potential importance of f, which is denoted as $c(f)$, is defined as the number of the fragments that has a semantic relationship with f. Since the common strategy is independent of the specific situation of presentation, the potential importance is calculated regardless the semantic relationships between knowledge fragments.

The potential importance described above determines the degree of spreading the importance weight of the knowledge fragments over G. Specifically, if the fragment f_1 is subordinate to the fragment f_2 and $c(f_1)$ is less than $c(f_2)$, the importance weight of f_1 is decreased by the value

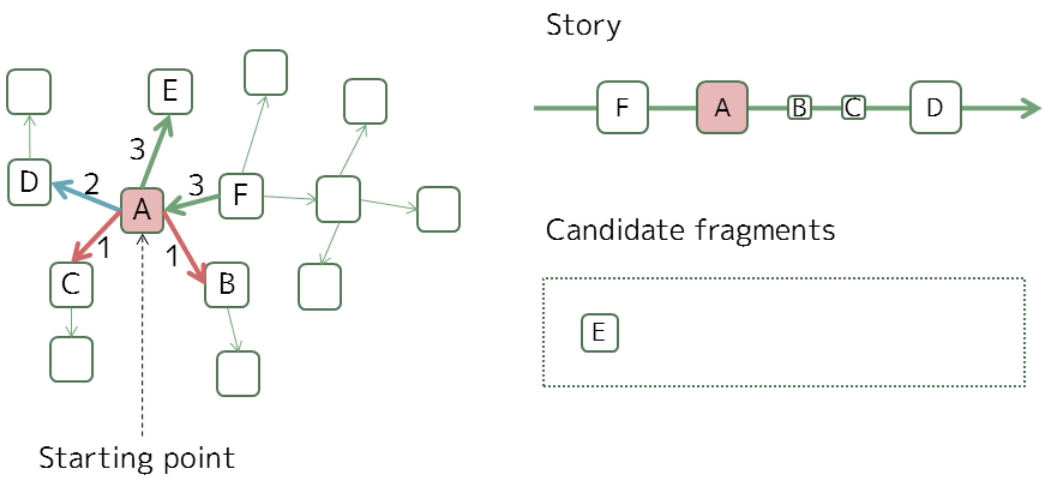


Figure 5.5: Outline of the story construction procedure

decay specified in S. If the importance weight of a fragment is less than a predefined threshold, the searching procedure stops visiting any further fragments in G.

5.4 Constructing Presentation Story

5.4.1 Policies in Story Construction

The procedure of story construction generates a partial story from a presentation strategy and a knowledge fragment specified by a presenter. The procedure searches the network from the fragment under the following policy. First, the procedure visits the fragments neighboring the current one. In this step, the priorities specified in the given strategy determines the order of visiting. Suppose a knowledge fragment network illustrated in Figure 5.5 is given. In this example, a presenter specifies a presentation strategy that gives the highest priority to the semantic relationship indicated by red arrows. The strategy gives the second highest and the lowest priorities to the semantic relationships indicated by blue arrows and green arrows, respectively. When a presenter specifies a knowledge fragment A as a starting point, the search procedure visits the neighboring fragments in the order of B, C, D, E, and F. Second, the procedure propagates importance weights to the neighboring fragments. In this step, the type and the decay degree in the presentation strategy determines the rate of decreasing the importance weight to be assigned to the neighboring fragments. If the propagated weight becomes lower than the predefined threshold, the neighboring fragment is treated as a candidate of a story. Third, the neighboring fragments with higher importance weights are added to a partial story. In this step, the sequence of the fragments in a story reflects the order of visiting them in the search procedure. The sequence also reflects the direction of the semantic relations between knowledge fragments. In the example of Fig. 5.5, B, C, and D are ordered in a story in the order of visiting. On the other hand, F precedes A in a story. This is because the direction of the semantic relationship between A and F indicates that F should appear in a story before A. E is not included in a story because its importance weight propagated from A is lower than the threshold. The procedure constructs a story by repeating these three steps for each of the neighboring fragments.

5.4.2 Procedure

In constructing a presentation story from a knowledge fragment network $G = (F, L)$, a story is represented as a list of a pair (f, w) such that $f \in F$ and w is its importance weight in a presentation story. Additionally, a set of candidate fragments is introduced. Each element in this set is represented as a triple (f, w, a) such that $f \in F$, w is its importance weight, and a is an activation degree. While w indicates the importance of a knowledge fragment, an activation degree a indicates to the range of searching G.

Algorithm 1 describes the procedure for constructing a presentation story. This procedure searches a knowledge fragment network with a policy similar to breadth-first search. The procedure Construct-Story takes six arguments as inputs: a knowledge fragment network $G = (F, L)$, a translation of a specific presentation strategy S, a list of knowledge fragments T that represents a presentation story, a set of candidate fragments C for a story, the index p indicating the position of a knowledge fragment in T, the activation degree a. Construct-Story returns a list of knowledge fragments T' and a set of knowledge fragments C'. This procedure computes T' and C' by visiting the fragments on the knowledge fragment network and then adding them to T and C.

In the phase of story construction, Construct-Story is called when a presenter specifies a knowledge fragment f_0 in G and its position p_0 in T. Before the procedure is called, a pair (f_0, w_0) is inserted into T at position p_0. Here, w_0 is an initial value of an importance weight. Then,

Algorithm 1 CONSTRUCT-STORY(G, S, T, C, p, a)

```
T′ ← T, C′ ← C, Q ← φ
(f, w) ← (T[p].f, T[p].w)
for all (r, type, direction, priority, decay) sorted by priority specified in S do
  for all f′ such that (r, f, f′) ∈ L or (r, f′, f) ∈ L do
    (w′, a′, p′) ← PROPAGATE(G, r, type, direction, decay, f, f′, w, a, p)
    if (f′, w̃, ã) ∈ C′ then
      C′ ← C′ − {(f′, w̃, ã)}
      w ← MAX(w′, w̃), a ← MAX(a′, ã)
    end if
    if f′ already exists in T′ at position p̃ then
      T[p̃] ← (f′, MAX(T[p̃].w, w′))
    else
      if w′ > Th_w and a′ > Th_a then
        INSERT((f′, w′), T′, p′)
        ENQUEUE(Q, (f′, w′, a′))
      else
        C′ ← C′ ∪ {(f′, w′, a′)}
      end if
    end if
  end for
end for
while Q is not empty do
  (f′, w′, a′) ← DEQUEUE(Q)
  (T′, C′) ←CONSTRUCT-STORY(G, S, T′, C′, p′, a′)
end while
return (T′, C′)
```

CONSTRUCT-STORY is called with arguments G, S, $T = [(f_0, w_0)]$, $C = \phi$, $p = 0$ and $a = a_0$, an initial value of an activation degree.

The procedure CONSTRUCT-STORY is divided into three main steps. First, the neighboring fragments in G are enumerated according to the priorities of semantic relationships specified in the strategy S. In this step, if a neighboring fragment exists in a candidate set C, its importance weight and activation degree are updated. Second, the importance weight and the activation degree are propagated to neighboring fragment in the procedure PROPAGETE according to the semantic relationship and its direction. Third, the neighboring fragment is added to a story T' if both its importance weight and its activation degree are higher than threshold. Then, a triple of the fragment, its importance weight and its activation degree is enqueued in a queue Q. Otherwise,

Algorithm 2 PROPAGATE$(G, r, type, direction, decay, f, f', w, a, p)$

```
if type = hierarchical then
  if (direction = same and (r, f, f') ∈ L) or (direction = reversed and (r, f', f) ∈ L) then
    {f' is subordinate to f}
    if c(f) > c(f') then
      w' ← w − decay, a' ← a − decay, p' ← p + 1
    else
      w' ← w, a' ← a − α · decay, p' ← p + 1
    end if
  else if (direction = same and (r, f', f) ∈ L) or (direction = reversed and (r, f, f') ∈ L)
  then
    {f is subordinate to f'}
    w' ← w, a' ← a − α · decay, p' ← p − 1
  end if
else if type = sequential then
  if (direction = same and (r, f, f') ∈ L) or (direction = reversed and (r, f', f) ∈ L) then
    {f precedes f'}
    w' ← w, a' ← a − α · decay, p' ← p + 1
  else if (direction = same and (r, f', f) ∈ L) or (direction = reversed and (r, f, f') ∈ L)
  then
    {f' precedes f}
    w' ← w, a' ← a − α · decay, p' ← p − 1
  end if
else if type = undirected then
  if ((r, f, f') ∈ L) or ((r, f', f) ∈ L) then
    {f precedes f'}
    w' ← w, a' ← a − α · decay, p' ← p + 1
  end if
end if
return (w', a', p')
```

the neighboring fragment is saved in a candidate set C' for future search. After these steps are finished, the procedure CONSTRUCT-STORY is called recursively for each fragment in Q.

The procedure of PROPAGATE is described in Algorithm 2. This procedure takes a knowledge fragment f, its importance weight w, activation degree a, position p in a story, neighboring fragment f' and the semantic relationship between f and f' as inputs. The procedure also takes the type, the direction, the decay degree of r indicated in a presentation strategy as inputs. From these inputs, the importance weight, the activation degree and the position in a story of a neighboring fragment f' are calculated. How to calculate these values is determined by whether the semantic relationship r is hierarchical, sequential or undirected.

Case when r is a hierarchical relationship In this case, one of the fragments f and f' is subordinate to the other. Since a hierarchical relationship indicates the difference of importance, the importance weight of a subordinate fragment is decreased by *decay* indicated in a strategy. On the other hand, the subordinate fragments might be potentially important according to the common strategy as described in Section 6.3.2. Therefore, the decay degree is reduced if the potential importance of the subordinate fragment is higher than that of its dominant fragment. To do this, the procedure compares their potential importances by comparing the degree centralities $c(f)$ and $c(f')$. At the same time, the subordinate fragment follows the dominant fragment in a story. If f is subordinate to its neighboring fragment f', the importance weight is propagated from f to f' without any decay. This is because f' is as important as f in a story.

Case when r is a sequential relationship In this case, a neighboring fragment f' is considered as important as f. Therefore, the importance weight is propagated without any decay. On the other hand, the activation degree is propagated with the decay reduced by a discounting factor α. The parameter α $(0 < \alpha < 1)$ determines the rate of decreasing the propagated values. The procedure decreases the activation degree in order to avoid searching the knowledge fragment network infinitely. The activation degree determines the range of search on the network. The order of f and f' in a story is determined according to the *direction* of a sequential relationship. Namely, the preceding fragment indicated by r and *direction* precedes the following fragment in a story.

Case when r is a parallel relationship In this case, the importance weight and the activation degree is propagated in the same way when r is a sequential relationship. In this case, the order of the fragments appearing in a story is not deterministic. Therefore, a neighboring fragment f' follows f in a story.

5.5 Estimating Time for Explanation

The story composed by the procedures described in the previous section does not always satisfy the time constraint. Namely, the time it takes to explain the contents in the story may exceed the time specified by a presenter. In such a case, it is necessary to remove the extra knowledge fragments from the temporary story. To achieve this, the proposed method estimates the time for explanation based on the content of the knowledge fragments. Here, the method assumes that the contents of the knowledge fragments are texts written in Japanese. Although the estimation method should also be applied to other languages including English, such estimation is left as future work.

5.5.1 Preliminary Investigation

A preliminary investigation was conducted in order to estimate the time for explaining based on the contents of the knowledge fragments. Several presentations available online were investigated, and the author prepared a knowledge fragment network manually for each presentation. The presentations were selected from the archive of research conferences hosted by the Database Society of Japan[1], and the stream video shared on USTREAM from the Workshop hosted by Japan Society for Software Science and Technology[2]. The knowledge fragments were prepared so that they would include only the contents that were relevant to the researches by presenters.

