博士学位請求論文

A Storytelling Model based on Semantic Relations and Interest Interaction

意味的関係と興味に準じる交流に基づく物語生成法

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Abstract

In a general sense, stories are defined as unique sequences of events, mental states, or happenings involving human beings as characters or actors. Any properly constructed story always aims to deliver a particular message to its audience, and the content of this message is commonly conveyed through discrete pieces of information, referred to as events, so that users can assimilate the story in a more convenient and orderly way. Nevertheless, a story is not only defined by its content, but also by the manner this content is presented. Even though the information that defines the content of a story can be fixed, several different "told stories" may arise depending on how such information is sequenced. Storytelling is, in other words, the process by which content is conveyed to the audience in order to maximize not only its attention, but also its understanding and eagerness, and researchers have created extremely complex applications to enhance not only the manner a story can be told, but also the manner users can enforce their preferences in content presentation through interaction.

In this context, interactive storytelling (IS) models, either implicitly or explicitly, have had to deal with three major aspects in their implementations, regardless of their technology: (1) how to define events, i.e. the pieces of information that constitutes the content of any story, (2) how to present events, i.e. the algorithm that is used to convey this content to the user, and (3) how the user is to interact with the story, i.e. the variables that the user can modify in order to change the presentation of the events in content or in order. The majority of IS implementations encode in their definition of story event timing information (the range of time specified in terms of the story timeline in which the event must be presented) and interaction variables associated with that predefined timing. This approach is convenient for story presentation, but presents several restrictions in terms of story understanding if events are not adequately organized, and story dynamism since it leaves story algorithms with little or no manipulation ability to arrange the events taking into consideration the narrative appeal to the user. In this thesis, I present ISRST (Interactive Storytelling Model using RST), my proposal for a storytelling model based on the organization of generally defined events using a subset of rhetorical relations proposed by the Rhetorical Structure Theory (RST) and the application of narrative principles and user interaction through interest to generate appealing stories.

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Dedication

First and foremost, to God, for He guided me throughout all these years of hard work and dedication. Let the glory of this work be to Him only.

And to my parents and my sister, whom I love dearly, for their constant support through my entire career … Thank you very much.

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Chapter One: Introduction

In a general sense, stories are defined as unique sequences of events, mental states, or happenings involving human beings as characters or actors [Bruner 1991a]. Although the events in any story refer to situations located in the past, present, or future with respect to the content of the story itself, the narrated events themselves always refer to situations located in the past with respect to the reality experienced by the audience of the story [Labov 1997]. It is true that, in most cases, stories' protagonists are human beings; however, a set of situations that could happen to characters that are not human or even animated may be considered a story in a full sense as long as the actions that are described in such story reflect some degree of intentionality from the audience's point of view. Any properly constructed story always aims to deliver a particular message to its audience, and the content of this message is commonly conveyed through discrete pieces of information, referred to as story events, so that users can process the story in a more convenient and orderly way. In this context, a story event is defined in several different ways, each one to suit the particular channel that a story uses to deliver its intended message. Events can be represented as plain text ([Figa and Tarau 2003], [Silva et Al. 2003], [Sumi and Tanaka 2005a]), scripted individual character actions [Gebhard et Al. 2003], story world states ([Magerko and Laird 2003], [Magerko and Laird 2004], [Szilas 2003]), or multimedia content ([Callaway et Al. 2005], [Rober et Al. 2006]), and the choice on which one is the most appropriate for a specific story will depend not only on the technology used for the storytelling application, but also on the level of sophistication granted by the story teller to his or her creation.

Nevertheless, a story is not only defined by its content, but also by the manner this content is presented to its audience. Even though the events that define the content of a story can be fixed, several different "told stories" may arise depending on how such events are sequenced.

Storytelling is, in other words, the process by which some content in the form of events is conveyed to the audience in order to maximize not only its attention, but also its understanding and eagerness. In this context, storytelling models define four aspects that allow them to fulfill the expectation of a well constructed story in its intended set of users:

- Event Definition: This aspect deals with the type of content an event will be allowed to support. Most storytelling models make use of a scheme that highly depends on the objective of the application and the technology used in its implementation.

