On modeling conceptual and narrative structure of fairytales

*Shinya Kawakami, *Yoko Sato, *Masaki Nakagawa, **Bipin Indurkhya
*Department of information and communication,
**Department of mechanics,
Tokyo University of Agriculture and Technology
*kawakami@hands.ei.tuat.ac.jp

Abstract. We describe here our ongoing research on modeling conceptual and narrative structure of fairytales by a computer system. In this paper we focus on the variations of fairytales based on Cinderella from all around the world. We analyzed twenty-three Japanese texts of Cinderella tales and modeled their conceptual and narrative structures using the notions of composition elements and motifs. We then incorporated all these structures into a unified structural model of Cinderella story. Finally, we implemented a computer system based on the unified structural model to automatically generate variations of Cinderella tales. The system was able to generate variations that were quite different from any of the original Cinderella tales.

1. Introduction

Humans find it natural to organize information in terms of narrative structures. For example, in ancient times, elders passed their knowledge and wisdom to the new generation by telling stories, which were often augmented or modified slightly with each retelling to incorporate the experiences and interpretations of the narrator. Variously referred to as folktales, fairytales, myths, etc., such stories have played a powerful role as archetypes that influence one's individual perceptions and actions as well as define societies and cultures, and continue to do so even in this modern age of information technology (Campbell [1]).

Several studies have been done to analyze the structure of folktales, fairytales, and stories in general (Bal [2], Chatman [3], Currie [4], Martin [5], Propp [6]). Essentially, two structural components can be identified in a story: one concerned with the relationship among the characters, which we will refer to as *conceptual structure*, and the other concerned with the temporal relationship among the events, which we will refer to as *narrative structure*. Artificial Intelligence researchers have also been quick to recognize the importance of the role played by stories in knowledge representation, and some attempts have been made to model their underlying conceptual and narrative structures and apply it for various purposes (Lang [7], Rumelhart [8], Schank [9]). All this research has been applied to develop narration theory-based information systems that present stories in various mediums such as text, theater, animations, etc., and allow different levels of interactions between the system and the user, who manipulate the system to generate stories (Szilas [10], Riedk *et.al.*[11]).

In all the studies mentioned above, the narrative elements are defined independently of each other, and the task of braiding these elements into a story is relegated to narrative theories. Such approaches do not clarify how a user imagines and plans the conceptual and narrative structures of a generated story, and how the user-system interaction leads to the unfolding of this structure. Of course, in these situations, the system can produce unexpected progressions of events in stories, which can entertain or delight the user. Nonetheless, it reduces the role of the user to an audience or at most to a limited participant. For story-generating systems that are designed to leave the user in the driver's seat, unexpected progressions generated by the system can cause frustration to the user and may lead to ineffectiveness.

The purpose of this research is to extend these ideas and explore more deeply the issues concerning how to represent the conceptual and narrative structures of stories in an information system, and how to manipulate and apply these structures effectively. More concretely, we have focused on variations of the classical fairytale Cinderella found around the world. We refer to these variations as *Cinderella tales* in this paper. In the research presented here, we analyzed twenty-three Japanese texts of Cinderella tales to abstract the conceptual and narrative structures inherent in these stories. Based on this analysis, we created a synthesized structural model of Cinderella tales.

The motivation behind developing this structural model, and the criterion used for evaluating it, is that it can be used to regenerate each of the original stories on the analysis of which the model was based, as well as new variations. As far as the original stories are concerned, they can be generated from the structural information containing definitions of kinds and consequences of actions, sequences of actions, and methods to reason about actions and situations. In generating new variations, however, the following problem occurs. Once an action in a sequence is replaced with another kind of action, the consequence of the new action and the following sequence may become quite different from the original. In this case, the story based on the generated sequence may not always be regarded as a variation of the original. In order to resolve this problem, it is necessary to somehow capture the essence of a story in terms of constraints on its conceptual and narrative structure. But this is difficult to realize in models based on action sequences because a generated action sequence carries a different significance than the original, and the essence of the story, however it may have been characterized, must cover the new action sequence (in being able to decide whether it is a variation of the original or a different story.) Therefore, one must rely on some other method to characterize the essence of a story.

Our approach is to introduce a *motif network model* of narrative structure to resolve this issue. In our analysis, we identified the motifs appearing in each of the stories, looked at their order of appearance, considered which motifs can be unified with each other, and generated groups of mutually compatible motifs. The motif network model incorporates the conceptual and narrative structures of each of the analyzed story, multiplexing parts of the stories where motifs are unified. This characteristic of the structural model makes it easy to regenerate any of the original stories and also to generate new ones. Thus, the motif network model described here is an open-ended synthesized structural model of Cinderella tales.

Finally, we implemented a computer system to automatically generate variations of Cinderella tales. The system can regenerate any of twenty-three original Cinderella tales as well as versions not in the original. We present one such variation generated by our program, and then discuss the implications of our research for information modeling as well as future research directions.

2. Analysis of Cinderella tales

The goal of this analysis is to identify and delineate the conceptual and narrative structures underlying different variations of Cinderella-based fairytales, and identify a common archetype for them. The traditional approaches for analyzing folk and fairy tales often use *motifs* for representing narrative structures. Though we also use motifs to represent abstract structure of a story, our method of analysis is to divide the text of a story into small fragments, and then represent the structure of each fragment as a *composition element.* Thus, in our approach, conceptual and narrative structures are analyzed and composed in terms of compositional elements. This allows us to stay very close to the concrete text, which makes it easier to use the model in the reverse direction, that is, to generate a text based on the structure specified in terms of compositional elements.

In the rest of this section we provide a list of texts used in our analysis, define motif and composition element, describe the factors that affect compositional elements, compatibility among compositional elements, and a method to integrate conceptual and narrative structures of each text.

2.1 Texts for Analysis

We analyzed the following twenty-three texts of fairytales from around the world that can be considered as variations on Cinderella. All the texts used were in Japanese.

Text01: *SANDORIYON or Shoes of small glass, France* [12]
Text02: *HAIKABURI, Germany* [13]
Text03: *RODOPISU NO KUTSU, ancient Egypt*
Text04: *RIAOH NO KODOMOTACHI, Ireland*
Text05: *RAGUNA RODOBUROKU NO SAGA, North Europe*
Text06: *KUNARATAISHI NO HANASHI, ancient India*
Text07: *RARUDAIOH TO HUTARI NO ADOKENAI HIME, India*
Text08: *KIN NO SHOKUDAI, Iran*
Text09: *KEGAWA MUSUME, Turkey*
Text10: *MAMAHAHA TO MAMAMUSUME, Macedonia*
Text11: *YOGEN SURU USHI TO SONO SHUJIN, Hungary*
Text12: *JUUNI NO TSUKI, the Czech Republic*
Text13: *KUCHI WO KIKU ATAMA, England*
Text14: *NAKUSHITA KIN NO KUTSU, Iceland*
Text15: *KIN NO KUTSU, Ukraine*
Text16: *FURISHA TO HUTARI NO MUSUME, North Africa*
Text17: *AOI OUSHI, New México, North America*
Text18: *PAWANGU PUTEE TO PAWANGU MERA, Java island*
Text19: *KONJI PATJI, Korea peninsula*
Text20: *HUTATUME, North China*
Text21: *YANPA TO YANRAN, the Miao tribe, China*
Text22: *PA ERU PU NO SANSHIMAI, Tibet* [14]
Text23: *NUKAHUKU KOMEHUKU, Japan* [15]

Some texts are partially abbreviated and a few others exist only as outlines. The last text is originally mentioned in a separate volume, “Folktale of Ina-mura”, of “Notebook of folktale” (Daiichi Hohki and Society of Japanese folktales).