As a result of the investigation, the proposed method estimates the time for explaining the content of a knowledge fragment f with the following formula:

$$t(f) = \frac{length(f)}{210/60}.$$

In this formula, $t(f)$ is the time in seconds for explaining the content of f and $length(f)$ is the length of the character string (written in hiragana letters and Chinese characters) representing the content of f. This formula calculates the time based on the assumption that a presenter utters at the speed of 210 characters in a minute. The assumed speed is about the 60 percent of the speed at which most broadcasters utter (300 to 350 characters in a minute) [38]. This is because

[1]http://www.dbsj.org/Japanese/Archives/streaming.html
[2]http://www.ustream.tv/channel/wiss2011

presenters tell their audience what they say next in order to fill in the gap between slides. Also, presenters sometimes stop speaking abruptly for some reasons such as forgetting what to speak next and troubles in presentation tools in actual presentations.

5.5.2 Story Construction Considering Time Constraint

The proposed method selects the knowledge fragments for a story so that presenters will explain the contents within the specified time. To achieve this, the system calculates the number of characters N for explaining the contents within a time in seconds t using the following formula:

$$N = (t + 15) \times \frac{210}{60}.$$

In this formula, N is calculated considering the extension of the presentation time up to 15 seconds. The reason for adding extra time as 15 seconds is that the proposed method permits extension of the presentation time caused by unexpected troubles. While how to determine the extension time requires discussion, 15 seconds is considered as permissible extension time in many presentations.

Using the value N defined above, the method selects the knowledge fragments in a story according to the following procedure. In this procedure, T and $N(T)$ denotes the temporary story and the total number of characters in the knowledge fragments in T, respectively. This procedure removes extra knowledge fragments from the temporary story constructed by the procedure described in the previous section. The knowledge fragments to be removed are those that have lower importance weights assigned in searching a knowledge fragment network.

Step 1 If $N(T) \leqq N$, stop this procedure and output T as a final result.

Step 2 If $N(T) > N$, select a knowledge fragment f' whose importance weight is the lowest in T.

Step 3 Remove f' from T and go back to Step 1.

5.6 Prototype System

5.6.1 Overview

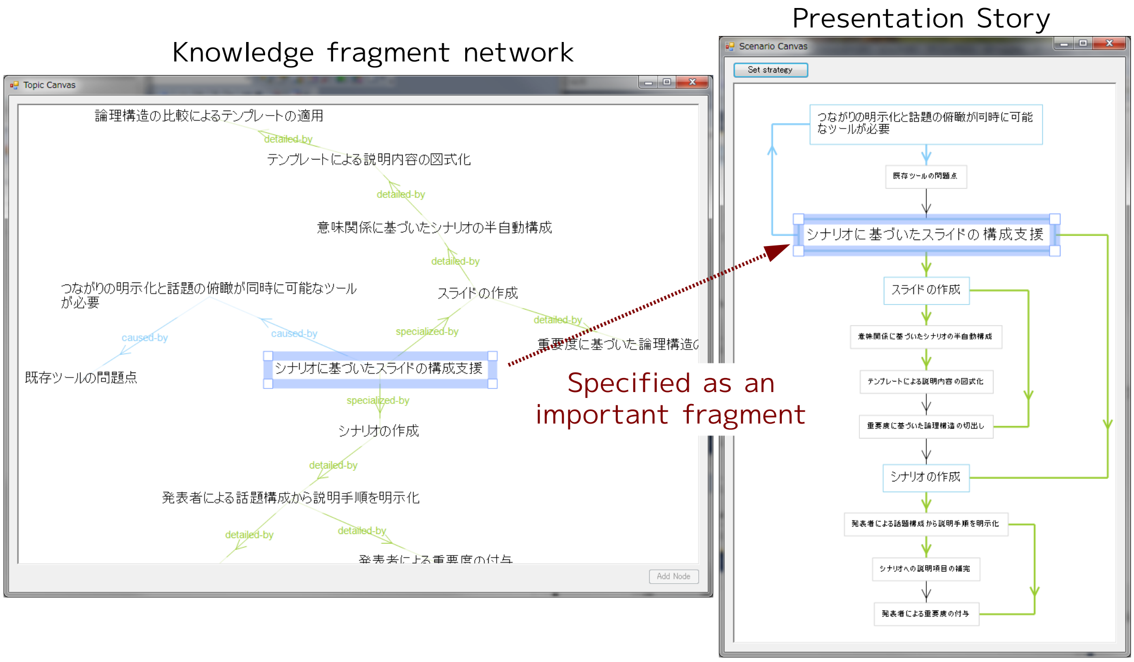
This section presents a prototype system for composing presentation stories. Figure 5.6 shows the screenshots of the system. A presenter prepares a knowledge fragment network in the left window and compose a story in the right window in Fig. 5.6(a). The system arranges the fragments in a story from the top of the right window. The importance of each fragment is reflected in its size on the window. Fig. 5.6(b) shows the components for controlling story composition on the top of the story composition window. A presenter specifies her presentation strategy and time for presentation through these components. When a presenter picks an important fragment from a knowledge fragment network and moves it to a story composition window, the system selects the fragments relevant to the picked fragment and orders them according to the specified strategy. If the estimated time for a story exceeds the specified time, the system alerts a presenter to determine whether the system will remove extra knowledge fragments from a story. Then, the system updates a story and displays it in the story composition window. The estimated time for a story is displayed on top of the window as shown in Fig. 5.6(b). A presenter completes her story by repeating these manipulations.

Figure 5.7 shows a window for determining a presentation strategy. The semantic relationships available in the prototype system are listed in this window. The meanings of the semantic relationships are displayed on the left of the list. A presenter can determine her strategy by specifying the type, direction, priority and decay for each relationship. Since it is a burden for a presenter to specify all of these attributes for each relationship, she can select a predefined strategy from the drop-down list on the top of the window. Therefore, a presenter can use the predefined strategies in the prototype system and create her own strategy by modifying them.

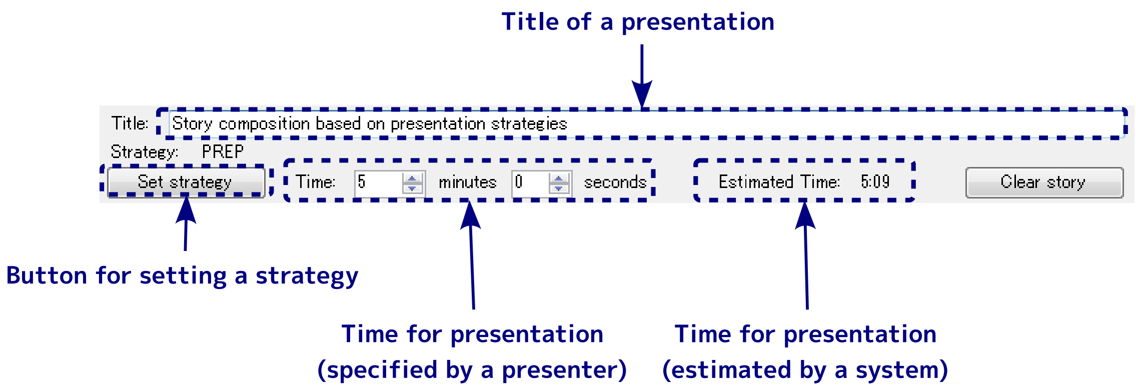
5.6.2 Examples of Story Composition

This section presents an example of a story generated by the prototype system. The author prepared the knowledge fragment network illustrated in Figure 5.8 as input. The network consists of six knowledge fragments.

The author examined whether the stories are constructed differently according to the presen-



(a) Interface for story composition



(b) Components for controlling story composition

Figure 5.6: Screenshots of the prototype system for story composition

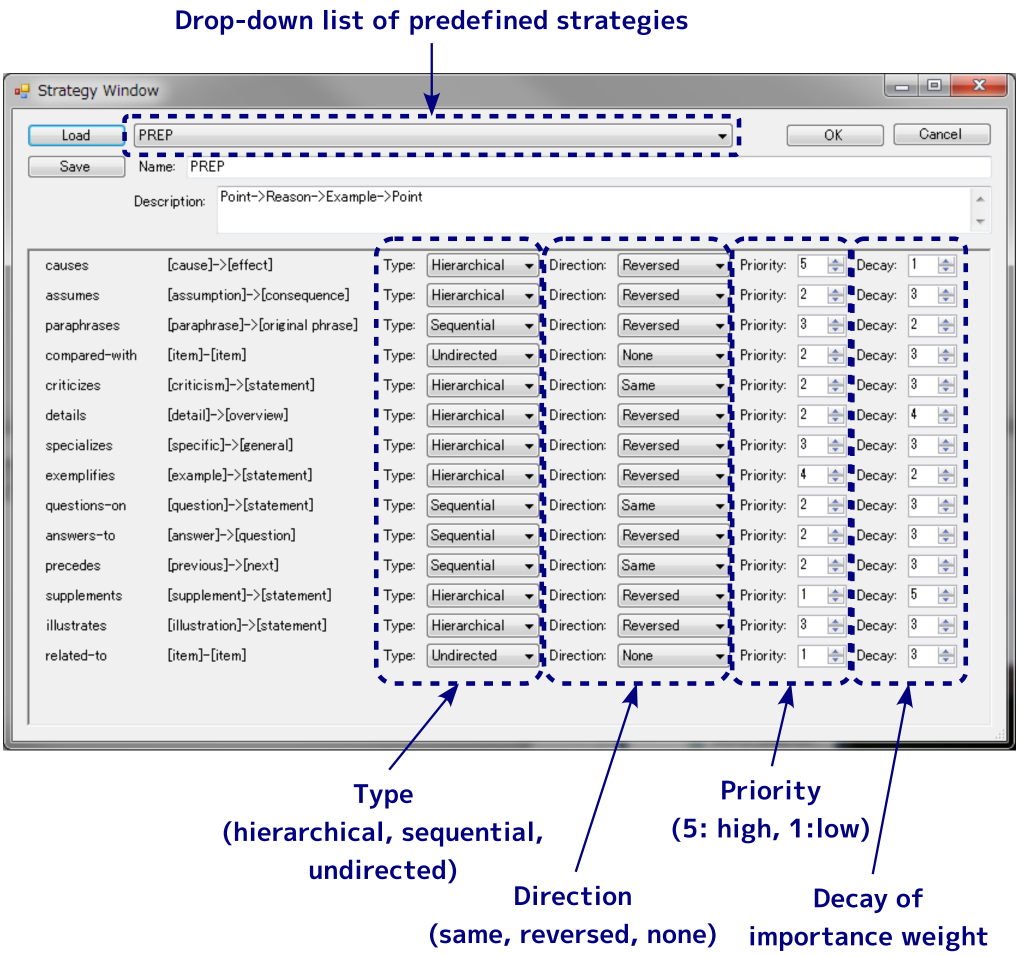


Figure 5.7: Screenshot of a window for specifying a presentation strategy

Table 5.1: Examples of presentation strategies

Name	S_1 (PREP)				S_2 (Preferring examples)			
	Type	Direction	Priority	Decay	Type	Direction	Priority	Decay
caused-by	H	reversed	1	1	H	reversed	2	2
assumed-by	H	reversed	4	3	H	reversed	4	3
paraphrased-by	S	reversed	3	2	S	reversed	3	3
criticized-by	H	same	4	3	H	same	4	3
compared-with	U	none	4	3	U	none	3	3
exemplified-by	H	reversed	2	2	S	same	1	1
detailed-by	H	reversed	4	4	H	reversed	3	5
specialized-by	H	reversed	2	4	S	same	1	2
questions-on	S	same	2	3	S	same	2	3
answers-to	S	reversed	2	3	S	reversed	2	3
supplemented-by	H	reversed	5	5	H	reversed	5	5
illustrated-by	H	reversed	4	3	S	same	1	1
followed-by	S	same	4	3	S	same	4	3
related-to	U	none	4	3	U	none	4	4

tation strategies shown in Table 5.1. In this table, H, S, and U in the column "Direction" means that the relationship is interpreted as hierarchical, sequential and undirected, respectively. S_1 represents a strategy called PREP (Point-Reason-Example-Point). In this strategy, the relationship "caused-by" has the highest priority because the causal relationship is the most important. S_2 represents a strategy that prefers examples. In this strategy, the relationship "exemplified-by" has the highest priority so that examples will take precedence. The author compared the stories constructed by these strategies and the one without a strategy. The story without a strategy is constructed by regarding all the semantic relationships as undirected and searching the network with uniform priority. Namely, a knowledge fragment network is interpreted as an undirected graph, and thereby searched by breadth-first approach.

