Storytelling Ontology Model using RST

Arturo Nakasone and Mitsuru Ishizuka
Dept. of Information and Communication Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo Ku, Tokyo 113-8656, Japan
arturo@mi.ci.i.u-tokyo.ac.jp *ishizuka@i.u-tokyo.ac.jp*

Abstract

Storytelling applications are increasingly being used and researched due to the fact that they are capable of conveying information and experience to users in a more natural and familiar way for them. The range of developed applications increases as we realize new ways to present content as stories or "sequences of narrative significant events". Nevertheless, implemented storytelling models are usually constrained to a particular application because of the nature of the narrated events and the way those events are linked. In order to develop a more generic model to create storytelling applications, we need to focus the solution on the manner the content is organized and conveyed to the user.

We present our proposal for a generic storytelling ontology model based on the organization of events using the relations proposed by the Rhetorical Structure Theory (RST) and how narrative principles are applied to these RST relations to generate coherent stories.

1. Introduction

Throughout the course of our lives, we are constantly incorporating experiences to enrich our personality. These experiences, perceived in the form of world events, are organized by our minds, so we can better grasp their significance. Narrative construction through stories helps us not only to organize these experiences, but also to communicate them to others. In this context, stories are unique sequences of events, mental states, or happenings involving human beings as characters or actors [3].

The notion of "story event" is defined in several ways, each one to suit a particular way to deliver the intended message to the audience. Events can be represented as plain text, speech with intonation features, video fragments, or multimedia content based on web technology. Storytelling models are usually constrained to a particular application due to the nature of these events and the way they are linked to one another. Most applications rely on the content of the event to describe a story, and its inherent temporal property to construct it. This tight coupling between content and temporality makes it very difficult to use or even adapt the model to other domains due to its inherent complexity. On the other hand, most applications rely on the temporal relation of events to convey a narrative experience, but in most cases, this experience is predetermined, either by defining event by event sequences or by grouping events with similar space and temporal properties and defining group by group sequences. In order to develop a more generic model to create storytelling applications, we need to focus the solution not on the content itself, but on the manner the content, in the form of events, is organized and how this organization can be conveyed to the user in the context of a narrative experience.

In this paper, we present our proposal for a generic storytelling ontology model based on the organization of events using the relations proposed by the Rhetorical Structure Theory (RST) [14] and how narrative principles are applied to these RST relations. This work is an extension of a work presented in [17].

The rest of the paper is organized as follows. The next section will present related work on storytelling application from the point of view of events. Section 3 discusses our approach to a generic storytelling model based on ontology classes and narrative rules. Section 4 presents the current implementation of our web based application that uses annotated data from the ontology. Finally, our plans for future research topics and a summary will conclude the paper.

2. Related Work

Even though storytelling applications were mostly oriented to text generation in the beginning, the range of applicability of storytelling has increased due to the ubiquitous presence of communication networks such as the Internet, and the availability of multimedia content. The lack of a suitable way to present such rich content to different kinds of users has motivated researchers to focus in storytelling principles and techniques as the most appropriate tools for the job.

Most researchers assume a concept of "event" in order to organize the content of their storytelling applications, and therefore, have developed methods to deliver such events using narrative techniques. Based on these techniques, storytelling applications can be classified as:

Rule based: Events are concatenated based on predefined logic rules that take into account current event status and historical information in the form of facts. Tarau and Figa [30], and Crawford's Erasmatron [7] are good examples in this category.

State Transition based: Events are defined as states that specify the current situation in a particular point of the story. Bayesian Networks, Finite State Machines, and their variations are commonly used. In this category we can find the research works of Gebhard et. Al. [8], Mott and Lester [16], Swartout et. Al. [27], Silva et. Al. [24], and Magerko et. Al. [13]

Goal based: To construct a story, a goal event(s) is established as the final outcome of the story. From a set of initial conditions, a story is unfolded by the sequence of events that are needed to reach such goal event. Planners and their variations are commonly used for these applications. Research work based on the Mimesis Architecture [32], Callaway and Lester [4], Cavazza et. Al. [6], and Szilas [28], are good examples in this category.

Permutation and Template based: Events are selected from template stories and permutated to create new narrative experiences. In this category, we can reference the work of Ong et. Al. [18], Gervas et. Al. [9], Wolff et. Al. [31], and Sobral et. Al. [25].