2.2 Motif and narrative structure

Given a portion of text, we define its *motif* as the most significant action described by the text. The representation of a motif contains information about the kind of action, the characters performing the action or affected by the action, the objectives of the action, and so on. Certain motifs may be incidental, whereas others may recur repeatedly and contribute to the narrative structure of the story. Also, in comparing motifs across different stories, we find that some motifs are peculiar to a certain story, but some others are shared by different stories.

Motifs make it possible to compare the structure of two or more stories without having to abstract and standardize objective units such as actions, episodes, etc. that may differ in various texts. Narrative structure of each story is expressed in terms of motifs. Different narrative structures arise from different configurations of motifs. In previous research, Cox [16] and Rooth [17] have examined and compared some common motifs underlying Cinderella tales. Cox classified three hundred forty-five variations of Cinderella tales into five categories, where each category is characterized by its principal motifs as shown below:

Group1	"heroine abused" and "recognition by shoes"
Group2	"unusual father" and "flight of heroine"
Group3	"Judgment of King Rea" and "banishment of heroine"
Group4	Similar but not applicable to those three groups
Group5	The protagonists are male.

Rooth also classified Cinderella tales into five types. Each type and its particular motifs are given in the following table:

Type A	"stepmother", "deceased mother", "spin into yarn" and "cow as an assistance

	person"
Type AB	"garments", "party", "shoes" and "marriage" in addition to type A
Type B	"stepmother", "deceased mother", "tree", "garments", "division grains", "party", "shoes" and "marriage"
Type BI	"father proposes"
Type C	The protagonists are stepsons.

Even though those motifs signify structural differences among the groups, they contain only information that is common among the original stories. In other words, the motifs and other information pertaining to the peculiarities of individual stories are not maintained.

2.3 Composition element

We define a *composition element* to be a small set of actions that comprises an action sequence. A composition element also contains a label pointing to the motif corresponding to it, information about the characters participating in the action and their situational settings, and a template of the original text. Thus, each composition element contains a partial conceptual and narrative structure and also preserves information that is omitted from the original story in motifs.

To divide an original story into composition elements, first we extract principal characters from the story and all actions concerning these characters. Next we identify those actions that make a sequence of actions temporally or spatially dependent. Actions such as speaking are combined with other related significant actions. These sets of actions are now regarded as composition elements. Then the most significant action is extracted from each action set and is regarded as the motif of the composition element. Relationships among the characters that were affected by the actions, as well as their state and setting is also extracted and included in the composition elements.

Composition elements are similar to events, episodes or scripts, which are often used to represent narrative structures. For example, Rumelhart [8] and Schank [9] described narrative grammars that represent narrative structures using these concepts. Based on these representations, some story-generating systems have been implemented by Lang [7], Hosaka *et al.* [18] and Kawakami [19]. However, episodes and scripts (also stories) are eventually represented as a sequence of actions conceptually. Thus, if each action sequence can be identified, narrative structure of a story would be represented by the series of actions without mentioning episodes or scripts. We choose this action-level representation because it has the flexibility and potential for being extended when using the model for generating stories. Fig. 1 shows the conceptual relationship among different levels of representation including composition element and motif.

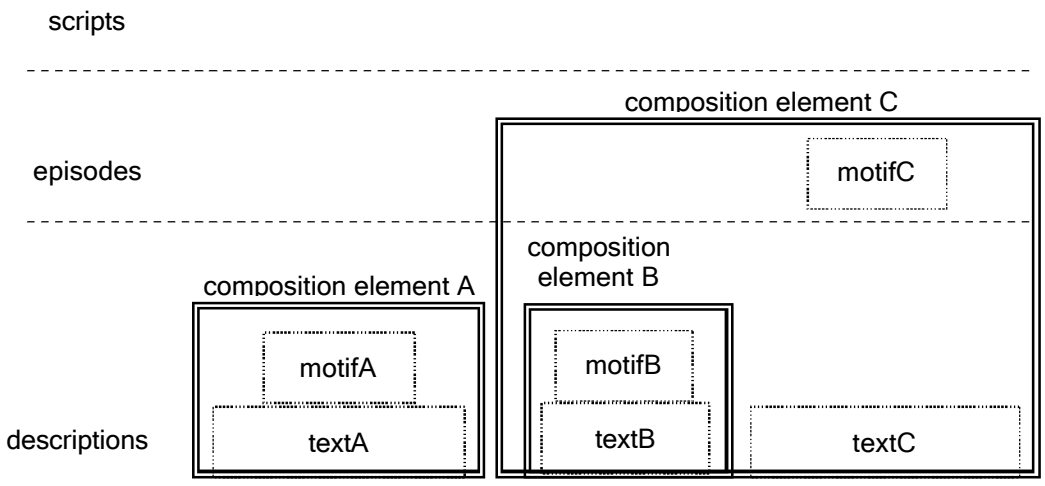

Fig.1 Conceptual level of stories and composition elements

2.4 Narrative structure

Narrative structure of a story is represented by appropriate composition elements ordered linearly. In previous studies that focused on narrative grammars or motifs as mentioned before, narrative structures of folktales were also linear. For example, Propp [6] analyzed Russian folktales and extracted forty-two functional elements in terms of which narrative structures of many of the Russian magical folktales can be represented. In this approach, each functional element is property that relevant part of a folktale signifies that kind of function and the narrative structure of the folktale is constituted by a linear sequence of functional elements. However, in cases when a false hero or heroine appears in a story, its narrative structure becomes partially parallel.

The effectiveness of representing the narrative structure of a story in terms of functional elements is marred by the fact that a sequence of functional elements does not allow sufficient variations in the features. Features are inherently variable in any part of a narrative structure. In functional element-based representation, in order to figure out feature variations allowed within a functional element, it is necessary to refer to the contents of all those parts of the narrative structure that are relevant to that functional element. This problem is also encountered in action-based approaches [7][8][9], where narrative rules define features as 'variation' gathered from all relevant parts of the narrative structure.

Accordingly, our model focuses on narrative structures of variations in 'Cinderella tales'. In particular, we define composition elements and linkages between composition elements to represent detailed information about the contents of a story and allowable feature variations for 'Cinderella tales'. Of course our model is not yet extensible to cover other kinds of fairytales, especially general stories, but we feel that our research constitutes a first step towards this larger goal.

2.5 Conceptual structure

Conceptual structure of a story is composed from information contained in various facts mentioned in the story. This structure includes information about the characters, their attributes and roles, settings, social relationships among them, ownership relation between them and items, and so on. The information contained in the conceptual structure, which is essentially situational, is orthogonal to the structure contained in the narrative structure, which is temporal. However, the situational information also changes in response to the unfolding of the narrative structure. Therefore, we explicitly introduce the concept of time into conceptual structures. Temporal durations, if attached to a fact, determine the time period during which that fact remains valid.