- Event Organization: Even though stories are linear by nature, events in a storytelling model are mostly not organized in that way. The purpose of an event organization is to have an ordered and flexible manner to store events in a story, but also to reflect the different hierarchies that may exist among different events that refer to the organization of the story as a whole. For instance, in spite of the fact that stories are composed of events, stories normally have a more detailed structure that give the grouping of their events a logical coherence in terms of situation similarity, context reference, or topical issues.

- Event Sequencing: This aspect deals with the process of conveying the story events to the user in a coherent and appealing way. This is the most important aspect in any story telling, since this alone determines the effectiveness of the storytelling model as a tool for content understanding and interest enhancer.

- Event Interaction: Although this aspect was not considered an essential one, the advancement of the technology has made it an indispensable component in any modern storytelling model. It refers to the way in which a user may interact with the story itself in order to alter its shape, either in content or in sequencing. The first storytelling models did not consider such possibility feasible due to the restrictions in hardware and communication protocols. As these technological restrictions were lifted, storytelling models had the opportunity to generate extremely sophisticated stories by allowing their users to interact in several, albeit obtrusive, ways. This allowed the evolution of storytelling models into what we know today as storied games or Role Playing Games (RPGs)

Due to its easiness in design and implementation, most storytelling models construct stories by creating sequences of events that depend highly on the inherent temporal property of such events. Despite this fact, several ways to organize story events have arisen from this simple manner to join events, going from the simplest linear sequence to more complex modular structures.

The linear structure is regarded as the simplest form to concatenate events. In this structure, a story is defined as nothing but a linear sequence of events, as shown in the next figure.

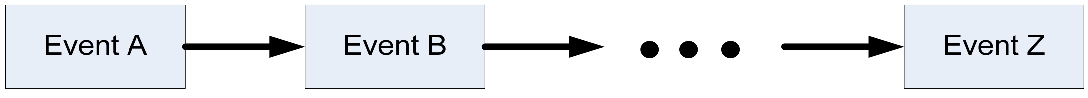


Figure 1: Story Representation - Linear Structure

The most obvious limitation in this structure is that it forces the user to have only one path, with no possibility to select which content to see or how to see it. A movie is a good example of this kind of structure and, even though most people find movies pleasurable to see, if the story is not well constructed, the risk of having dissatisfied users during the story telling process is quite high.

In order to reduce this dissatisfaction risk, storytelling models stated to let the users have more freedom regarding what content they want to see and how they wanted to see it. This freedom translated into provisions in the models for content selection and event sequencing selection. In this regard, the branching structure was designed to give content flexibility and a better story experience by providing multiple choices in events as well as in story paths. Although it was a welcomed improvement from the previous linear structure, the branching structure still kept the temporal attribute of the events as the main way to join them. Figure 2 shows a typical branching structure.

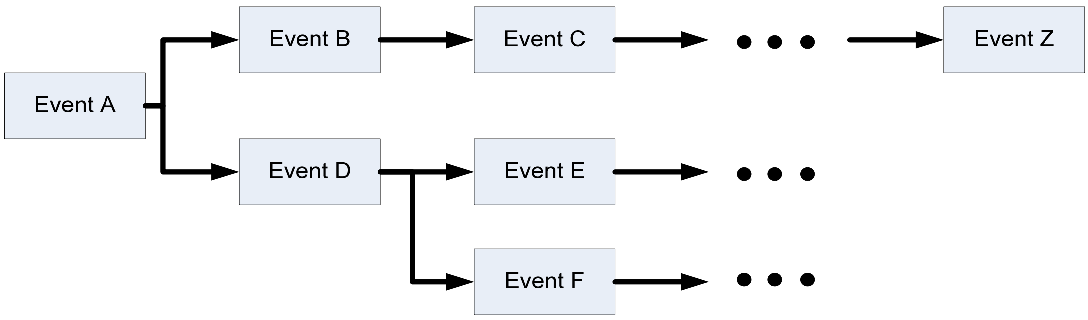


Figure 2: Story Representation - Branching Structure

Unlike the linear structure, the branching structure has more ways to specify a story by selecting which events will be presented based on the user's decisions in every branching point and the desired outcome of the story itself, which, as the structure implies, it is not the same for every generated story. One particular characteristic of this structure is that, once the decision has been made, there is no way to go back since the events' temporal constraint restricts it. If the user wants to look at other possibilities, he or she has to replay the whole story again. The branching structure was and remains a very popular scheme due to the fact that it is regarded as a fully tested technology and people that develop stories are very familiar with it. Despite of the freedom gained by the user, authorial control of the story is not given up in this structure, but creates to the user a very convincing illusion that his or her actions really determine the story thematic and objectives.