Script based: Stories are scripted using a high level language. The application, then, present the events in the way specified by such scripts. In some cases, some narrative or dramatic effects are applied during the event transitions. The research works of Rocchi and Zancanaro [21], Andre et Al. [1], Sgouros et. Al. [23], and Sumi and Tanaka [26], are considered in this category.

Semantic Inference based: Applications in this category create stories based on a network of semantically organized events. The most common organization is based on RST. In this category we can find the works of Callaway et. Al. [5], Geurts et. Al. [10], and Little et. Al. [12].

Emergent Narrative based: These kinds of applications do not really enforce any story or narrative principles, but give the users the appropriate tools to create their own stories based on their social interactions inside a play. The work of Paiva et. Al. [20] is a good example in this category.

Narrative Function based: Applications in this category make use of a special narrative function that tries to enforce narrative principles in the context of the whole story. Therefore, event sequencing is constrained not only by direct event relations, but also by its contribution to the overall narrative experience. Szilas's IDTension engine [29], and Mateas and Stern's Façade [15] are the most interesting examples.

3. A Generic Approach to Storytelling

In the majority of the research works presented above, the method applied to construct stories was implemented because of the selected event definition and vice versa. Even though the results obtained in these applications are mostly impressive, this cohesion of concepts makes the task of adapting these models to other domains extremely difficult. Therefore, a model in which event definition and sequencing are separated is necessary to guarantee its generic attribute.

Events in the world are not isolated, but interconnected by some kind of relation between one another. Even though each event itself is meaningful in its content, the relations between events are what make these events meaningful in the context of a story. Semantic relations imply not only a relationship of meaning, but also a relationship of temporality through the use of rhetorical extrapolations, giving us enough flexibility to create stories, regardless of the type of events.

Semantic Inference based applications take this idea into account, but they only deal with a very limited set of relations and, in most cases, without analyzing the narrative consequences that each relation has in the context of the story.

In this section, we will present our approach to define a general ontology model for storytelling based on semantic RST relations. We will define not only how RST relations are referenced in the context of stories, but also how narrative properties are enforced by the proper use of these relations.

3.1. The Conceptual Aspect: what the Story is about

Even though stories are commonly referred to as "sequences of events", they are always developed in some particular context or around a particular topic. When we talk about stories, we need to convey to the user not only a general sequence of isolated events, but also a series of interconnected ideas that will evolve as a knowledge pattern inside our memories. Using storytelling to convey this complex mesh of ideas is what gives storytelling methods and properties their true value [7]. Therefore, our generic ontology must support a concept representation model that can reflect not only this complex organization of ideas but also a way to convey them through narrative channels.

In our model, a Concept Ontology is defined as a networked organization of issues, which are connected through directed links, showing a traversing path from one concept to the other. Figure 1 shows the representation of a concept ontology. In this representation, each node is defined as a Concept or "a particular theme a story or part of it may talk about", and each link is defined as "a directed relation that defines the dependency between the two connected concepts".

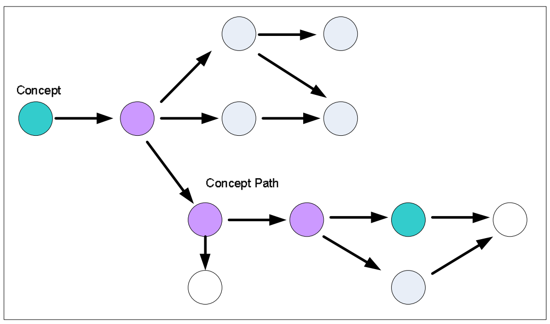


Figure 1: Concept Ontology Representation

A Concept in our model reflects not only a topic in which a story may be based, but also a topic in which "part of a story" may be based. When a story is fully constrained to talk about one particular topic, only one node in the Concept Ontology is referred; but when a story spans several topics, a smooth transition through the use of links between concepts ensures a fluid narrative experience. Even though links only specify a requirement relation between two concepts (i.e. the telling of one concept must precede the telling of the other), it also gives a pseudo-temporal relation since concepts are conveyed through linear narrative channels.

The main advantage of this model is that this sequenced organization of issues allows users to construct fluid and coherent stories based on the selection of a few key concepts. When a user specifies the key issues the story will be constructed around, the storytelling model engine automatically selects other concepts that must be included in other to have a fluid story. Even though a path might not be found, the engine makes sure that transitions between concepts be as smooth as possible.