2.6 Compatibility of composition elements and Similarity between narrative structures

We chose to enforce a conceptual compatibility among composition elements that correspond to the same motif. A motif essentially contains an abstracted structure, as explained above in Sec. 2.2, and each composition element contains its own concrete narrative structure, as explained in Sec. 2.3. Therefore, different composition elements that are labeled with the same motif must be conceptually compatible.

However, composition elements labeled with the same motif are not always compatible when narrative structures are reconstituted. It is because, even though different composition elements are labeled with the same motif, each composition element contains different conceptual and narrative structures internally. Furthermore, the number of times each composition element can recur in a narrative structure is restricted. When a composition element needs to be chosen from among the available compatible composition elements, the choice must be determined depending on relevant conceptual and narrative structures. In creating a structural model of Cinderella tales, to be described in the next section, we unified narrative structures of different stories.

It is possible to consider similarity between narrative structures based on motifs. For

example, in the area of oral literature, Aarne and Thompson [20] focused on narrative features including motifs to consider similarity between various kinds of folktales in their comparative studies. Seki [21] also classified Japanese folktales by a similar method. Our method of analyzing the similarity between texts focused on composition elements including relevant motifs. This method keeps the potential for comparison, while at the same time maintaining the required information to describe the contents of each part in the structural model of Cinderella tales.

2.7 Temporal points through a story

The concept of temporal point is used to represent the time progression in a story. We divided narrative structure of a story into several composition elements, with all the elements serially ordered. The indices corresponding to the position of each composition element in the sequence of narrative structure is regarded as temporal points of the story. A simple example is shown in Fig. 2.

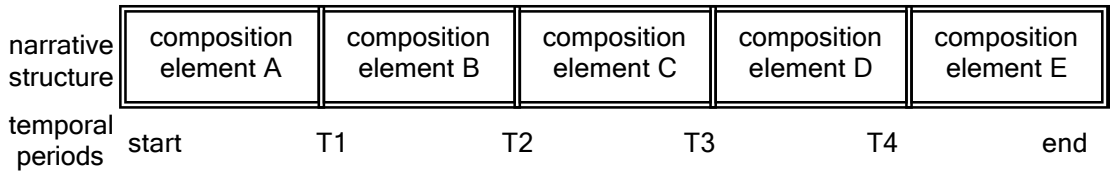

Fig.2 Temporal periods through a narrative structure

Strictly speaking, any action performed by a character requires some time to finish. Under this consideration, a composition element that contains several actions is spread over a period of time. In stories other than fairytales, such as novels and movies, this kind of spread over time is explicitly mentioned or visually presented. For example, a scene is described in more detail and many concrete particulars are provided. However, this kind of spread over time is not common in fairytales. For example, Luthi [22] noted that in fairytales, the time progression does not cause any change in the protagonists. Therefore, we assume that any changes in the protagonists happen suddenly at a particular point in time and are completed immediately. Thus, in our analysis, only the concept of temporal points is considered.

2.8 Unifying composition elements

We unified composition elements extracted from variations of Cinderella tales into an integrated model. In the unification process, each composition element is regarded as a node and each link between two composition elements is represented as an arrow. Nodes of conceptually compatible composition elements are unified into a node and links between the unified node and following composition elements form branches. We performed integration of composition elements following this process:

Step1 Analyze HAIKABURI and SANDORIYON, compare composition elements of each story and unify them. These two stories are quite typical and their variations are well known. They were also written at about the same time. So it is easy to compare them.
Step2 Analyze other texts and unify composition elements extracted from them that are compatible to the composition elements unified at Step1.
Step3 Unify “banishment” and “flight”
Step4 Unify other appropriate composition elements.

2.9 Results of analysis

We obtained five hundred fifty-four composition elements and relation links between pairs of them from analyzing twenty-two stories. We also obtained consistent conceptual structures for these composition elements. From this data, we created a structural model of Cinderella tales as described in the next section.

3. A structural model of Cinderella tales

The structural model of Cinderella tales is composed from composition elements, consistent settings of characters that were mentioned in each story and linkages between pairs of composition elements occurring in a sequence. Composition elements and linkages between pairs of composition elements are combined into a network model of narrative structures. Composition elements which are recognized as compatible are unifiyed in the network model of narrative structure. Conceptual structures are made up of composition elements and settings of characters. Fig. 3 shows the information contained in the structural model.

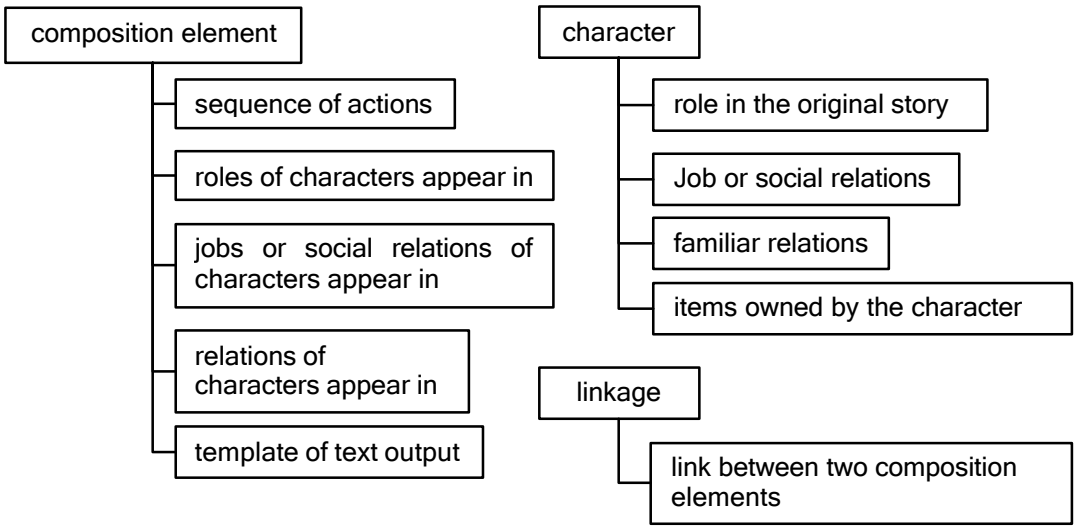

Fig.3 Knowledge stored in structural model

3.1 Setting of characters in each analyzed story

Settings of the characters mentioned in the story in which the characters appeared originally are integrated into the structural model. Each setting is consistently available throughout the story here. There are four items of information contained in the setting of a character as follows:

Role in the original story
Job or social relations
Familial relations
Items owned by the character

3.2 Composition elements

Each composition element has a label to identify its motif. It contains a series of actions where apropriate roles of characters occur as well as conceptual information and restrictions required of those roles. Situational settings are also restricted in the composition elements and defined under temporal points. Five kinds of information and restrictions contained in each composition element are:

Sequence of actions
Roles of characters appearing in this part
Job or social relations of characters appearing in this part
Relations of characters appearing in this part
Template of text output

3.3 Links between pairs of composition elements occurrring in a series

Links between pairs of composition elements occurring in a series are integrated into the structural model. The structural model has the characteristic of a network model.

The progression of a story is represented through composition elements from the start to the end. Some composition elements are connected with two or more linkages at the output. Such connections carry the information that the progression of the story has branches here. Fig. 4 shows a part of the structural model containing some composition elements and linkages between them. Each labeled rectangle signifies a composition element. Arrows signify the direction of progression of the story.