Even though branching structures remain widely used and solved some of the problems presented by the linear structure, the control endowed to the user in the story telling process was very simple, reduced in most cases, to a handful of predetermined choices that let them advance in the story until its outcome was reached. Some storytelling models and games have taken this structure to its limits by generating hundreds of events and decisions in order to lengthen the user's catharsis, but the lack of true free story interaction remained the same. The restrictions of this tree like structure still were evident in the fact that stories were always moving forward, and past events or different paths could not be relived in the same story experience. The web structure was created in order to overcome these problems by improving the branching structure in order to add more flexibility not in the content of the story itself, but in the event sequencing process. Figure shows a typical design for a web structure.

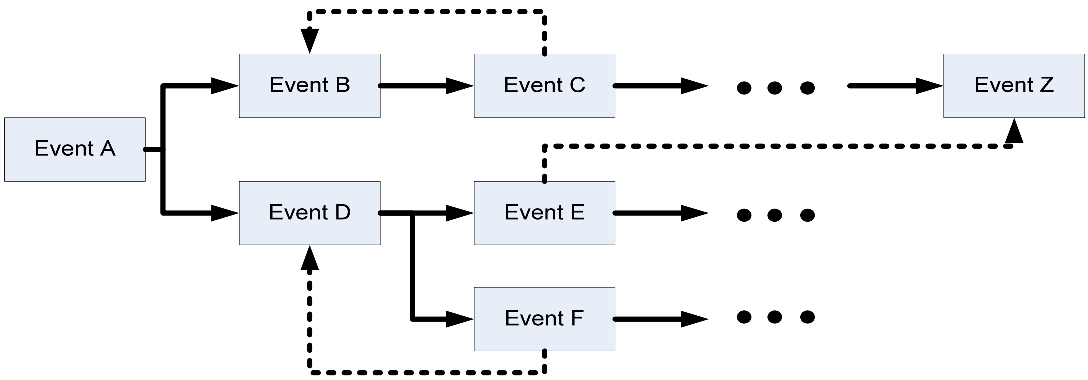


Figure 3: Story Representation - Web Structure

The web structure is essentially the same as the branching structure in content hierarchy with the added difference that it allows for backward branching decisions, which allows the user to re-experience the story to some extent, and gives an illusion of “time independency”. Despite the fact that branching decisions allowed the story to move “backwards”, temporal attributes of events were still preserved, since in most cases, events were temporally parameterized in order to allow this backward experience. For instance, if the user is located on Event C and chooses to re-enact the happenings of Event B, the temporal attribute of the newly played Event B will be ahead in time with respect to the first time the user experienced Event B; in other words, Event B (and possibly Event C) was to be parameterized in time in order to generate in the user a feeling of re-enacting, when in fact it was designed as a fully linear experience by the story content author. Nevertheless, this is considered the first true non-linear form of storytelling since most storytelling applications that involve gaming experiences adapted this structure very well by constraining story advancement to the fulfillment of specific requirements by the user, and, for the first time, the story author’s grip on its creation was loosened.

Despite the rather obvious freedom obtained by the web structure, some people still advocated the idea of total control by the user and no control from the author. This philosophy, which some people refer to as “emergent narrative”, was behind the next level of structure that would evolve from the previous schemes: the modular structure, whose typical constitution is shown in the next figure.