Figures 5.9 through 5.11 show the results of the story construction. The horizontal position of a knowledge fragment indicates the order of appearing in a story. Namely, the knowledge fragment on top of the figure are the first knowledge fragment appearing in each of the stories. For each of the strategy, the author selected the knowledge fragment "Currently, ecologically-friendly products sell well on the background of public opinions." as an important fragment, and assigned the importance weight 1 (the highest value) to it. The size of a knowledge fragment in a

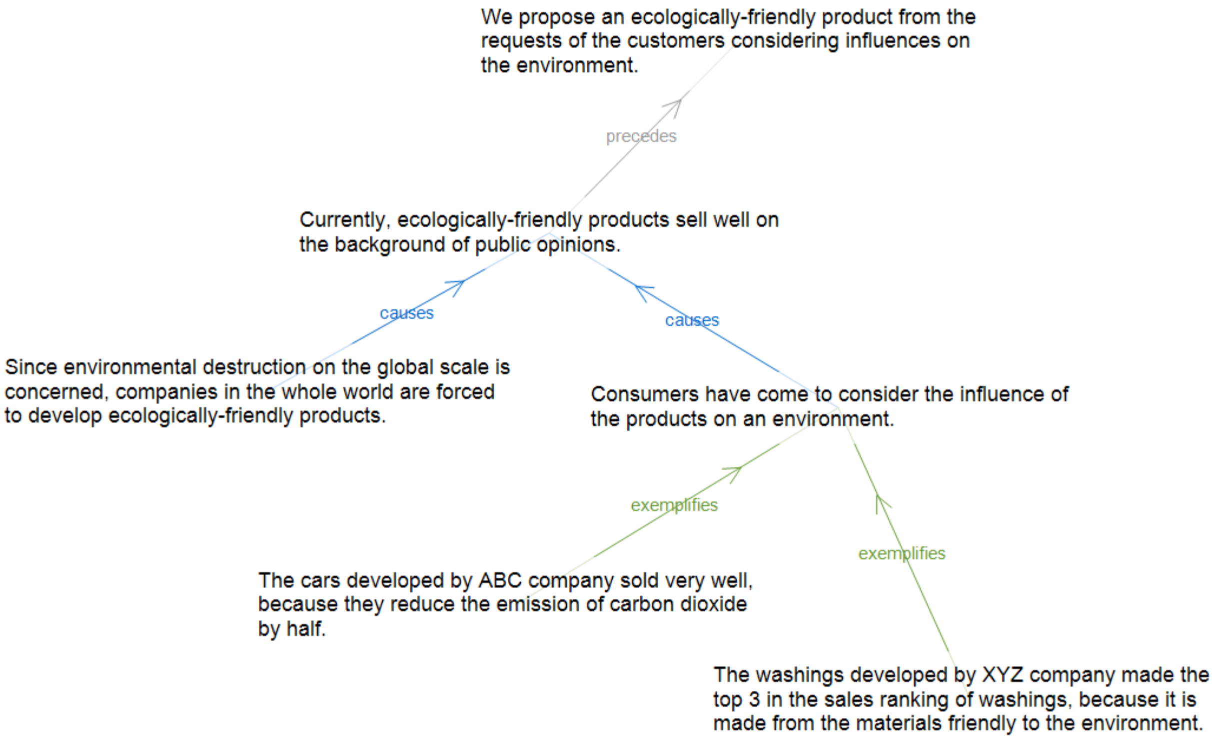


Figure 5.8: Example of a knowledge fragment network

story reflects its importance weight in the story scaled to the range [0, 1]. The decaying rates of importance weights indicated in the column "Decay" in Table 5.1 are scaled to the range [0, 1]. The story shown in Fig. 5.10 is the one constructed by the strategy S_1 (PREP). Comparing the sequence of the knowledge fragments and the network structure shown in Fig. 5.8, the knowledge fragments in the story appears in the order of a point, first reason, first example, second example, second reason and another point. This result shows that the story was constructed according to the PREP strategy defined in Table 5.1. Also, the story shown in Fig. 5.11 reflects the strategy S_2 (preferring examples) because the knowledge fragments representing examples appear before the fragment specified by the author. These results show that the system can construct different stories that reflect the presentation strategies specified by a presenter.

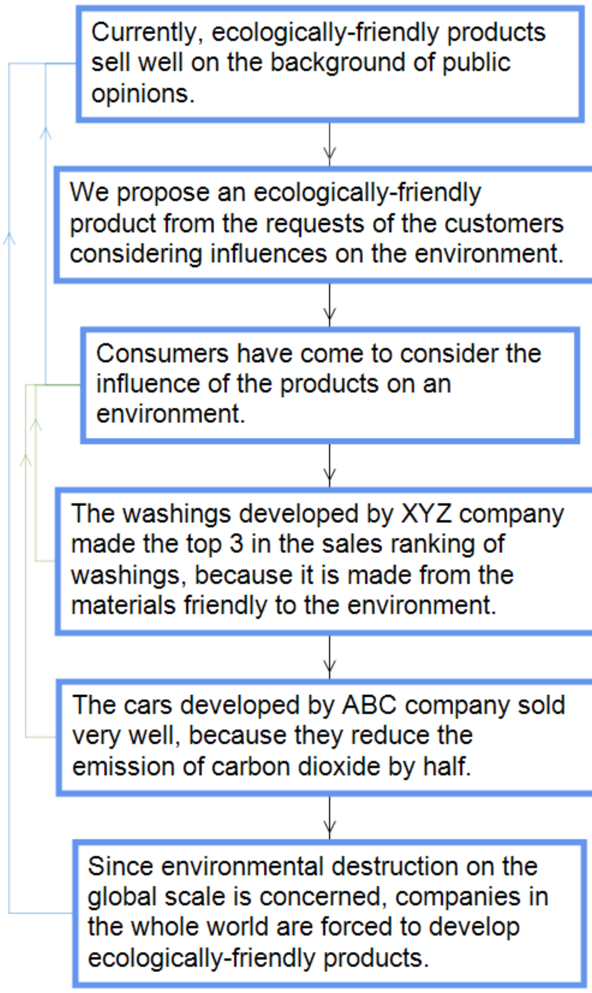


Figure 5.9: Story generated without strategy

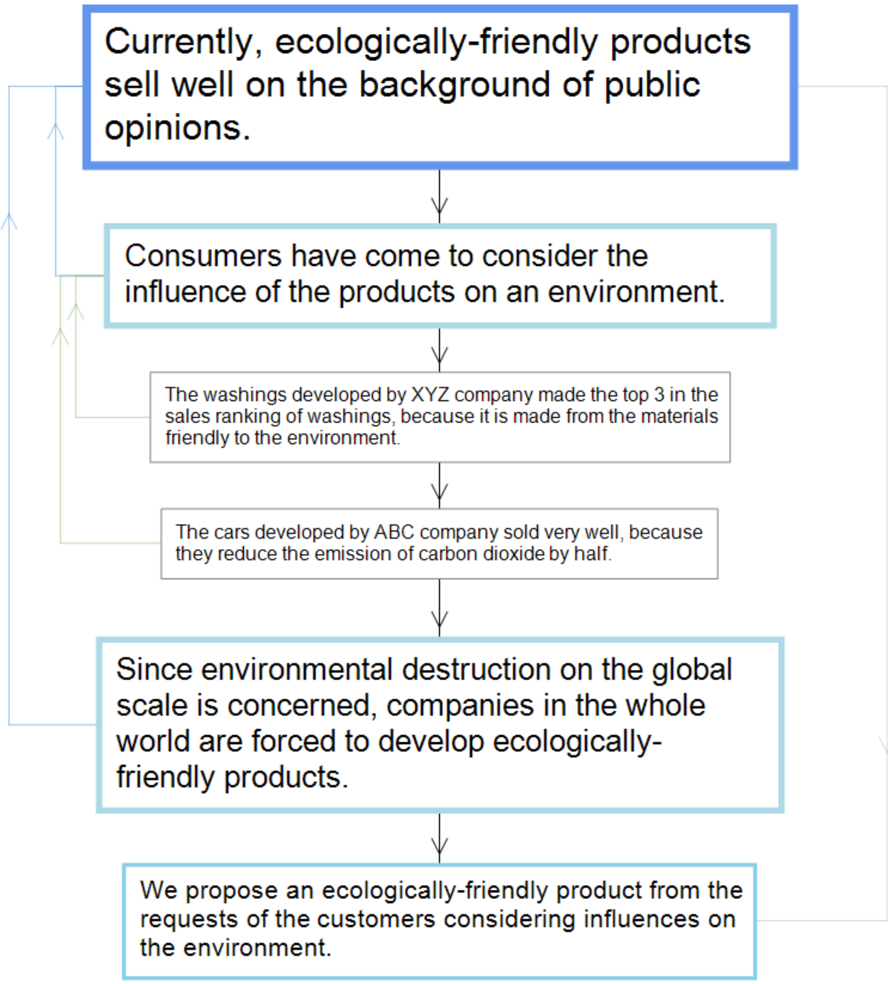


Figure 5.10: Story generated with a PREP strategy

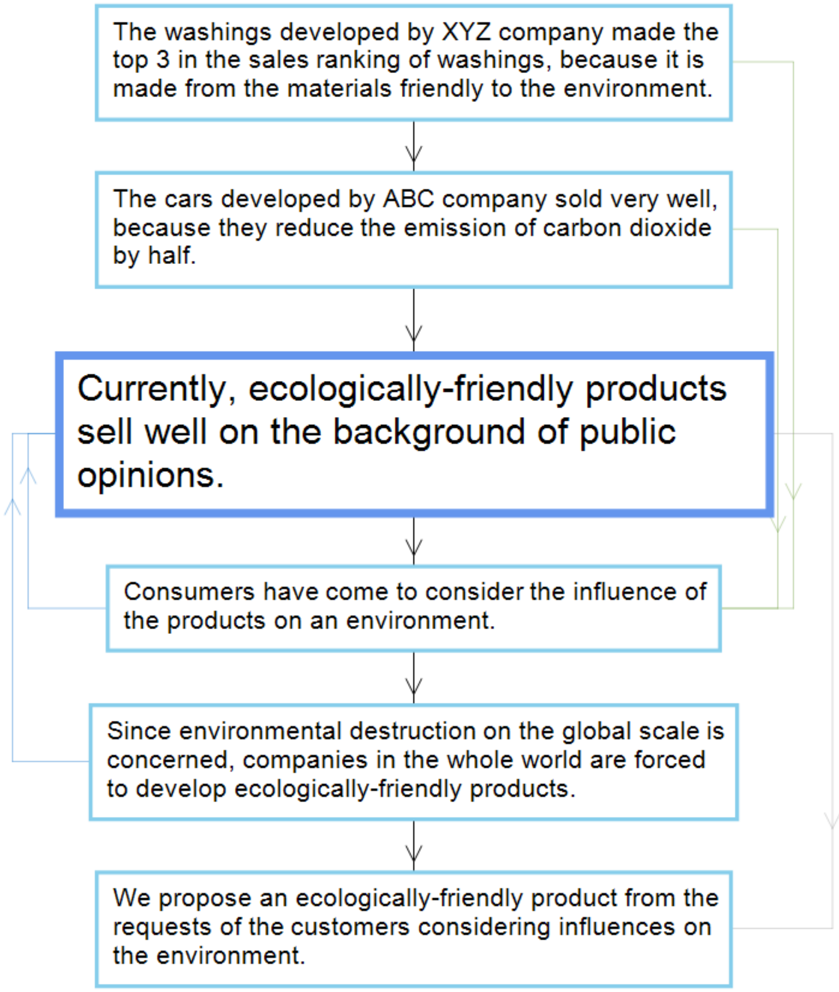


Figure 5.11: Story generated with a strategy preferring examples

5.7 Summary

This chapter presented a method for supporting composition of presentation stories according to presentation strategies. In the proposed method, a presentation strategy is handled as a policy of searching a knowledge fragment network. This chapter also presented the prototype system for story composition and an example of stories generated from a knowledge fragment network. The example of generated stories shows that the proposed method generates partial stories differently according to strategies. The mechanism implemented in the prototype systems allows a presenter to compose a scenario from a small number of knowledge fragments explicitly specified by her.