3.2. The Semantic Aspect – how the Story is organized

In every story, Events are related to one another with some kind of relation. From the very definition of story, we can extract the most common one: diachronicity [3], which means that events have a temporal relation between them. In most story construction paradigms, this relation is taken for granted and researchers have enriched this temporal synchronization of events by modifying the mechanisms by which events are concatenated.

Nevertheless, temporal relations are only one aspect in the story construction process. Temporal relations between events refer to the fact that narrative channels of communication are linear and, therefore, the only way to transmit these events is through the use of a time-sequenced pattern. Actually, stories in our minds are much more than a linear definition of events. Stories are "complete patterns that communicate a special kind of knowledge to our pattern recognizing mental module" [7]. Since these patterns are present in our minds as a web of interconnected events, it is clear that such connections deal with much more complex relations than the temporal ones.

Natural text is one of the oldest ways to transmit a story and has been extensively analyzed in order to discover which rules govern its generation not only in terms of text organization, but also in terms of narrative characteristics. From a semantic point of view, rhetorical theories have provided us with the most useful insight on which kinds of relations can be found between pieces of text in a narrative. Moreover, it can be stated that rhetorical relations reflect not only semantic relations between pieces of text, but also between ideas, concepts, and events in a broader sense. Relations such as CAUSE (i.e. one event is the cause of another) or BACKGROUND (i.e. one event serves as background information for the other) that can be inferred from a text reflects not only the rhetorical organization of the text, but also the meaning that the events linked by these relations have in the mental story pattern of the author.

Hence, we have defined the relations between events as rhetorical in order to accurately reflect this story pattern in our model. By defining only the relations between events and not the events themselves, we were able to enforce the generic attribute of the storytelling ontology model. The set of rhetorical relation definitions was taken from the Rhetorical Structure Theory (RST) proposed by Mann and Thompson [14]. Nevertheless, we have taken only a subset which holds the most interesting characteristics in terms of narrative contribution.

3.3. The Ontology Model

Considering the conceptual and semantic aspects described above, we propose an OWL based ontology model [19] that deals with the generic aspects of storytelling. The classes in this model were defined taking into account the many different definitions that researchers gave to their story components, but associating each class with a more general meaning that encompasses all those different definitions. Each class has a purpose in the context of story pattern organization, either to define a specific story component or a property of such component. The classes defined for this version of the ontology model are:

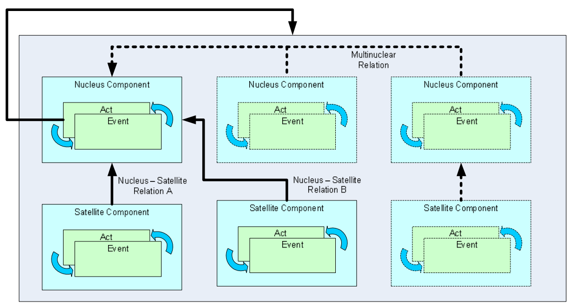


Figure 2: Act Structure Diagram

<u>Concept</u>: A Concept defines a specific topic that a story or part of it may refer about.
<u>Event</u>: An Event is defined as a single piece of meaningful information worthy of being shown. Due to the generic property of the model, an Event can hold a reference to piece of text, video clip, image, game scene, character scripts, etc.
<u>Relation</u>: A Relation is a rhetorical binding between two entities, which refers to a specific rhetorical function. As specified in RST, entities in a Relation can be both Nucleuses (which is defined as a Multinuclear Relation Type), or a Nucleus – Satellite pair (which is defined as a Nucleus-Satellite Relation Type)
<u>Act</u>: An Act is defined as a hierarchical structure composed of Nucleus and Satellite entities, joined by Relations. This class describes the minimum level of story organization in which a story may arise. An Act is a recursive structure, which means that Nucleus and/or Satellite entities can contain an Event or another Act object. Figure 2 shows the structure of an Act.
<u>Scene</u>: A Scene is defined as a set of Acts, which are grouped in the context of a single Concept.
<u>Agent</u>: An Agent is an actor that takes part in a Scene by executing or being part of one or more Events.
<u>Role</u>: A Role is a part that an Agent plays during a Scene.