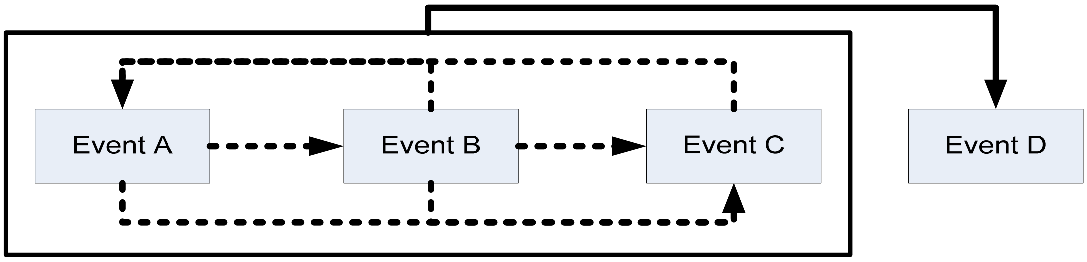


Figure 4: Story Representation - Modular Structure

In this type of structure, the user has total freedom to make the story progress as he or she wishes, with the exception of the beginning and the end of it, which should be specified by the content author. Still, this perceived freedom is constrained to the fact that it is the story author who identifies the implicit rules by which a user will traverse through the story. The user freely controls his or her own actions, but restricted to a particular set of conditions which adequate themselves as the story advances.

Despite the freedom provided by the structure, there is still a temporal character into the events that form such structure that dominates the whole creation process of the story. The temporal character in the creation manifests itself when the author must decide how the user must traverse the events so that he or she can have a fulfilling time-wise experience. Even if the story makes exclusive use of cyclical or recurrent time structures [Hogan 2003], disruptions in the flow of the story experience may occur and dissatisfaction may arise.

Stories are more than temporal structured sequences of events, since one of the main purposes of stories is that they help us assimilate (or learn) information in a convenient and orderly way. Stories, in the form of narratives, help to make our world of experiences and desires intelligible. It is a fundamental way to organize information [Branigan 1992], since most human experiences are organized in this way and the acquisition process is not dependant on which information arrived first, but on how it fits into a preconceived pattern [Graesser and Clark 1985]. In this context, the relations between the different story events ought to reflect that mental organization by specifying proper attributes to them. A temporal relation scheme is, in most cases, an overstated simplification that does not accurately represent the actual mind of the user.

Therefore, even though the organization of story events is diverse, evolving from linear structures to more modular structures [Sheldon 2004], the tight coupling between content and temporality makes it very difficult to directly use or even adapt the models to other contexts. Since temporal links presuppose a "fixed" sequential structure in terms of content events (i.e. some content events must invariably precede other content events), the presentation of such events is generally predetermined by their position in the temporal line of the whole story and does not give the storytelling engine enough flexibility to convey these events according to, for instance, the user's level of satisfaction with the story.

On the other hand, interactivity has played an important role in storytelling models due to the capacity of the computer to provide a much richer experience to the user by means of immersive interaction through the use of devices ranging from simple gamepads [Rober et Al. 2006] to virtual rooms and objects embedded into mixed reality environments [Lindinger et Al. 2006]. As a result, most storytelling models deal with this kind of intrusive interaction in order to let users select their own way to experience the content of a story. Even though it constitutes an accurate representation of the interests of the users, in some cases this level of obtrusiveness hinders the user experience in terms of the natural flow in the story [Csikszentmihalyi and Csikszentmihalyi 1998] and accentuates the dependency between the interaction paradigm and the story itself.

To overcome this problem, non intrusive (i.e. unobtrusive) interaction in the form of emotion detection is a technique that can be used to determine how the content of a story is to be presented, not only emphasizing its narrative aspects, but also enhancing its natural flow. Emotion detection has been used to minimize the obtrusiveness of the user interaction experience in several other types of applications like game playing and simple content selection and manipulation. Using the emotion paradigm as the basic framework of analysis, it can be concluded that a story is perceived as an emotional episode centered on a single most important emotion, namely interest, and extending it with some degree of continuity throughout the entire story [Tan 1996]. Interest is the main emotional component in stories because not only it is long lasting, but also provides the context in which short lived emotions, like joy, anger, and fear, are elicited. Therefore, user interest can be used to formulate a special type of interaction in which the user shapes his or her experience in the story not in terms of intrusive manipulation of event content, but in terms of non intrusive manipulation of event sequences.