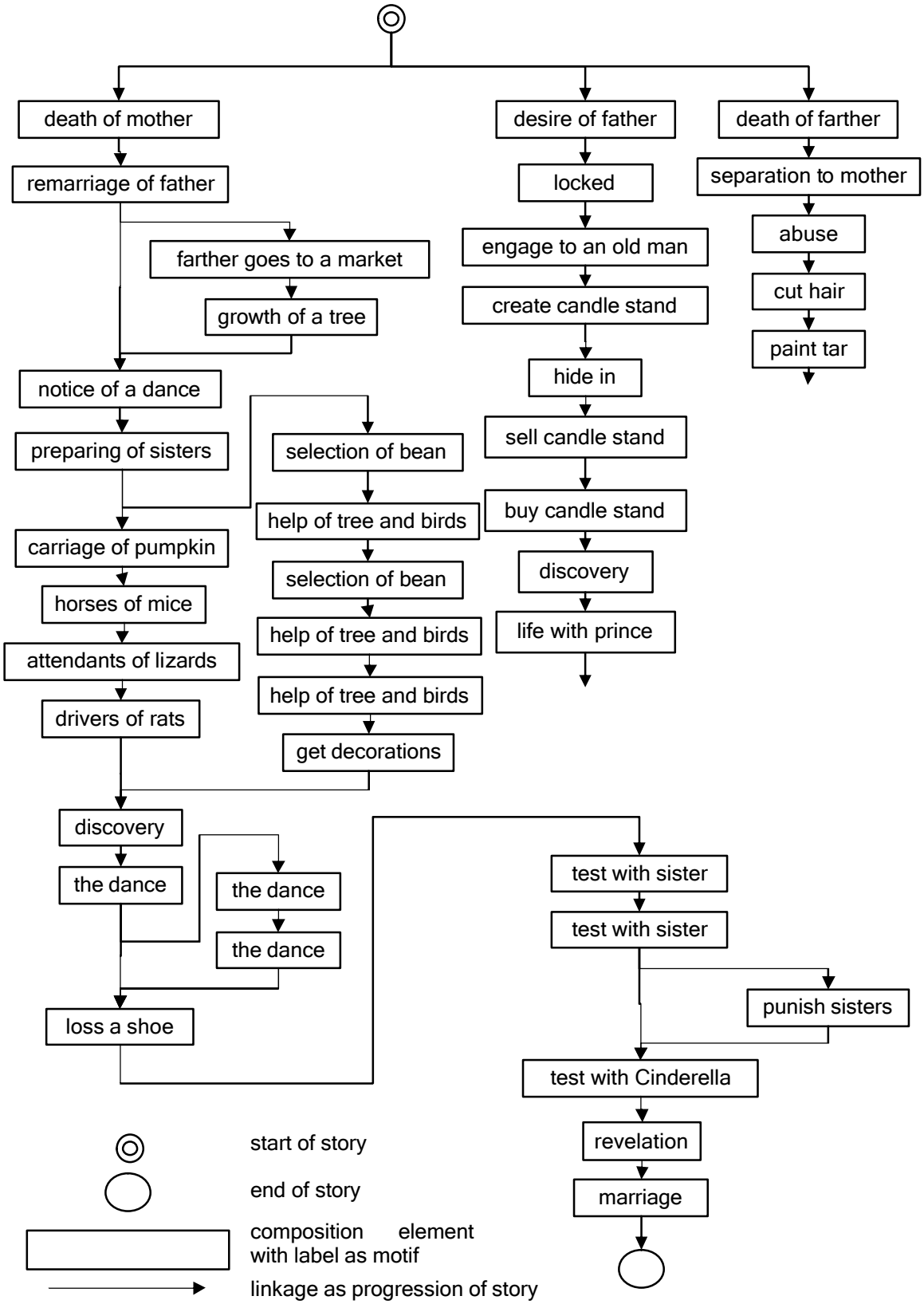

Fig.4 A part of the structural model

4. A story-generation system based on the structural model of Cinderella tales

Based on the structural model of Cinderella tales, we implemented a system to generate variations of Cinderella tales. It contains five kinds of database, including the structural model explained above, and a main module containing four sub-modules. The story-generation system generates variations as 'Cinderella tales' searching the network model. Fig. 5 shows the internal structure of the story-generation system. We briefly describe each database and each module in the rest of this section.

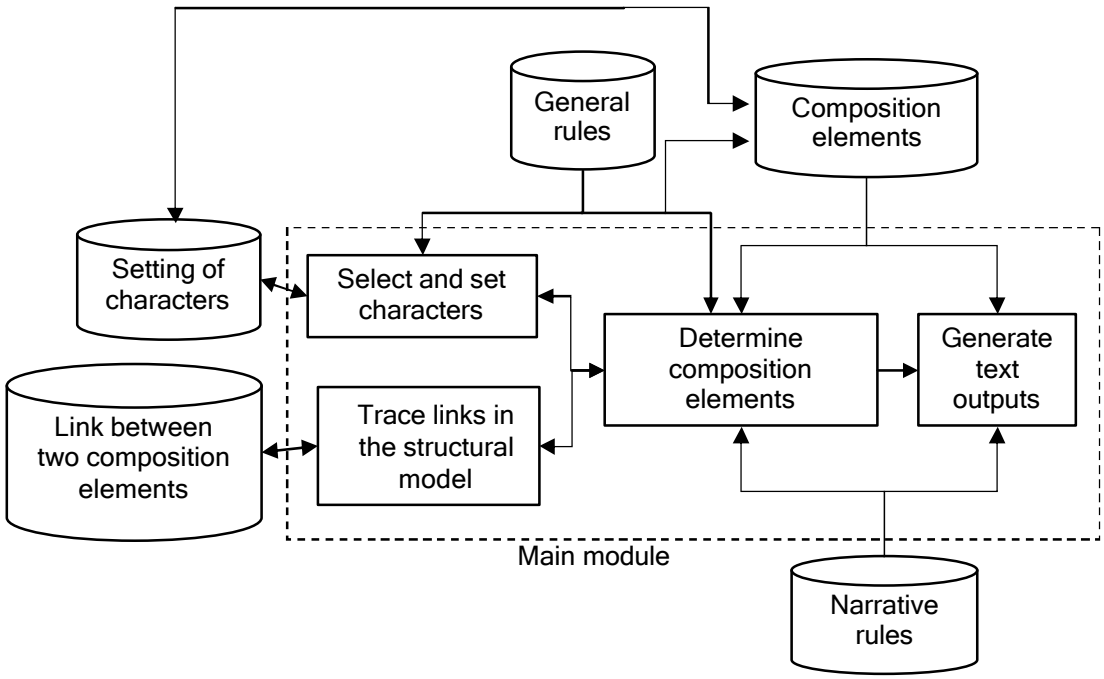

Fig.5 Internal structure of the story generation system

4.1 Databases

Five kinds of databases are used in the system. The database of character settings, composition elements and links between two composition elements corresponds to the three kinds of information contained in the structural model of Cinderella tales. Even though the databases of general rules and narrative rules are not based on the analyzed stories, the rules contained in these databases are generally available in folktales.

Setting of characters

Setting of characters is done based on their appearance in the analyzed stories, for example:

role(sandoriyon, protagonist, 0, 100).