Currently, the prototype system requires many inputs by a presenter in order to determine a presentation strategy. Therefore, a mechanism for specifying it with less input must be considered. Also, it is necessary to confirm that the prototype system enables a presenter to compose a scenario according to her presentation situation.

Chapter 6

SLIDE COMPOSITION BASED ON LAYOUT TEMPLATES

6.1 Introduction

This chapter presents a method of generating presentation slides automatically from the discourse structure discussed in Chapter 4. The discourse structure represents semantic relationships among slide components such as texts and images. Although most of the slides generated by conventional methods follow the standard format of bullet lists, the method proposed in this chapter attempts to generate slides with diagrammatic representation. The main idea is to find the layout templates that are appropriate to express the discourse structure specified by presenters. To achieve this, the proposed method introduces the logical structure of slides. The logical structure represents sequential and inclusive relations among the slide components. The method handles the logical structure as the precondition for applying a template to a discourse structure. By comparing the preconditions and the logical structure constructed from the discourse structure, appropriate templates can be applied. The result of the case study showed that the prototype system can generate the slides with diagrammatic representation from a given discourse structure.

This chapter is organized as follows. Section 6.2 presents the approach of diagrammatic representation based on layout templates. Then, Section 6.3 describes the process of generating presentation slides. Section 6.4 presents the prototype system and the examples of generated slides, and then discusses the feasibility of the proposed method. Finally, Section 6.5 summarizes this chapter.

6.2 Approach

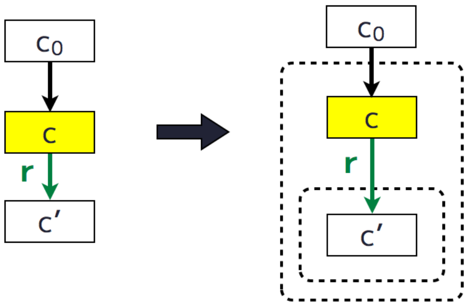
The proposed method introduces a mechanism of translating a discourse structure into the layout of slide components. A discourse structure defined in Section 4.3.2 is an inherent structure of passages and dialogues composed of multiple sentences. Shibata et al. proposed a method of generating slides based on a discourse structure [56]. In their method, a discourse structure is represented as units and the coherence relationships among them. A unit represents a clause and a sentence. In the method proposed in this chapter, each unit represents a slide component such as a text and an image. The links between units represent a semantic relationship defined in Section 4.3.1.

The basic mechanism in the proposed method is the mapping from a logical structure to a geometric structure based on the semantic relationships. The processing flow consists of two steps: editing and allocation. The logical structure and properties of slide components are acquired at the editing step, and the geometric structure is derived in the allocation step. In the editing step, a presenter prepares slide components and specifies semantic relationships between the components manually. As a result, a discourse structure is constructed as a network structure of slide components. Then, the system derives the logical structure by grouping slide components according to the semantic relationships. This becomes the input for allocation step. In the allocation step, the system selects appropriate templates by comparing the logical structure with that of the templates. Then, the system allocates the components according to the geometric structure defined in the selected template. If some components have not been allocated yet, the system applies other templates to the remaining part of the logical structure. The system repeats this step until all the components are allocated on presentation slides.

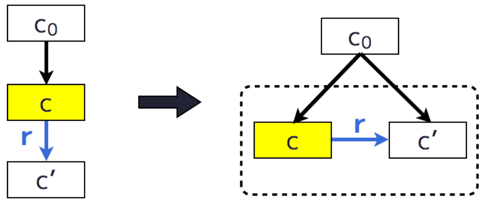
6.3 Procedure for Slide Generation

6.3.1 Constructing Logical Structure

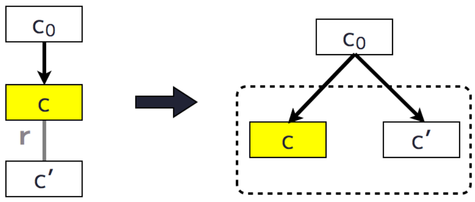
The discourse structure discussed in Chapter 4 is taken as an input for generating presentation slides. In the proposed method, slides are generated for each topic frame in a given discourse structure. A slide is generated by finding and applying appropriate templates for diagrammatic



(a) Case when r is hierarchical



(b) Case when r is sequential



(c) Case when r is parallel

Figure 6.1: Grouping slide components based on the category of a semantic relationship r

representation. In order to apply templates to the discourse structure, the logical structure of a presentation slide is constructed by grouping the components according to the semantic relationships among them. Given discourse structure $DS = (\text{Skeleton}, \text{Topics}, \text{Components})$, the logical structure LS_t is defined for each topic frame $t = (id, name, C_t, L_t)$ in Topics as follows:

$$\begin{aligned} LS_t &= \{(c, S_c) | c \in C_t\} \\ S_c &= \{(r, c', S_{c'}) | (c, c', r) \in L_t \wedge (c', S_{c'}) \in LS\} \end{aligned}$$

Here, S_c is a set of triples $(r, c', S_{c'})$. r is a type of semantic relationship and $S_{c'}$ is a set of components that are related to c by the relationship r. $S_{c'}$ is a subgroup of S_c. Computing S_c means grouping components related to c according to the types of relationship. The proposed method categorizes semantic relationships into three types and groups components according to the following policy.

Hierarchical relationship (Figure 6.1(a)) If $(c, c', r) \in L_t$ and r is a hierarchical relationship, c' is subordinate to c. Namely, c' is included in a subgroup of c.

Algorithm 3 MAKE-GROUP(c)

Require: c is a slide component in a topic frame $t = (id, name, C_t, L_t)$
Ensure: S_c is a set of components related to c, in which the components are categorized by relationships

```
LS ← φ
S_c ← φ
for all relation type r do
  for all c' such that (c, c', r) ∈ L_t do
    S_c' ← MAKE-GROUP(c')
    if r is hierarchical relationship then
      S_c ← S_c ∪ {(r, c', S_c')}
    else if r is directed relationship then
      S_c ← S_c ∪ {(r, c', S_c')}
      LS ← LS ∪ {(c', S_c')}
      (c_0, c, r_0) ← GET-PARENT(c)
      if c_0 ≠ nil then
        S_c0 ← S_c0 ∪ {(r_0, c', S_c')}
      end if
    else
      LS ← LS ∪ {(c', S_c')}
      (c_0, c, r_0) ← GET-PARENT(c)
      if c_0 ≠ nil then
        S_c0 ← S_c0 ∪ {(r_0, c', S_c')}
      end if
    end if
  end for
end for
LS ← LS ∪ {(c, S_c)}
return LS
```

Directed relationship (Figure 6.1(b)) If $(c, c', r) \in L_t$ and r is a directed relationship, c' is the sibling of c. Namely, a directed relation exists from c to c' and these sets are included in the same subgroup of c_0 such that c is subordinate to c_0. Here, c_0 satisfies $(c_0, c, r_0) \in L_t$ and r_0 is a hierarchical relationship.

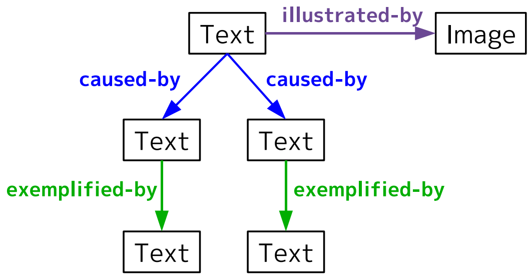
Parallel relationship (Figure 6.1(c)) If $(c, c', r) \in L_t$ but r is neither directed nor hierarchical, c' is considered to be independent of c. Namely, c and c' are disjoint with each other and included in the same subgroup of c_0. Here, c_0 satisfies $(c_0, c, r_0) \in L_t$ and r_0 is a hierarchical relationship.

Table 6.1: Types of relationships between slide components

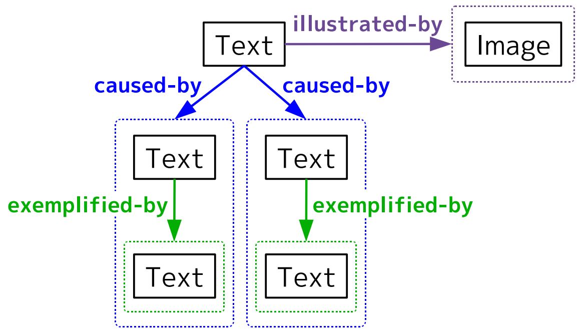
Type	Directed	Hierarchical
caused-by	yes	yes
assumed-by	yes	yes
paraphrased-by	yes	yes
opposed-to	yes	no
compared-with	no	no
exemplified-by	yes	yes
detailed-by	yes	yes
specialized-by	yes	yes
supplemented-by	yes	yes
questioned-by	yes	no
answers-to	yes	no
illustrated-by	yes	yes
followed-by	yes	no
related-to	no	no

Algorithm 3 describes the procedure MAKE-GROUP. This procedure derives the logical structure LS from a given topic frame. Since each topic frame has at least one component whose *role* is *point*, Make-Group constructs a logical structure recursively from such component. When two components c and c' are related by sequential or parallel relationship, these components are considered as siblings. In this case, Make-Group attempts to find a common parent of c and c'. The procedure GET-PARENT called with a slide component c retrieves the triple (c_0, c, r_0). Here, c_0 is a component that has a hierarchical relationship with c and the r_0 represents the relationship. Therefore, c_0 becomes the parent of c' if c and c' are siblings and that c_0 is the parent of c. The logical structure constructed by this procedure represents inclusive relationships and sequential relationships among groups of slide components.

Slide components are grouped according to their semantic relationships defined in Table 6.1. Although the types of semantic relationships are the same as those discussed in Chapter 4, this table has additional information on whether each of the semantic relationships is directed and hierarchical. Since this table has the same attributes in a presentation strategy discussed in Chapter 5, the proposed method in this chapter can be extended so that a presentation strategy will be reflected in generating slides.