3.3.1. Scene and Act Relationship. In the ontology model, we have made a clear distinction between semantically organized events and conceptually organized events. Even though relations and concepts are indivisible properties in any story, this separation has been established to emphasize the fact that similar conceptually organized events can have different semantic organization to express, either the same content or a different content related to the same concept. For instance, if we were to define the Concept "ARRIVING LATE TO WORK", we could express the idea of this concept by using these two different semantic organizations of events:

- It was raining, THEREFORE, I missed the train (CONSEQUENCE relation)
- I missed the train, BECAUSE it was raining (CAUSE relation)

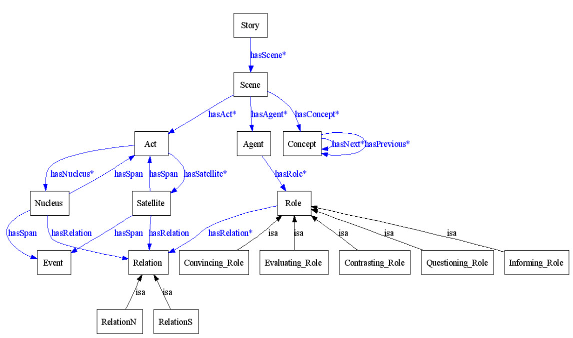
Despite the fact that we used the same set of events, the relations used to join them are different in each case and, therefore, the impression about which event is more important to a user changes accordingly.

3.3.2. Act, Nucleus, and Satellite Relationship. An Act represents the basic structure in which nucleus and satellite components are connected through relations. Even though the model is flexible enough to allow an unlimited number or nucleus and satellite components connected to each other, this structure is constrained in our current implementation to allow the creation of: (a) purely multinuclear relations of the same type, or (b) a single nucleus with one or more satellites with the same or different type of relations. This is due to the fact that in this version of the ontology we are dealing with events in the form of texts which are to be uttered by an Agent. As more narrative domains are analyzed, other combinations in the Act structure will be considered in the model. For a better understanding on the concepts of nucleus and satellite in rhetorical relations, refer to the work of Mann and Thompson on RST [19].

3.3.3. Scene, Agent, and Role Relationship. In every Scene, Agents are specified as character entities that either present the content of Events or take part during the execution of Events as actors. Since not every Agent can be part of every Event inside an Act/Scene, the Role object is associated with every Agent and defines in which kind and on which side of Relations it may intervene. Although the Role objects depend on the kind of application in which the ontology is used, we have predefined five roles in our model that identifies and groups the main characteristics of the selected RST relations in terms of narrative relevance. The predefined roles for our model are:

- <u>Questioning Role</u>: The Agent will receive the information contained in the relation will be conveyed to. (e.g. Nucleus of SOLUTIONHOOD)
- <u>Informing Role</u>: The Agent will convey the information contained in the relation (e.g. Satellite of SOLUTIONHOOD)
- <u>Contrasting Role</u>: The Agent contrasts information of one side of the relation with another (e.g. Satellite in CONTRAST)
- <u>Convincing Role</u>: The Agent gives a convincing explanation about the information contained in a relation (e.g. CAUSE)
- <u>Evaluating Role</u>: The Agent states a final conclusion or assessment in a relation (e.g. EVALUATION)

The complete diagram of the ontology is shown in Figure 3.



3.4. The Engine – Adding the narrative component

The Ontology model described above gives us the class definitions to construct a story organization based on common and general story components. In this section, we will talk about the rules by which a story construction takes place considering not only the predefined story organization, but also the narrative principles that will guide the process.

Based on Jerome Bruner's work on narrative and its characteristics [3], we have devised general rules and concepts that introduce narrative quality to the storytelling process. We will specify the most important narrative principles, as well as the way in which they are implemented in the system.

<u>Diachronicity</u>: As explained before, the use of the Concept Ontology provides us with a pseudo-temporal organization for Scenes and Acts.

<u>Intentional State Entailment</u>: This principle states that every actor must have a set of beliefs and intentions that gives coherence to its performance in a narrative. The basic idea of implementation of this concept is through the Role class.