The first argument defines the name of the character, and the second argument its role. The name of each character is unique, and it can take one of the 8 possible roles: *protagonist*, *father*, *mother*, *step-mother*, *villain*, *helper*, *gift*, and *spouse*.

relation(parents, father, sandoriyon, 0, 100).

The first argument names the relation between the characters specified in the second and the third arguments. This example defines that the character *father* is a parent of the character *sandoriyon*. We classified the possible relations between characters into two kinds as follows:

Familial relations: Parent and child, married couple and brothers or sisters

Social relation: Master and servant

own(sandoriyon, pampikin, 0, 100).

It defines that the character specified in the first argument owns the item specified in the second argument.

job(prince, prince, 0, 100).
It defines that the character specified in the first argument has the job named in the second argument.

live-in(king, castle, 0, 100).
It defines that the character specified in the first argument lives at the location or place specified in the second argument.

The last two arguments of each rule signify the initial point and the final point of the time period when the declaration of the rule is valid. A value of 0 means beginning of the story and 100 means its end. By default, each definition is assumed to be valid from the beginning till the end, but it can be set differently depending on how a particular story is progressing.

Additionally, definitions containing two binary functions, *a-kind-of* and *locate-in*, are incorporated in the database. These definitions form an invariant part of the database. In other words, these two functions cannot be invoked in a story.

ako(pumpkin, pumpkin).
It defines the first argument to be a kind of the second argument. Such definitions create a classification hierarchy of characters, items, locations, etc.

locate-in(pen of elephants, castle).
It defines the location or the place corresponding to the first argument to be located at the location or the place named in the second argument. Such definitions declare geographic relations between two locations or places that cannot be moved.

Composition elements

Composition elements are formed as shown in the example below:

```
element (test with shoe,1,X,T,R,STORY1,STORY2):-
   determine character (protagonist, A, X, T),
   determine character (spouse, B, X, T),
   determine character (sister, D, X, T),
   determine character (sister, E, X, T),
   relation (elder and younger, D,E,T),
   relation (master and servant, B, C, T),
   determine character (assistant, C, X, T),
   own (A,H,T),
   concept (H, shoes),
   re-define(DEFINITIONS_OF_CHARACTERS),
   define(DEFINITIONS_OF_CHARACTERS),
   generate text ([STORY1,Relevant_template, character list], STORY2).
```

The first argument of a composition element is a label that serves as its identifier. The second argument contains the index of the original story from which the composition element was extracted. The third, fourth, and fifth arguments contain, respectively, a unified list of characters that are related to any action in this composition element, a temporal step indicating the sequential position where this composition element occurs in the current narrative structure, and the number of times the composition elements that have the same label recurs. The last two arguments contain text outputs.

When any composition element is evoked, its corresponding characters are activated to satisfy each role related to its character settings. Some of these characters are examined to see if they hold any appropriate relation or own any item that is required and that appears in this composition element. If any item appears in this composition

element, the concept or kind of that item is examined. If any part of a character's definition is added or changed, the corresponding setting is defined or re-defined. These determinations, detections, definitions and re-definitions proceed under the current temporal point in accessing the databases 'Setting of characters' and 'General rules'. Finally, a text output is generated from the unified data and the appropriate text templates.

Links between two composition elements

A link is formed when two composition elements are ordered. For example:

Link elements (propose, give presents).

The order of the arguments corresponds to the order of the composition elements. A link can be defined recursively. For example:

Link elements(imitate king, imitate king).

This information is accessed from the module 'Trace links in the structural model' to explore possible progressions of a story. These definitions are randomly ordered when the story generation system is initialized.

General rules

This database contains concept definitions and declarations of commonsense reasoning. These rules are accessed from the module 'Select and set characters', 'Determine composition elements'. Some examples of these rules are as follows:

Concept definitions (reasoning for conceptualization of characters and items)

These rules are used to conceptualize characters and items when composition elements are activated.

Commonsense reasoning (reasoning about familial relations)

This kind of rules is used to determine familial relations such as parent-child, elder sister-younger sister, and spouses, between two characters. Referring to these rules, it is determined which character takes which part. In Cinderella tales, for example, such relations occur frequently.

Narrative rules

This database contains typical rules used in constructing narratives. We incorporated the analysis of Luthi [22], who found that the same motif or episode is repeated by the protagonist often three times in a fairytale with variations and expansions in the details of the situation or setting, by designing corresponding rules. These rules are used by module 'Determine composition elements' and 'Generate text outputs'. Two examples of such rules are:

Rules for repeating a kind of composition elements

This rule allows a composition element to be repeated in a story that is being generated in the system. The repetition depends on the linkages in the structural model because composition elements or sets of composition elements are connected recursively. These rules permit repetitions at most thrice. However, the composition elements of "marriage", "help of fairy", "discovery" and "revelation" are exceptions (they are not allowed to be repeated) because they typically do not occur twice in a fairytale.

Rules for determining items of the same kind but differing in degree

These rules are used to determine items that are of the same kind, but in differ in the degree of some relevant attribute such as expensiveness, beauty, etc. For example, in variations of Cinderella tales, an event corresponding to the protagonist going to a dance often appears three times. He or she wears a general dress the first time, a more expensive dress the second times then the most expensive dress the last time. These three kinds of dress in different degrees are determined referring to the rule that allows repeating the same

kind of composition elements.

Rules for determining items in the same concept and different kinds
These rules are used to determine items which are in the same concept but are of different kinds, for example, a general dress and a robe where each kind is in a concept 'wears' and differ from each other. These rules are often referred to when an assistant who has magical abilities transforms poor items owned by the protagonists into expensive items in certain composition elements.

4.2 Main module

The main module manages all the other modules used in generating stories. The procedure for generating a story proceeds in four main steps: 1) select and set characters, 2) determine composition elements, 3) trace linkages in the structural model and select composition elements, and 4) generate text outputs. The process of selecting and setting characters occurs once at the beginning of generating a story. The process of determining composition elements proceeds by selecting and determining composition elements and forming narrative structure of the story being generated. This process manages the other two processes of tracing linkages in the structural model and process generating text outputs. We designed a module corresponding to each of these four processes. Each of these modules is briefly described below.

Select and set characters
This module selects characters to fill various roles from the database, and makes a list of these characters at the beginning of generating a story. The characters are chosen randomly, or as the original set of any of the analyzed stories. In the case of random selection, the original settings of all the characters in the database are inherited. However, relations between selected characters can change.

While the narration is in progress, this module decides whether a character included in the list of characters and assigned a restricted role under a composition element satisfies the required conditions. Different composition elements often require different arguments to compose consistent components of a story.

Whenever the character settings change, for example if relations between the characters change during the progression of story, this module updates the character settings. This redefinition is processed when an updated definition satisfies the temporal point at which a composition element is currently active.
Fig. 6 shows the internal structure of the module 'Select and set characters'.