(a) Input discourse structure



(b) Constructed logical structure

Figure 6.2: An example of constructing logical structure

Figure 6.2 illustrates an example of constructing a logical structure from a discourse structure. The logical structure is constructed by calling procedure MAKE-GROUP(c) such that $c \in C_t$ and attribute *type* of c is *title*.

6.3.2 Applying Templates to Logical Structure

A layout template is a characteristic pattern of allocating slide components that is practically used for visualizing a discourse structure. In the proposed method, a layout template is defined as a pair of a logical structure and a geometric structure. A logical structure corresponds to the preconditions for applying a template. A geometric structure contains relative positions among slide components and additional shape objects such as lines and arrows. Given a topic frame in a discourse structure, a layout template is selected by comparing its precondition with the logical structure constructed from the topic frame. Algorithm 4 describes the procedure of allocating slide components in the logical structure LS_t. Allocating slide components starts by calling ALLOCATE-COMPONENTS(c_0, S_{c_0}, R_0, ϕ) for each slide component c_0 in C_t such that $(r, c_0, S_{c_0}) \notin S_c$ for all c in C_t. This means that c_0 has no parent node in LS_t. R_0 is the size of a blank slide. First,

Algorithm 4 ALLOCATE-COMPONENTS(c, S_c, R)

Require: $(c, S_c) \subseteq LS_t$, and R is a rectangular region on a slide
Ensure: Some components are allocated on a sub-region of R

```
P_G ← FIND-TEMPLATES(c, S_c)
for all p such that t ∈ P_G do
  if c.size ⊆ GET-AVAILABLE-REGION(c, p, R) then
    R_remain ← ALLOCATE(c, p, R)
    for all g = (r, c', S_c') such that g ∈ S_c do
      R_g ← GET-GROUP-REGION(g, p, R_remain)
      if S_c' ≠ φ then
        ALLOCATE-COMPONENTS(c', S_c', R_g)
      end if
    end for
  else
    Mark c as un-allocated
  end if
end for
```

the layout templates are acquired by calling procedure FIND-TEMPLATES. This procedure selects the templates by comparing the preconditions represented as a logical structure with the logical structure in LS_t. If a template t can be applied to a given logical structure, the mapping from a subgroup in the logical structure to a subgroup in p is computed. Next, a component c is allocated according to the template p and the given region R. If c can be allocated, the remaining region R_{remain} is computed by removing the region occupied by c from R. Otherwise, c cannot be allocated on a slide because of overflow. In this case, c is marked as “un-allocated.” Then, procedure ALLOCATE-COMPONENTS is called recursively with the subgroup of components $S_{c'}$ and the subregion R_g allocated according to the template p. These steps are repeated until all the components are allocated on slides or the procedure detects a component that cannot be allocated. After a slide is generated by allocating all the components that can be allocated, it is possible to call procedure ALLOCATE-COMPONENTS for the components marked as “un-allocated.” This means that more than one slides can be generated from one logical structure. Although the relations between multiple slides are important for composing a deck of slides, the mechanism of sequencing multiple slides is not considered here.

Figure 6.3 illustrates an example of allocating components in the discourse structure of Figure 6.2(a). In generating slides, layout templates are applied to logical structure of Fig. 6.2(b). In

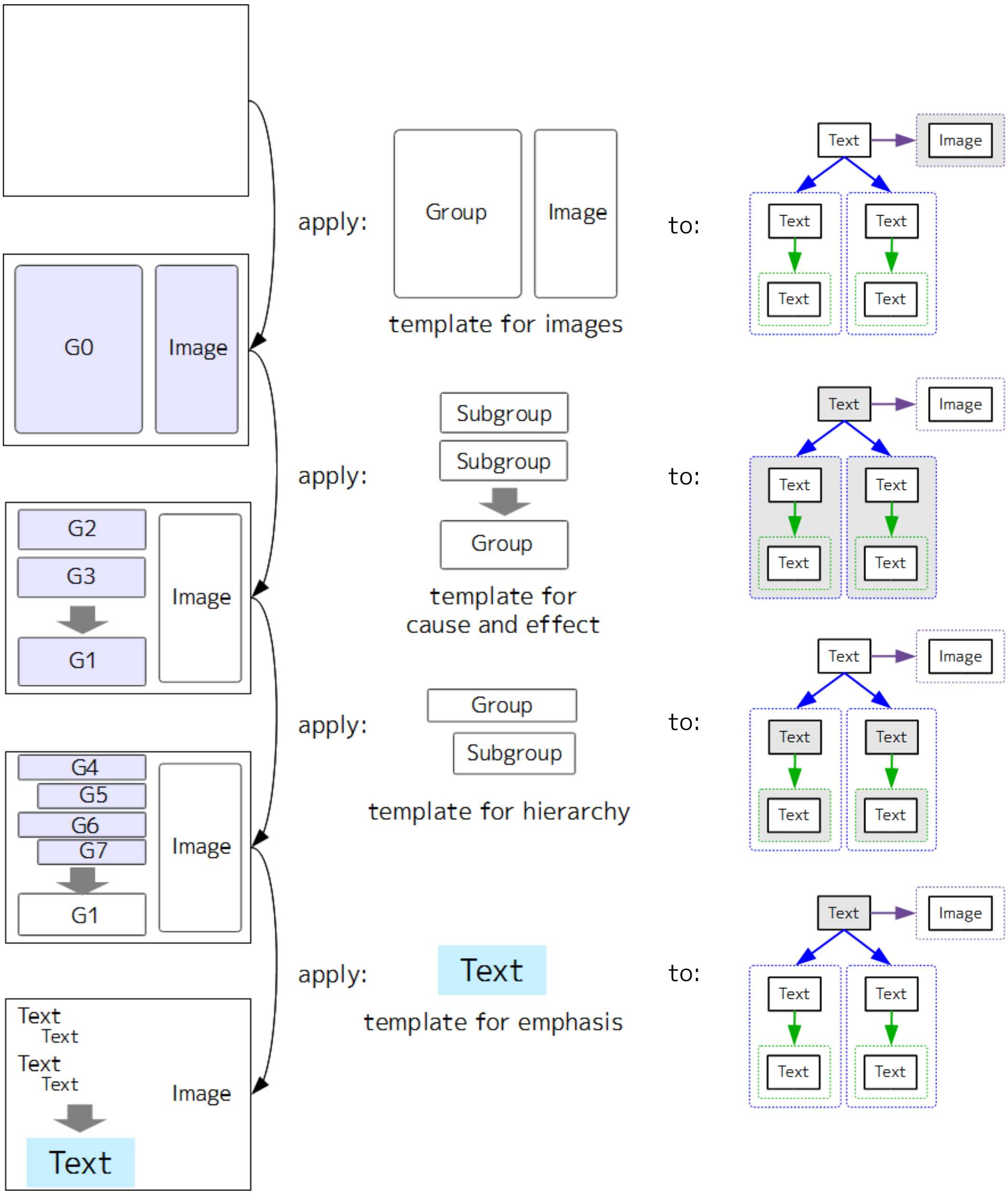
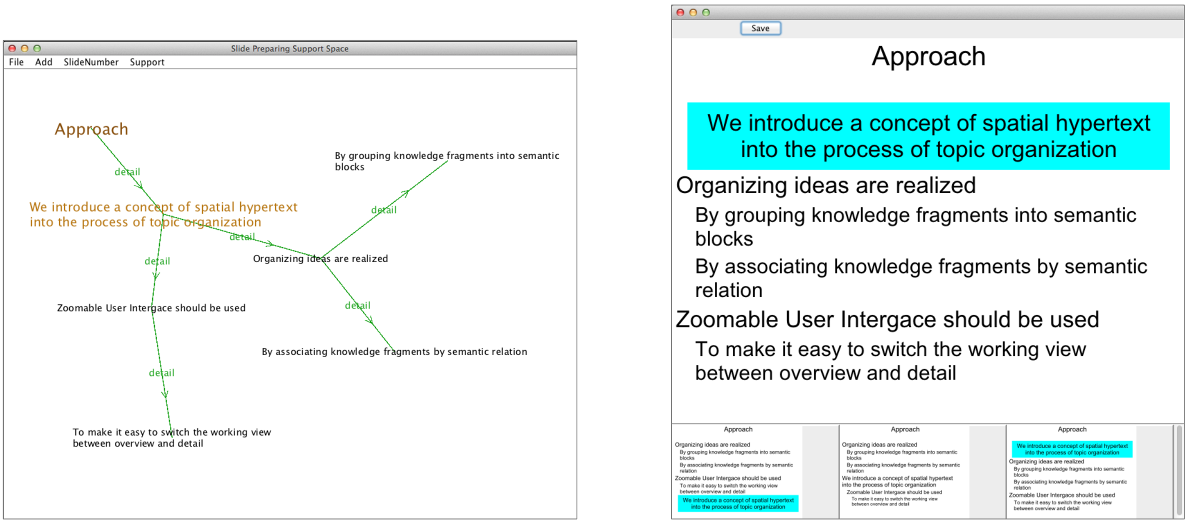


Figure 6.3: An example of applying templates



(a) Window for composing a topic frame (b) Window for browsing generated slides

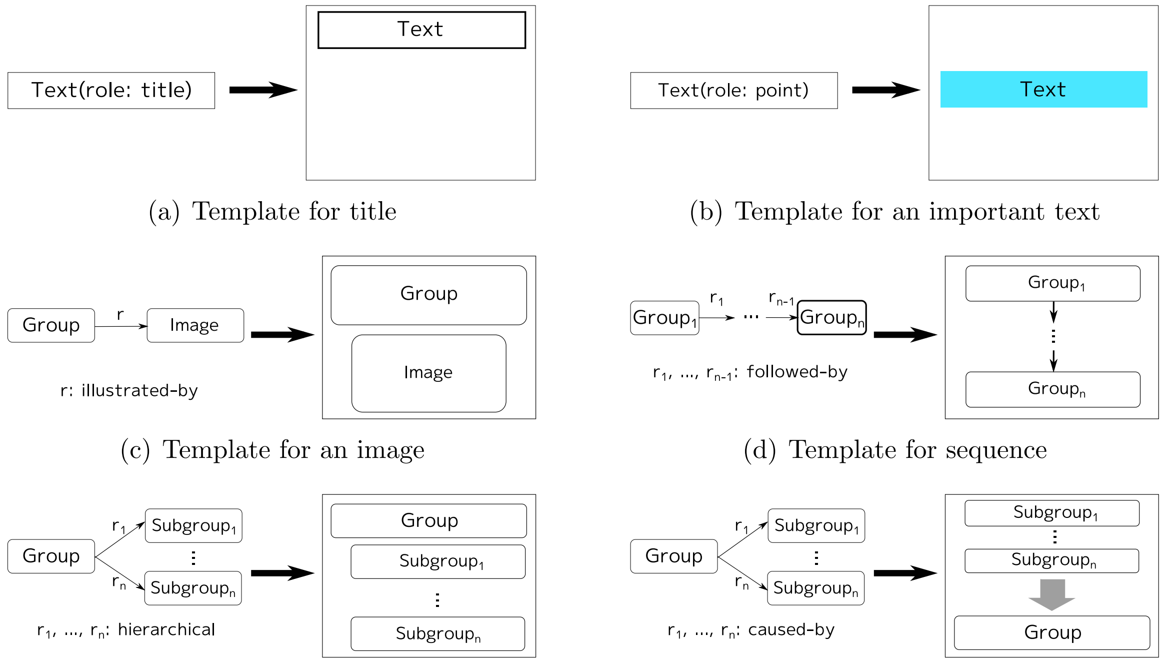
Figure 6.4: Screenshots of the prototype system for generating slides

this example, an image is included in the logical structure. First, the template for slides with images are selected. The region on a slide is divided vertically into two subregions and the image is allocated on the subregion on the right of a slide. Second, the remaining five texts are allocated on the subregion (G0) on the left of a slide. Here, the template for illustrating cause and effect relationship is selected because the two subgroups are related to the parent text by the relationship "caused-by". Then, the region G0 is divided into subregions G1, G2 and G3. Next, the shape that represents an arrow is added on a slide. The parent text is allocated on G1 and the two subgroups are allocated on G2 and G3. Third, the template for representing a hierarchy is applied to each of the two subgroups because both of them have the relationship "detailed-by". Finally, the template for expressing emphasis on a component is applied to the parent text. Thus, the final presentation slide is generated from the logical structure.