<u>Hermeneutic Composability</u>: This principle defines how Events shall be put together in order to constitute a narrative. In our engine, the story construction process is centered in the notion of Conflict, defined as an imminent change on the current state of affairs [2]. Based on this concept definition, the most suitable RST relations to introduce a Conflict are:

- CONTRAST: Provides a direct and confronting comparison between 2 events. This is the strongest form of Conflict.
- SOLUTIONHOOD: Provides a way to change the current unknown state with the solution of a stated problem or question.
- ELABORATION: Provides a way to change the current partial known state with detailed information that helps clarify the situation
- CONSEQUENCE: Provides a way to change the current state by providing an automatic event fired with the current situation.
- SEQUENCE: Provides a way to change the current state by providing a different aspect of it. This is the weakest form of Conflict.

These relations are defined as Conflict Relations. Since not every conflict relation has the same value when selecting a conflict, a numerical value is assigned to each conflict relation to show its importance. This value is defined as the Conflict Weight Value or CWV. The rest of the relations in our model are defined as Resolution relations, since they will provide the events to successfully resolve the conflicts presented by the Conflict relations.

Given that a general story is constructed around a Conflict and its resolution [2], we created the following story template, based on this schema and how RST relations fit into the conflict and resolution phases.
For each story constructed inside the scope of an Act, the following relations have to be considered in this specific order when available:

- Background Information
- Conflict Presentation. According to the CWV for Conflict Relations, conflicts will be created in a way that weaker conflicts will come first. Therefore, the order for conflict presentation in any level of the Act tree will be: Consequence, Elaboration, Solutionhood, Contrast, and

Sequence (even though sequence information is the weakest form of contrast, it must be solved last since it implies a change of aspect in the context of the Act)

- Conflict Resolution. This is achieved when the information on the other side of the relation is stated. Any relation specified in the set of Resolution relations may be used. In order to build up narrative tension, relations must be chosen following this pattern:
  - Context Explaining Nodes (Circumstance, Purpose)
  - Multinuclear / Temporal Nodes (Content Explaining Nodes)
  - Result Nodes (Result, Cause)
  - Presentational Nodes (User's belief alteration nodes)
- Restatement or Evaluation. If both are available, the Evaluation relation will come first, since it is assumed to contain more narrative tension that the Restatement relation

4. Current Implementation

In this section, we will explain about the different modules that integrate our web based application used to test our ontology model. The design diagram for our application is shown in Figure 4. The application was implemented using .NET technology, Visual C#, and Java and consists on 3 main modules:

Text Services: The Text Services Module is the module that is in charge of dealing with text processing and format conversions into the input needed by the system. Since creating the OWL text data can be a cumbersome process, this module facilitates the work of creating these files by processing LISP formatted files obtained with the RSTTool [22]. Even though the RST annotation process must still be done with this tool, the conversion process into OWL files is greatly simplified.

Visual Services: This module deals with the presentation of the OWL annotated content and acts as the interface of the application.

OWL Services: This module acts as a proxy between the OWL Reasoner module (in this version of the application, a reasoner called Kaon2 [11] has been used due to its simple interface) and the Visual Services module. It is in charge of loading the ontology definitions and data into the reasoner, and retrieve events based on the narrative rules specified by the ontology. Since this module maintains the whole status of the story at any moment, it can be deployed using any visual interface through a socket connection.

5. Conclusion and Future Work

In this paper, we have presented our proposal for a generic storytelling ontology model based on the organization of events using the relations proposed by the Rhetorical Structure Theory (RST). We have taken into consideration the most important story components and narrative rules to be included in the ontology. Nevertheless, since our model is based on rhetorical relations that come from natural text analysis, definitions like the Act class structure are still constrained to this textual domain. In order to refine our storytelling ontology model, we will study the following issues regarding class organization and user interactivity.

Class Organization Issues:

Even though the model was designed as generic as possible and taking into account all the different contributions from other works, there are some other elements that are part of stories that were not considered for this version. Elements such as Location or Stage (see [9]), and Props (see [7]) will be tested to see how their contribution affects the narrative rules in the model.

Given the textual constraint of the Act class structure, a new alternative will be analyzed to consider multinuclear – multisatellite relations. Since this analysis goes beyond the textual domain, our most immediate concern will be how this new structure may affect event relations and its impact on the narrative generation rules.

Interactive Storytelling Ontology Model:

Aside from making a complete ontology model for storytelling, our research is also focused on the interactive aspect of it. Therefore, we will analyze how a user model can be implemented into this generic framework. Although most user model information depends on direct input received by the storytelling applications, our analysis will concentrate mostly on interaction that is non intrusive, like interest measurement.

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