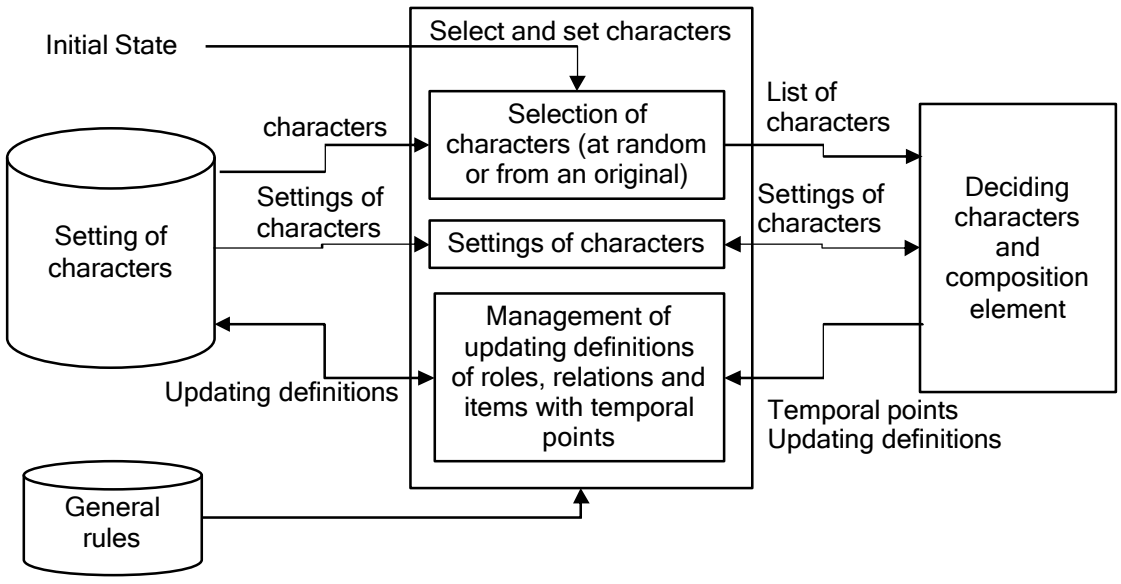

Fig.6 Internal structure of the module 'Select and set characters'

Determine composition elements

This module makes up the narrative structure of the story being generated, determines its composition elements, and indicates sequels of generating story and formation of text data corresponded into the composition elements. These processes are implemented as clauses of the procedure *make_storytrace*:

```
make_storytrace(opening, X, T, List, STRUCT, STORY):-
        link_elements(opening, NextElement),
        make_storytrace(NextElement, X, T, List, STRUCT, STORY).

make_storytrace(ending, X, T, List, List, end):-!.

make_storytrace(CurrentElement, X, T1, List, STRUCT, STORY1):-
        countAppear(CurrentElement, List, 0, R1),
        check_repeat(CurrentElement, R1, RR1),
        element(CurrentElement, ANY, X, T1, RR1, [], BUFF1) ->
                link_elements(CurrentElement, NextElement),
        T2 is T1+1,
        make_storytrace(NextElement, X, T2, [CurrentElement|List], STRUCT,
        STORY2),
        countAppear(CurrentElement, STRUCT, 0, R4)->
        check_repeat(CurrentElement, RR1, R4, R),
        element(CurrentElement, ANY, X, T1, R, [], BUFF4),
        atom_concat(BUFF4,STORY2,STORY1).
```

The first argument corresponds to a composition element that is indicated as a possible candidate. The second argument corresponds to the list of characters set at the beginning of story generation. The third argument corresponds to the temporal point of this step. The fourth and the fifth arguments, respectively, correspond to the list of composition elements that are currently being used to construct the narrative structure, and to the completed structure. The last argument corresponds to the text output of the generated story.

We now briefly describe the process of determining composition elements. First, this module counts how many times the composition element *CurrentElement* occurs in the narrative structure *List* that is being former. Then, it verifies that the number of repetition of this composition element is under the limit specified in the database of narrative rules.

Next, this module activates the composition element *CurrentElement* and determines whether it can occur consistently at this step in the story being generated, referring to the database of general rules and that of narrative rules. This process is repeated recursively as necessary. In case the composition element is found to satisfy all the requirements, the control is passed to the module 'Trace linkages in the structural model' to select a candidate as *NextElement*. Next, the temporal point is incremented and the search for the next composition element is started.

If the search reaches up to the *ending*, the narrative structure of the current story is stored in *STRUCT* and the process of generating text output begins.

First, this module counts how many times the composition element *CurrentElement* occurs in the narrative structure *STRUCT*, and adjusts the index of this composition element in the *STRUCT*. The index of a recurring composition element can take one of three values: first, second, and last. In the case when a composition element occurs once or twice in the completed narrative structure, the index of the last occurrence of the composition value takes the value 'last'. This assignment of index values is consistent with the limit on the number of recurrences of a composition rule as defined in the database of narrative rules.

Next, this module activates the composition element *CurrentElement* and determines whether it occurs consistently in the completed story. This process is repeated if necessary.

Finally, the control is passed to 'Generate text output' module to generate the text corresponding to the sequence of composition elements and the character settings.

Trace linkages in the structural model

This module refers to the database of links between pairs of composition elements and selects composition elements that can possibly occur in the generated story. It also reorders all the link information randomly at the start of each story generation. Finally, it passes a candidate composition element to the module 'Determine composition elements.' Fig. 7 shows the internal structure of this module.

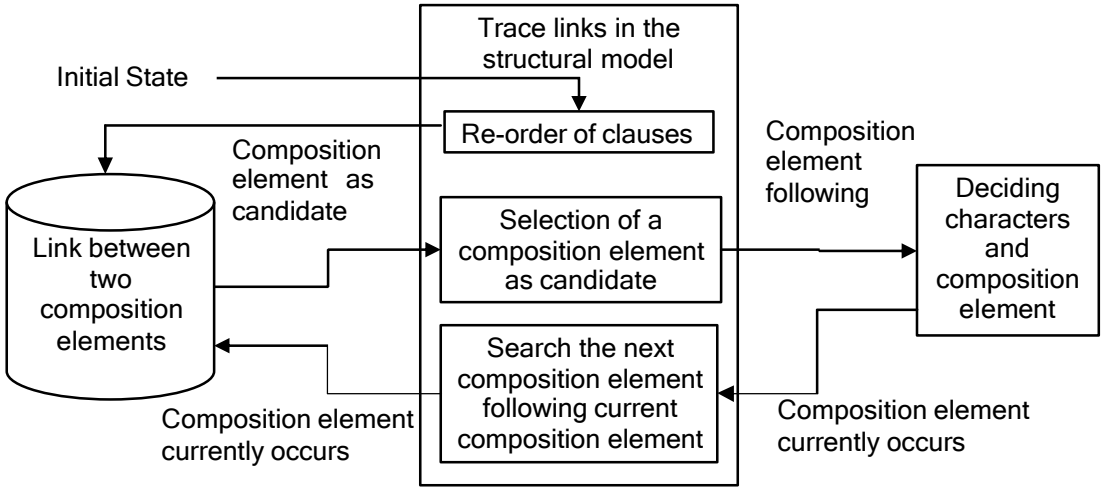

Fig.7 Internal structure of the module 'Trace linkages in the structure model'

Generate text outputs

Depending on the output of the module 'Determine composition elements', this module generates a text containing the relevant parts of the story that are covered by the composition elements. In this process, this module receives information about the characters, items and templates from the module 'Determine composition elements' for generating the text. It also refers to the database of narrative rules for adding narrative characteristics into the text.

4.3 Samples of generated stories

The story-generating system produced variations of Cinderella tales that were not the same as any of the analyzed stories. We provide below two sample stories generated by the system with a sets of characters and an order of composition elements that are combined into each story. Sample story1 is almost the same as one of the original analyzed story (Text08). This story is generated under the restriction that the character settings were the same as in Text08. Sample story2 is a new variation, and is generated with the kinds of roles allowed set to a maximum, and with the characters being selected at random from several analyzed stories.