6.4 Prototype System

6.4.1 Overview

This section presents a prototype system for generating a presentation slide. The system is implemented in Java and generates slides in the format of Microsoft PowerPoint using the API called Apache POI [7].



(a) Template for title

(b) Template for an important text

(c) Template for an image

(d) Template for sequence

(e) Template for hierarchy

(f) Template for cause and effect

Figure 6.5: Templates and preconditions defined in the prototype system

As illustrated in Figure 6.4, the system consists of two windows. The first window (Fig. 6.4(a)) is for editing slide components and specifying semantic relationships among them. This window displays the slide components and their semantic relationships in one topic frame. The text colored with brown represents the title of a topic frame. The text colored with orange represents the slide component whose attribute *role* is *point*. The window has the same functionalities as the prototype system presented in Chapter 4 except that this interface focuses on constructing only one topic frame. Namely, the interface does not display multiple topic frames on a two-dimensional plane. The second window (Fig. 6.4(b)) is for browsing generated slides. This window appears when a user selects the menu item for generating slides. The slides generated by the system are listed on the bottom of the window. The system generates multiple slides if different slides can be generated from the topic frame. A user can choose the most preferable slide from the generated candidate slides. The chosen slide is exported in the format of PowerPoint presentation (*.ppt).

Currently, the prototype system has the templates listed in Figure 6.5 for generating slides. For each template in this figure, the logical structure shown on the left is the precondition for applying the template. The descriptions of the templates are as follows:

Template for title A text component whose *role* is *title* is located on the top of the given region.

Template for an important text A text component whose *role* is *point* is located at the center of the given region.

Template for an image An image component is located on the bottom of the given region.

Template for sequence Groups that are related by a sequential relationship are arranged vertically with directed arrows on the given region.

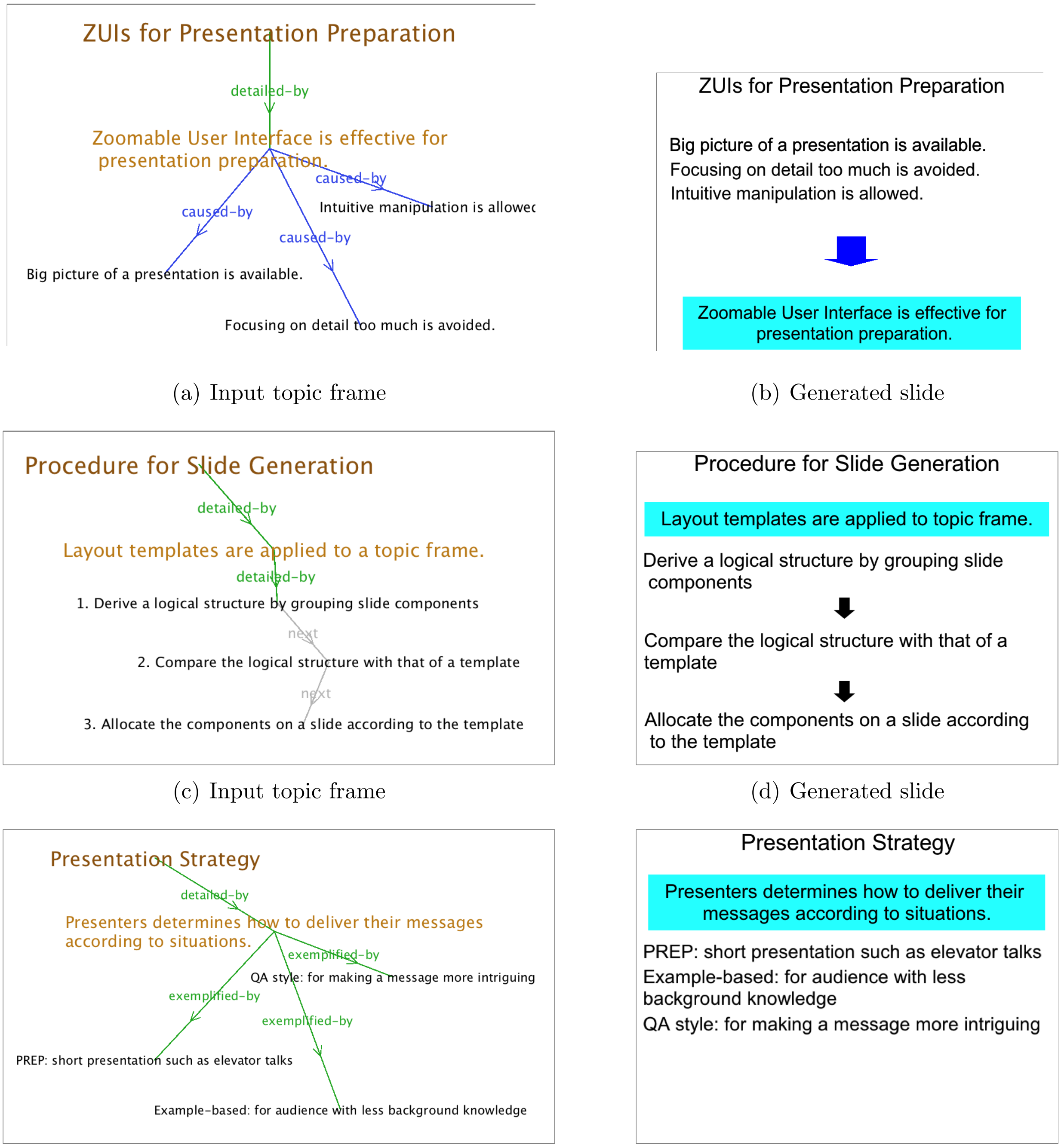
Template for hierarchy Subgroups of a group that are related by hierarchical relationships are horizontally indented on the given region. Also, the subgroups are arranged vertically.

Template for cause and effect Groups that are related by "caused-by" or "assumed-by" relationship are arranged using an arrow between two groups on the given region.

6.4.2 Examples

In order to confirm the validity of the proposed method, the author conducted preliminary investigation using several topic frames as inputs of the prototype system. The topic frames prepared in this investigation are illustrated in Figures 6.6 and 6.7. The system generated slides for each topic frame by applying the templates in Fig. 6.5.

Fig. 6.6 shows the examples of the slides that were successfully generated from the prototype system. The topic frame in Fig. 6.6(a) has one slide component whose content is the text "Zoomable User Interface is effective for presentation preparation." Since this component is related to three text components by a semantic relationship "caused-by", the system applied the template in Fig. 6.5(f) to the topic frame. As illustrated in Fig. 6.6(b), the generated slide reflects the cause-and-effect relationship among the slide components. Furthermore, the slide emphasizes the component whose *role* is *point* on the basis of the template in Fig. 6.5(b). The second example in Fig. 6.6(c) contains the slide components that are related to each other by a sequential relationship "followed-by". The system applied the template for sequence as illustrated in Fig. 6.5(d) to this topic frame. The generated slide (Fig. 6.6(d)) reflects the ordering among the text slide components colored with black. The third example in Fig. 6.6(e) shows a topic

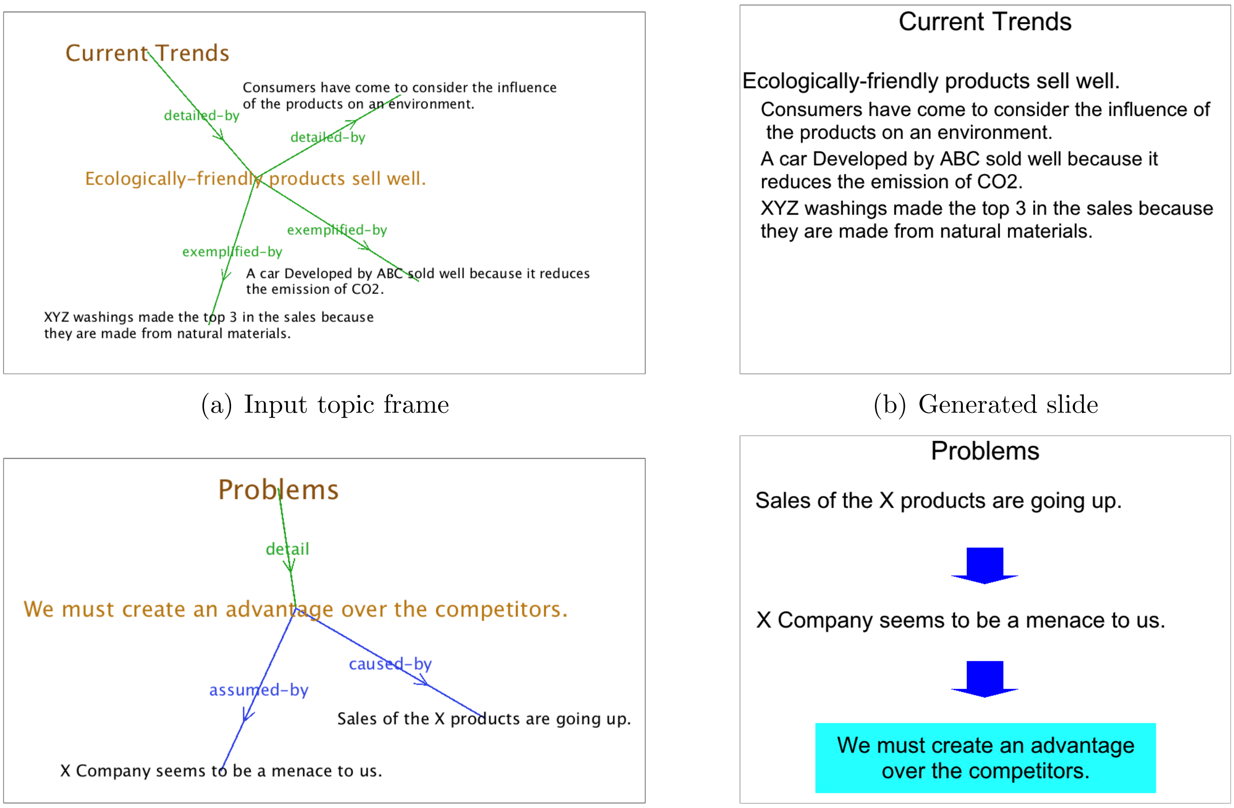


(a) Input topic frame (b) Generated slide

(c) Input topic frame (d) Generated slide

(e) Input topic frame (f) Generated slide

Figure 6.6: Examples of generated slides



(a) Input topic frame (b) Generated slide

(c) Input topic frame (d) Generated slide

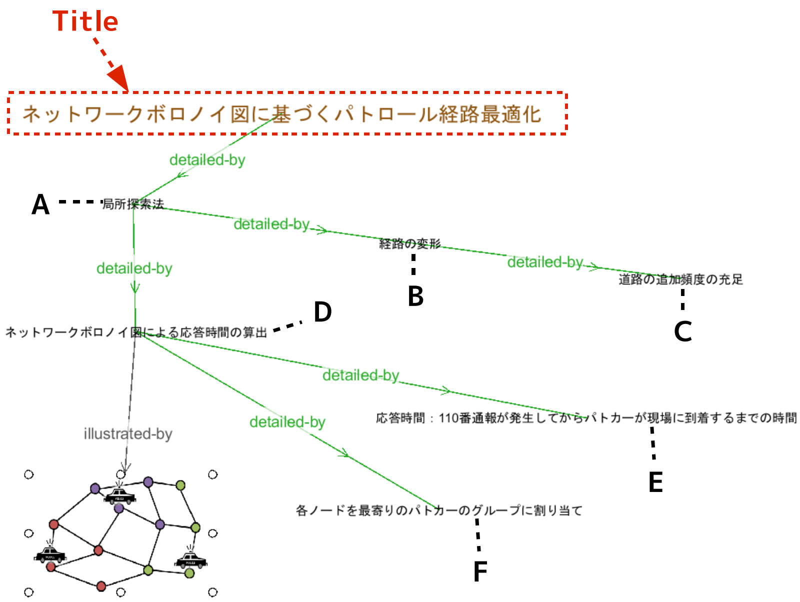
Figure 6.7: Examples of generated slides that did not correctly reflect the semantic relationships in the topic frames

frame that has a semantic relationship “exemplified-by”. This relationship is categorized as a hierarchical relationship according to the definition in Table 6.1. Therefore, the template for hierarchy (Fig. 6.5(e)) was applied in addition to the template for emphasis (Fig. 6.5(b)). These examples suggest that the templates predefined in the prototype system were applied successfully to the topic frames except for the template for an image.

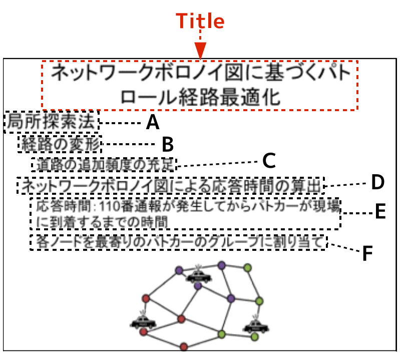
Although the prototype system generated the slides with diagrammatic representation including highlights and arrows, not all of the slides completely reflected the semantic relationships in the topic frames. For example, in the case of the topic frame in Fig. 6.7(a), the generated slide (Fig. 6.7(b)) had the format that is similar to a bullet point list. Furthermore, the slide does not represent the difference between “detailed-by” and “exemplified-by”. This is because the system applied the template in Fig. 6.5(e) to both of these semantic relationships. Another example is illustrated in Fig. 6.7(d). This slide was generated from the topic frame in Fig. 6.7(c) according to the template in Fig. 6.5(f). While the slide has arrows representing the causality, the arrows have no distinction between “caused-by” and “assumed-by”. These examples shows that the system must handle the slight difference between semantic relationships even if the same template can be applied to them. One possible solution is to introduce multiple templates for each precondition, and to apply different templates even when the different semantic relationships satisfy the same precondition.

6.4.3 Case Study

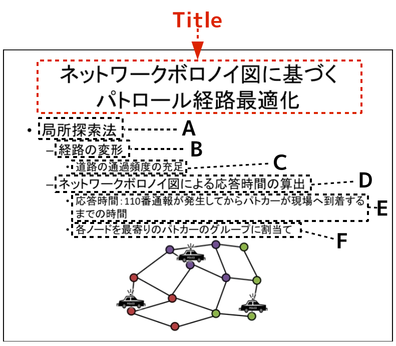
In order to examine the feasibility of the method, the author conducted a case study using the prototype system. The purpose of the case study is to confirm that the method makes it possible to generate slides from a given discourse structure. Several graduate students were asked to make slides for introducing the overview of their research. The students were specializing in information science. First, they made the presentation slide using PowerPoint. Then, they made the discourse structure of the same topic using the system. The author investigated how the system reflected the semantic relationships in the generated slides. From the viewpoint of the usability, it is necessary to evaluate the easiness of the operations in composing a discourse structure. Since the focus of this chapter is on the generation method of slides, evaluation on the utility in composing a



(a) Input discourse structure



(b) Generated slide



(c) Original slide

Figure 6.8: An example of a generated slide from semantic relationships

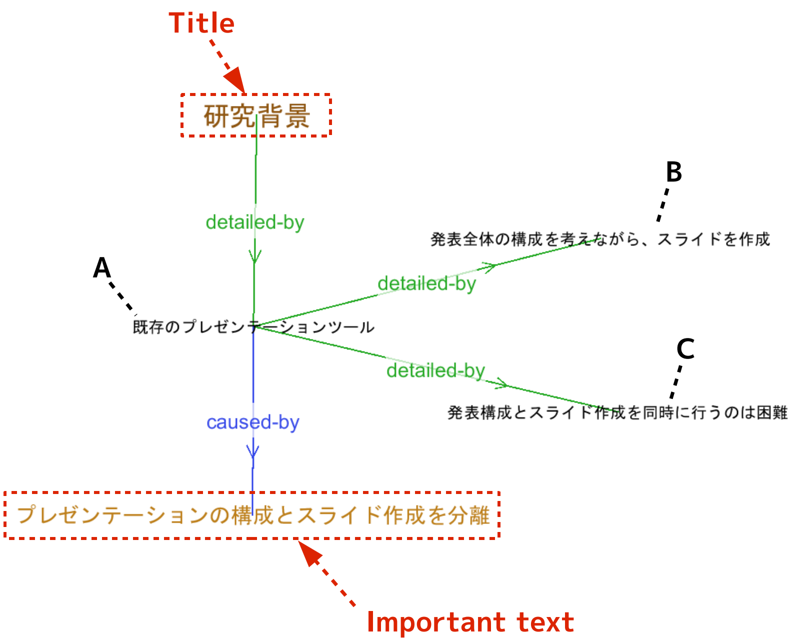
Table 6.2: Correspondence between components in Fig. 6.8 and translation in English

Component	Translation in English
Title	Optimization of Patrol Routes Based on Network Voronoi Diagram
A	Local search method
B	Modification of patrol routes
C	To satisfy the frequency of passing each road segment
D	Estimation of response time using network Voronoi diagram
E	Response time: the time it takes a police car to arrive at the scene after an emergency call
F	To assign nodes in a road network to a group of police cars

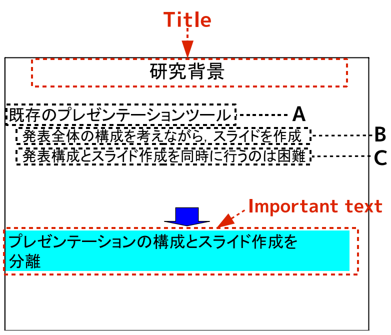
discourse structure is not conducted and left as future work.

Figure 6.8 presents an example. Fig. 6.8(a) is the discourse structure made by one student. The uppermost text object with the largest font size in Fig. 6.8(a) is the title of a topic. The links between slide components are semantic relationships. In this example, the discourse structure has one image and seven texts including the title. All the texts are related by the semantic relationship "detailed-by". Fig. 6.8(b) is a generated slide. The correspondence of a slide component in these figures and its translation in English is shown in Table 6.2. The slide reflects the hierarchical relationships between text components in the style similar to a bullet-point list. Also, the image is allocated on the bottom of the slide. In addition, the generated slide looks quite similar to the original one (Fig. 6.8(c)). This shows that the system can generate as expressive slides as those generated using existing methods such as [35], [56] and [69].

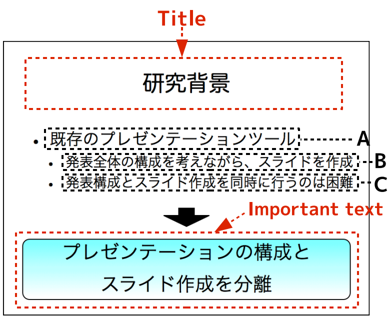
Figure 6.9 presents another example. Fig. 6.9(a) shows the semantic relationships made by another student. The text component on the top of the figure is the title and the one on the bottom of the figure is an important text (a component whose *type* is *text* and *role* is *point*). The important text is related to one text by the relationship "caused-by" and the other texts are related by the relationship "detailed-by". Fig. 6.9(b) is a generated slide. The correspondence of a slide component in these figures and its translation in English is shown in Table 6.3. In this slide, an important text is highlighted according to the template for emphasis (Fig. 6.5(b)).



(a) Input semantic relationships



(b) Generated slide



(c) Original slide

Figure 6.9: An example of a generated slide with an important text emphasized and a causal relationship represented as an arrow

Table 6.3: Correspondence between components in Fig. 6.9 and translation in English

Component	Translation in English
Title	Research Background
Important text	Composing a story and making slides should be separated.
A	Conventional presentation tools
B	Presenters have to consider a whole story while making slides.
C	It is difficult for a presenter to compose a story and make slides at the same time.

Also, the relationship of cause and effect is expressed by using an arrow between text components. In addition, this diagrammatic representation is adopted because the logical structure matched the precondition of the template for cause and effect (Fig. 6.5(f)). Although the layout of the generated slide is not so balanced as the original slide (Fig. 6.9(c)), it has almost the same expressiveness as the original one. This shows that the prototype system can generate slides that are more expressive than those generated using existing methods.

6.4.4 Discussion

In the case study described in the previous section, it is confirmed that the prototype system can generate presentation slides that are as expressive as those generated by existing methods as shown in Fig. 6.8. In addition, the prototype system also generates slides with the diagrammatic template as shown in Fig. 6.9. While the existing methods generate slides with limited format such as bullet-point lists, the proposed method can generate the slides with more effective layout. Specifically, the prototype system generated the slides with highlights for expressing emphasis and diagrammatic representation for expressing cause and effect.

Although the method generates slides with diagrammatic representation, it has two main problems. The first problem is that the physical features of the slide components are not considered in the precondition of a layout template. Currently, the prototype system checks if a layout template can be applied by referring to its logical structure only. However, the physical feature such as the number of components and their sizes should be considered in deciding the layout of a slide. A possible solution to this problem is to introduce the physical constraints to the precondition of a layout template. The second problem is that the templates in the method do not cover enough diagrammatic representation. For example, the prototype system cannot generate slides with the following representation:

- Tabular layout,
- Mutual dependency like Venn diagram,
- Circular layout.

A possible solution to this problem has two steps. First, templates have to be increased in order to cover the variety of SmartArts prepared in PowerPoint. Second, a mechanism has to be introduced to attach an attribute to groups of components that indicate relationships such as "complement", "independent-of" and "circular".

6.5 Summary

This chapter presented an experimental method for composing presentation slides automatically from discourse structure. The method is based on the transformation mechanism from the logical structure to the geometric structure. In the research fields of document image understanding, a logical structure and a geometric structure with a view to interpreting document organization has been successfully investigated. In the proposed method, the mechanism of transforming from a logical structure into a geometric structure takes an important role in composing presentation slides: the logical structure is constructed from a topic frame in a discourse structure; and the geometric structure corresponds to a layout template of a slide. The idea in the method is to assign the semantic relationships to the related slide components in order to attain the transformation using diagrammatic representation effectively. The results of the case study shows that the system can generate slides successfully with more expressiveness than the slides generated by existing methods. The method in this chapter considered only one of the interpretation of the semantic relationships. However, the interpretation (whether a semantic relationship is directed and hierarchical) is included in a presentation strategy discussed in Chapter 5. Therefore, the method can be extended to generate slides that reflects the strategies of presenters.

Chapter 7

CONCLUSION

7.1 Contributions

This dissertation presented the works on supporting presentation as the knowledge handling process. This research addressed the problems of traditional presentation tools, and investigated the possibility of computational support in presentation preparation as a creative activity.