Sample story1:

The following roles and characters were randomly selected:

[PROTAGONIST, FATHER, MAN, ASSISTANT, ASSISTANT, ASSISTANT, ASSISTANT, SPOUSE, OPPONENT, OPPONENT, OPPONENT].

Set of characters:

[Girl, Trader, Ugly oldman, Oldman, King, Blacksmith, Retainer, Prince, Princess, Queen, Slave]

Order of composition elements:

[desire of fathor, locked, marriage engage to oldman, create candle stand, hide in, sell candle stand, leave from home, buy candle stand, discovery, life with prince, jerous of princess, rent candle stand, burnt, abuse, excile, help of oldman, life with oldman, sick of prince, order to treat, cook gruel,

put ring, discovery of ring, revelation, marriage]

Story (Japanese descripsion):

あるしょうばいにんがうつくしいむすめをもっていました。むすめはあまりにもむすめがうつくしいので、よめにやるきになりませんでした。しょうばいにんはむすめをいえにとじこめて、だれにもあわせようとしませんでした。しょうばいにんはむすめをみにくいろうじんとけっこんさせようとかんがえました。むすめはしょうばいにんにかんがえをかえるようにたのみましたが、しょうばいにんはいうことをききませんでした。むすめはあきらめてしょうばいにんに「おおきなきんのしょくだいをつくってください。そうしたらわたしはしょうばいにんのおよめになりましょう」といいました。しょうばいにんはさっそくおおきなきんのしょくだいをつくりました。しょうばいにんがしごとにでかけると、むすめはいどにくつをおいてじぶんはきんのしょくだいのなかにはいって、とびらをかたくしめました。しょうばいにんがかえってくるとむすめのすがたはどこにもみえません。むすめのくつがいどにおいてあるのをみて、むすめがいどにみをなげたのだとおもいました。しょうばいにんはかなしくてきんのしょくだいをかじやにうってしまいました。あるとき、おうじがけらいをとおりかかりました。おうじはきんのしょくだいをとてもきにいり、かってかえりました。そしてじぶんのおしろにおきました。おうじは、そのうつくしいむすめのところへきて、そのてをとっていっしょにダンスをおどりました。ほかのひとがきても、おうじはけしててをはなさず、ぶとうかいのあいだじゅう、ずっとむすめとだけおどりつづけました。おうじはむすめをとてもすきになりました。おうじはつぎのひもまた、むすめがあらわれるのをベッドのなかからみていました。みっかめのよるにむすめがでてくるとおうじははねおきてむすめをつかまえました。おうじは「おまえはまものか、それともようせいか」とたずねると、むすめは「わたしはにんげんのおんなのこです」とこたえ、これまでのことをすべてはなしましたました。そうしておうじとむすめはなかよしになり、むすめは、ひるまはきんのしょくだいにかくれ、よるなるとでてきておうじとたのしくすごしました。ところがあるよる、おうじとむすめがおしろでたのしくはなしているのを、とおりがかったどれいがみみにして、なかをのぞくと、むすめがきんのしょくだいのなかにはいっていくのをみました。そしてどれいはおうじのこんやくしゃであるひめに、このことをつたえました。ひめはとてもおこりました。あるひ、おうじがかりにでかけてきゅうでんをるすにしました。ひめはおうじのははぎみに「きょうはわたしのところにきゃくがあるので、どうかきんのしょくだいをかしてください」とたのみました。ははぎみはおうじがきんのしょくだいにだれもさわらせないことをしっていたので、ことわろうとしましたが、ひめがくりかえしたのむので、ついにきんのしょくだいをかしてあげました。ひめはきんのしょくだいに 40 ほんのろうそくをたて、すべてにひをつけました。ろうそくのほのおできんのしょくだいのなかはだんだんとあつくなり、むすめはがまんしきれずにとびだしました。むすめはからだじゅうにやけどをおって、そのままきをうしないました。ひめはむすめがしんだとおもい、どれいにめいじて、むすめをきゅうでんのほりにすてさせました。そこへまずしいろうじんがとおりかかると、どこからかかすかなうめきごえがきこえてきました。ろうじんはむすめにきがついて、たすけだしました。そして、いえにつれてかえり、やけどにくすりをぬってあげました。ろうじんはむすめをかわいそうにおもい、やしなうことにしました。おうじがかりからもどってみると、きんのしょくだいはありましたが、なかはからっぽになっていました。おうじはむすめがいなくなったことをとてもかなしみ、とうとうびょうきになってしまいました。おうじは 40 にちのあいだくすりもたべものもとらず、ねたきりになりました。くにじゅうのいしゃがおうじをみましたが、だれもなおすことはできませんでした。あるとき、こまりはてたおうに、けらいが「おうじさまのやまいは、すきなひとのかおをみるまではなおらないでしょう」といいました。おうはそれをきいて「かねもちも

まずしいものも、みぶんのたかいものもひくいものも、すべてのものはりょうりをひとしなつくり、おうじのもとへじさんせよ」と、くにじゅうにめいれいしました。そうしてあらゆるひとがりょうりをもってきましたが、おうじはどれひとつとしてたべようとしませんでした。ろうじんがおかゆのおたっしのことをはなすとむすめはおかゆをつくりました。そしてむすめはおかゆをみすぼらしいうつわにいれて、おうじにもらったきんのゆびわをいれると、ろうじんにきゅうでんにもっていかせました。まずしいろうじんがみすぼらしいうつわをもってきたのをみると、みながあざわらいました。しかしおうじは、おかゆをみるとしょくよくがわいてきて、たべはじめました。おかゆはとてもおいしくて、おうじはすべてたいらげました。するとうつわのそこにきんのゆびわがはいっていました。おうじはとたんにげんきになり、すぐさまろうじんをよびよせて「おかゆをつくったのはだれなのか」とといただしました。ろうじんは「うちにいるむすめがつくりました」とこたえ、ろうじんはむすめのことをすべてはなしました。そうして、むすめはおうじとけっこんしました。おしまい

(Abridged translation):

There was a Girl and she was beautiful. Father desired Girl. Father locked Girl in the house and engaged her to an Ugly oldman. Girl asked Father to make a big gold candlestand. Girl hid in the candlestand. Father lost Girl and sold the candlestand to a Blacksmith. A Prince bought the candle stand from Blacksmith. Prince discovered Girl in the candlestand. Girl and Prince lived in the Prince's room. Princess found Girl and asked Prince lend the candlestand. Princess ignited candles and burnt Girl. Princess exiled Girl. An Oldman found Girl and helped her. Girl lived in the house of Oldman. Prince became sick. King ordered people to cook for Prince. Girl cooked gruel and hid the ring Prince gave her into the gruel on the plate. Oldman brought Prince the plate. Prince ate gruel and found the ring. Girl was found by Prince and they were married.

Sample Stpry2:

The following roles and characters were randomly selected:
[PROTAGONIST, STEPMOTHER, WOMAN, FATHER, SISTER, SISTER, ASSISTANT, ASSISTANT, ASSISTANT, SPOUSE, OPPONENT, MAN].