Chapter 3 presented the framework for effective support of presentation preparation. This chapter discussed the knowledge handling process in presentation preparation. Then, this chapter presented the fundamental approach to accomplishing an environment in which a presenter externalizes her implicit knowledge on presentations intuitively. Additionally, this chapter discussed what types of the knowledge must be handled computationally for effective support of presentation preparation. On the basis of the discussion, the requirements for supporting presentation preparation as a creative activity are presented.

Chapter 4 presented the model of a knowledge fragment and a discourse structure. This chapter also discussed the representation and operation on a discourse structure for supporting externalization of presenters' intentions. This phase corresponds to the acquisition and refinement operations on the knowledge fragments in outside of in-words in the knowledge handling model. The operation of interrelating knowledge fragments by semantic relationships enables presenters to clarify their intentions on how the concepts are related to each other. In addition, the prototype system provides the holistic view of a presentation story in which multiple topics are visible at the same time. Such view helps presenters examine whether their stories are consistent by comparing multiple topics. Furthermore, an operation of allocating knowledge fragments to the topic frames allows presenters to move a fragment in one topic to another intuitively. These features of the prototype system are expected to make it easy for a presenter to compose a consistent story of her presentation.

Chapter 5 presented a method for supporting composition of presentation scenarios from a knowledge fragment network. The proposed method constructs stories according to presenters' intentions on how to tell their stories and time constraint. This phase corresponds to the refinement operation on the knowledge fragments in outside of in-world in the knowledge handling model. The method handles such intentions as a presentation strategy. The key idea is to model a presentation strategy as a policy for searching a knowledge fragment network. The prototype system selects the knowledge fragments from a knowledge fragment network so that the story satisfies the time specified by a presenter. To achieve this, the prototype system estimates the time for explaining contents in a story based on the result of the preliminary investigation. From the examples of the story composition, it is confirmed that the prototype system generated stories reflecting the strategies.

Chapter 6 presented a method for generating presentation slides from a topic frame in a discourse structure. This phase corresponds to the presentation operation on the knowledge fragments from outside of in-world to out-world in the knowledge handling model. The proposed method addresses how to externalize semantically structured fragments in the form of a presentation slides. The method is based on the mechanism of transformation from the logical structure to the geometric structure. In order to generate slides with diagrammatic representation effectively, the prototype system constructs the logical structure from a topic frame and then finds appropriate layout templates by comparing the logical structures. The results of the case study showed that some of the slides were successfully generated by the system and had more expressiveness than the slides generated by existing methods.

The research discussed in this dissertation has the following contributions.

Representation and operation for authoring presentation materials Figure 7.1 illustrates the contribution of this research from the viewpoint of content authoring for presentation. The authoring systems for presentation materials using zooming user interface provides the holistic view of the presentation stories [16][30][45]. However, existing tools

	Provides holistic view of a presentation story	Handling semantic relationships among elements	Bridges the gap between organized ideas and final product
Our method	Yes	Yes	Yes
iMapping KJ editor Outline processors	Yes	Yes	No
CounterPoint FLY Prezi	Yes	No	No
PowerPoint Keynote Impress	No	No	No

Figure 7.1: The contribution in authoring of presentation materials

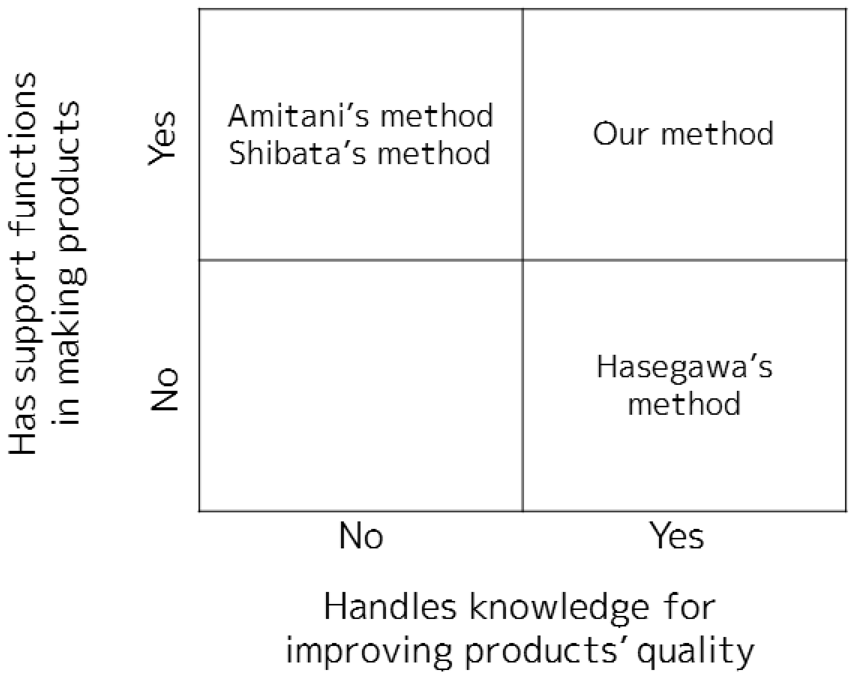


Figure 7.2: The contribution in supporting creative activities

did not handle the implicit knowledge such as semantic relationships among components. In addition to the zooming function, the prototype system discussed in Chapter 4 enables presenters to specify her implicit knowledge in the form of semantic links between knowledge fragments.

Also, the semantic relationships are handled for supporting story composition as discussed in Chapter 5 and generating slides as discussed in Chapter 6. This shows that the proposed framework realizes the seamless support in presentation preparation from idea organization to slide composition. The prototype system for externalizing a discourse structure has similar features to iMapping [17] in that both of them have an interface for zooming and a function for specifying semantic relationships. However, the prototype system is different from iMapping in that the output of the proposed system can be utilized in slide composition seamlessly.

Knowledge handling for improving products' quality Figure 7.2 illustrates the contribution of this research from the viewpoint of supporting creative activities. In the field of creative activity support, the systems have been proposed in order to support event planning [4], music composition [5], document composition [54][55] and requirement analysis in software development [62]. These systems often provide a two-dimensional plane on which elements such as musical phrases and linguistic concepts are arranged. Some systems adopt statistic methods in order to express the similarity and difference among the elements on a two-dimensional plane. These systems do not handle the explicit knowledge. On the other hand, the system discussed in Chapter 5 handles the knowledge for composing persuasive stories.

From the viewpoint of improving products' quality, Hasegawa et al. proposed a system for improving presentation skills on the basis of presentation semantics [18]. Their system was developed so that a presenter would acquire how to compose a well-structured story. While their system handles presentation semantics as the knowledge for composing presentation stories, the knowledge is not applied to the process of presentation preparation. In fact, their system is used to assign annotation representing a topic such as “objective” and “evaluation” to existing slides. The prototype system discussed in Chapter 5 is different from their system in that the knowledge for story composition is applied during the process of preparing presentations.

Automatic generation of slides with diagrammatic representation The existing methods for generating slides are mainly based on the summarization techniques in natural language processing [35][56][69]. These methods successfully extract the elements to be allocated on slides and their semantic relationships from existing resources such as research papers. On the other hand, the slides generated by these methods follow the standard format of bullet points prepared in traditional presentation tools. The method proposed in Chapter 6 generates slides with diagrammatic representation using shape objects such as arrows and rectangles for expressing the semantic relationships such as causality and emphasis. By combining the techniques of summarization and the method discussed in Chapter 6, it becomes possible to generate slides with diagrammatic expression from the resources.

7.2 Future Work

The future work includes evaluating the effectiveness of the prototype systems, extending story construction support, supporting other activities in presentation preparation.

Evaluation of the effectiveness of prototype systems The research in this dissertation leaves the evaluation of the effectiveness of the proposed framework through the user study. Although the author has confirmed that the prototype systems follow the mechanisms described in the previous chapters, it is necessary to investigate their effectiveness from the viewpoint of usability and availability.

In addition, it is necessary to evaluate the systems from the viewpoint of creative activity support. The evaluation must focus on the reproduction operation in the knowledge handling model because the operation corresponds to the enhancement of a presenter's knowledge for "better presentations". The knowledge handling model argues that some of the phenomena corresponding to reproduction can be observed as part of the sequence of knowledge handling operations. Specifically, reproduction can be triggered as the result of operations on the knowledge in outside of in-world such as refinement and acquisition. In order to validate this hypothesis, it is necessary to build a model on specific operations on knowledge in the state of inside of in-world. One of the approach is to introduce framework thinking as utilized in constructing a business model. The guideline called LATCH (Location, Alphabet, Time, Category and Hierarchy) is one of the representation for organizing fragments of knowledge [74]. Further investigation must include how the implicit knowledge such as frameworks, presentation strategies and layout templates will be updated computationally through the knowledge handling process.

Story construction support The proposed framework assumed that the knowledge fragment network is prepared in advance by presenters. However, this assumption is not always true because presenters who have little experience of using computers have difficulty in externalizing knowledge fragments and specifying semantic relationships among them. The method for supporting story construction is realized by referring only semantic relationships. To address these problems, it is necessary to devise a mechanism considering the contents of knowledge fragments. Some researches have proposed the computational methods for automatically composing a story from documents such as news articles and story fragments [1][51][52]. By combining these methods with the proposed method, it becomes easier for many presenters to organize their ideas.

In addition to the methods for story composition, some researches have been conducted in the field of research activity support. Tsuchida et al. proposes the DRIP system for supporting research activities in a laboratory [65]. Miyadera et al. proposes a system for managing personal repository of resources accumulated in the daily activities in a laboratory [34]. Since these systems enable their users to related fragments of contents to each other through their daily activities, they are expected to reduce the burden of preparing the network structure of contents. By combining these methods with the method proposed in Chapters 5 and 6, it becomes easier for presenters to compose presentation stories and slides.

Slide composition support Since the variety of the layout templates in the method is limited, it is necessary to extend the definition of layout templates and to evaluate the effectiveness of the method for generating slides. In order to extend the definition, additional templates with the precondition considering physical features must be introduced. In addition, it is necessary to devise a mechanism to generate slides from multiple topics. The proposed method assumes that the topic frame as the input corresponds to only one topic such as background, objective and conclusion. A mechanism of generating slides from multiple topic frames will make slide composition flexibly..

Furthermore, it is important to support the process of presentation preparation from the viewpoint of what content should be included in a presentation. That is because the content varies according to the situations such as the spoken language, the background knowledge of audience and time constraints, even though the subject of a presentation were the same. For example, a scientist giving speeches to people without scientific background has to translate scientific terms into familiar words and include example related to our daily life. Therefore, it is necessary consider how to support the preparation, selection and reuse of scenarios and slide components as well as slides.

Beyond presentation slides The presentation scenario handled in this research was incomplete because the interrelationships between the concepts to be spoken and the audio/visual materials to be presented were not defined in the model. Therefore, the primary future work is to develop a system that handles such relationships.

Another future direction is to devise a mechanism to generate presentation scripts including translation from a presenter's native language into other languages. To achieve this, it is necessary to consider the context and the relationships among contents in knowledge fragments. This is because the story composed by the prototype system represents only a sequence of knowledge fragments. In addition to the additional knowledge, the mechanism to apply the knowledge to automatic script generation must be considered.

The research in this dissertation is based on the assumption that a presenter uses visual aids such as slides and posters. However, whether a presentation will be successful depends on a persenter's message and story. The author believes that the work in this research contributes to the enhancement of the thinking process of a presenter. The ultimate goal is to assist a presenter in enhancing her presentation skills until she depends on no computer software for a presentation any longer.

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