Set of characters:

[*Cinderella, Stepmother, Queen, Father, Younger sister, Elder sister, Kusha-Rakan, Ministor, King Bob, Prince, Pirates, Rich man*]

Order of composition elements:

[*remarriage of father*] [*jealous of stepmother*] [*cut hair*] [*paint tar*] [*harsh work*] [*bathing*] [*discovery*] [*marriage*]

Story (Japanese description):

シンデレラというおんなのこがいました。あるとき、ちちはままははとさいこんしました。ままははとてもこうまんちきなおんなのひとでした。ままははシンデレラがうつくしいのにやきもちをやき、かみをきり、かおにタールをぬって、かちくのせわをさせて、ひどくはたらかせました。シンデレラはかちくにえさをあげたあと、おがわでみずあびをしていました。やがてシンデレラとおうじはけっこんしきをあげました。シンデレラはまた、あねたちもまた、だいきぞくとけっこんさせました。そうしてしあわせにくらしました。おしまい

(Translation):

There was a girl named Cinderella. One day, her Father married a Stepmother. Stepmother was very arrogant. Stepmother feeling jealousy towards Cinderella, cut her hair, painted her face with tar, and ordered harsh work. Cinderella bathed after working. Cinderella married a Prince. Cinderella arranged her sisters to marry with nobles.

5. Discussion

The story generating system produced new variations of Cinderella tales based on the structural model. Depending on the combinations of conceptual structures and narrative structures that the system chose, it produced some stories that were similar to the analyzed stories, but also some that were quiet different. When attempting to generate stories with characters that appeared in an original story, conceptual structures become closely constrained by the characters and by the composition elements from the original story. In the case of random selections, the conceptual structures are not so constrained. As one might expect, we found that more stories similar to the originals were generated in the former case than in the case of random selections.

Given the variety of narrative structures in generated stories, we consider that the number of composition elements and the linkages among the composition elements implemented in the structural model are sufficient for generating variations of Cinderella tales. However, as the character settings and relations among them are inherited from the original stories, relations among the characters and between characters and items are sometimes inconsistent. Thus, the system sometimes produces inconsistent combinations between some kinds of composition elements and sets of characters, and story generation under these conditions fails.

One way to resolve those kinds of inconsistencies is to add a possibility to redefine the settings of characters and relations between them at any activation of composition elements. However, relaxing this constraint may also weaken the cohesiveness of the structural model, thereby making it possible to generate stories that may not be considered a Cinderella tale at all.

Using composition elements has the potential to facilitate regenerating text outputs and expanding the structural model. A complex story can be divided into parts regarded as composition elements. Then the information about the settings of characters and the linkages between composition elements can be determined. Finally, one can incorporate the complex data into the structural model without having to conceptualizations in terms of narrative grammars and theories.

Another problem occuring in the current implementation of the story-generating system is that it sometimes generates strange stories because of juxtaposing unrelated composition elements. For example, a protagonist and the spouse may be married suddnly after their meeting. This problem may be resolved by introducing appropriate rules to constrain the possible places in a sequence that a composition element is able to occupy.

6. Conclusions and Future Research

We created a structural model of Cinderella tales that was composed from three kinds of information: settings of characters, composition elements and linkages between two composition elements. Narrative structures were made from composition elements ordered linearly, and conceptual structures provided settings of characters and composition elements. Based on this structural model, we implemented a story generating system that produces variations of Cinderella tales. Modelling of conceptual and narrative structures focussing on motifs and composition elements allows for ease of implementation and explanation.

We consider the structural model developed in this research is as a network model and also a state transition model. Taking this point of view, we plan to design an interactive system to generate stories between two computational systems or between a computation system and a human. Based on the rules which decide appearance of composition elements, it is also possible to introduce models of objective authoring into the story generating system. Many story-generating systems, including the current version of our system, determine conceptual and narrative structures that compose a new story from subjective characters in the story. However, functions with models of objective authoring cause the story generation task to let the conceptual structures and narrative structures proceed in parallel and influence each other.

References

[1] J. Campbell (with Bill Moyers), *The power of myth*. Doubleday New York,1988.

[2] M. Bal, *Narratology: Introduction to the theory of narrative.* Univ. of Toronto Press, Toronto, 1997.

[3] S. Chatman, *Story and discourse: Narrative structure in fiction and film.* Cornell University Press, Ithaca (NY), 1978.

[4] M. Currie, *Postmodern narrative theory.* St. Martin's Press, New York, 1998.

[5] W. Martin, *Recent theories of narrative.* Cornell University Press, Ithaca (NY), 1986.

[6] V. Propp, *Morphology of the folktales.* University of Texas Press, Austin, 1968.

[7] R. R. Lang, A declarative Model for Simple Narratives. *Narrative Intelligence Symposium: AAAI Fall symposium Series, 1999.*

[8] D. E. Rumelhart, Notes on a Schema for stories. In D.G. Bobrow and A. Collins (eds.), *Representation and Understanding,* Academic Press, New York, 1975, pp.211-236.

[9] R. C. Shank and R. P. Abelson, *Scripts, Plans, Goals and Understanding.* Lawrence Erbaum, Hillsdale (NJ), 1977.

[10] N. Szilas, IDtension: a narrative engine for Interactive Drama, *1st International Conference on Technologies for Interactive Digital Storytelling and Entertainment (TIDSE 2003)*, Darmstadt, Germany, 2003.

[11] M. Riedl, C. J. Saretto, and R. M. Young, Managing interaction between users and agents in a multiagent storytelling environment, *the Proceedings of the Second International Conference on Autonomous Agents and Multi-Agent Systems*, June, 2003.

[12] C. Prrrault, Contes de Perrault, In A. Niikura (translated in Japanese), Perrault's fairy tales, Iwanami, Tokyo, 1982.

[13] J. Grim and W. Grim, Kinder and Hause Marchen, In K. Kaneda (translated in Japanese), Grimm's fairytales, vol.1, Iwanami, Tokyo, 1979.

[14] S. Yamamuro, Cinderella tales in the world, Shinchosha, Tokyo, 1979.

[15] Society of a Japanese folktales authored, 100 tales of Japan, Kokudo-Sha, Tokyo, 1986.

[16] M. R. Cox Cinderella: Three Hundred and Forty-five Variants of Cinderella, Catskin, and Cap O'Rushes, Abstracted and Tabulated, with a Discussion of Mediaeval Analogues, and Notes, David Nutt, London, 1893.

[17] A. B. Rooth, The Cinderella Cycle, Greerup, Lund, 1951.

[18] Y. Hosaka and T. Ogata, Generation of Stories and their Visual Representation, *The 16th Annual conference of Japanese Society for Artificial Intelligence*, 2002.

[19] S. Kawakami *et al.*, A Story Making System for Children, Advanced research in computers and communications in education, G.. Cumming *et al.* (eds.), IOS press, Ohmcha, 1999, pp.359-362.

[20] A. Aarne, THE TYPES OF THE FOLKTALE - A CLASSIFICATION AND BIBLIOGRAPHY, translated and enlarged by Stith Thompson A.Aarne's "Verzeichnis der Marchentypen" FF Communication No.3 Second Revision, Helsinki, 1964, FFC No.184.

[21] K. Seki, Japanese folktales, vol. 1, vol12", Kadokawa, Tokyo, 1979.

[22] M. Luthi, Folktales of Europe, In T. Ozawa (translated in Japanese), Iwasaki Bijutsu-sha, Tokyo, 1969.