Due to the close integration between event content, temporal sequencing, and intrusive interaction paradigm in storytelling applications, the achievement of context independency in their models are difficult since they were created having a specific objective in mind (i.e. text document processing, video game controlling, slide presentations and so on). In order to develop a more generic model to create storytelling applications, we focused on the solution of the two issues stated above by organizing story events in a more semantically meaningful way and implementing a robust unobtrusive interaction scheme for the model based on the interest level of the user. In this thesis, I present ISRST (Interactive Storytelling Model using RST), my proposal for a generic storytelling ontology model based on the organization of events using a meaningful subset of rhetorical relations proposed by the Rhetorical Structure Theory (RST) [Mann and

Thompson 1987], and narrative principles combined with interest measurement to provide a unique interactive storytelling experience.

This research is aimed to bring more understanding to two aspects regarding storytelling models:

- How to create a generalized storytelling model using semantic relations, getting rid of the constrained temporal scheme. A storytelling model is essential since “no representation can be understood by the viewer unless some kind of existing schema is available within which elements of the work of art can be placed” [Gombrich 1977].

- How can unobtrusive interaction enhance the story experience and convey the semantically related events into a temporal channel (not a temporal structure), preserving the flow of the story.

Our approach consists on identifying the generalized attributes in the model, define interest in a story and how it could be computed, determine the ontological aspect of the model by identifying classes and attributes, and identifying the narrative issues that will drive the story telling process itself. To this end, I have developed a web application in order to test my model and let other people in the community test it in order to have an appropriate feedback for future improvement.

The usefulness of this research lies in the fact that it provides a model for story construction outside the scope of current time-restricted storytelling models, so people can enhance their own applications by giving them a story-type quality for better understanding and satisfactory experience through the use of unobtrusive interest calculation. This type of schemes can be proven useful for e-learning software, presentation applications, and role playing games (RPGs).

1.1 Structure of Thesis

This thesis is composed by eight chapters, which provide the background and starting point for my research, description of the storytelling conceptual framework, and the demonstration of the results of my work. The contents of each chapter are outline below.

- Chapter One: This chapter is the introduction of my thesis, in which I describe the essential concepts of a story and give proper fundaments for the value and approach of my work. It also describes the structure of this thesis.
- Chapter Two: This chapter describes the current state of the art in storytelling applications organized by the way these applications contribute to the field in terms of event sequencing and event interaction, two keys aspects for any storytelling model.
- Chapter Three: This chapter details the model attributes that were considered in order to have a generalized storytelling model and why they are needed.
- Chapter Four: This chapter details the role of the user’s interest in the storytelling process, its definition and principles regarding its relation with the story itself. It also describes how it is calculated in my model and the assertiveness of this calculation compared to other well known methods.
- Chapter Five: This chapter describes ISRST, the application I developed, by emphasizing its design components (story ontology, narrative functionality, interest calculation, and story generation)
- Chapter Six: This chapter describes the web implementation of ISRST.

- Chapter Seven: This chapter describes the analysis' results of ISRST by using two real stories with different objectives. I present the details of the construction of each story and the interest data I collected so far.
- Chapter Eight: This chapter states the conclusions of the research work, highlighting discussions about each component of the model and future work that may contribute to enhance the present version.

Chapter Two: Storytelling Application Models

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. Most researchers assume a concept of "event" in order to organize the content of their applications, and, therefore, have developed storytelling engines to deliver such events using narrative techniques. In most cases, these engines make extensive use of artificial intelligence concepts and their novelty is found in the way the applications that make use of these engines deal with the process of generating a story.

2.1 Model Classification based on Event Sequencing

Based on the Event Sequencing attribute of a storytelling model, the current state of the art research work can be classified as:

- Rule based Applications: In these kinds of applications, the storytelling engine component makes use of elaborated logical rules in the form of antecedent – consequent pairs in order to select the next event based on what the user performed or selected in the previous interactions with the story. In most cases, these rules acknowledge that certain dramatic effect must exist; therefore, applications normally try to categorize their rules according to a certain relatively fixed narrative pattern. The narrative pattern for any story in these models may proactively involve the user as a protagonist, as in a dialog exchange [Tarau and Figa 2004], or making the user take narrative-wise meaningful decisions through the manipulation of the story protagonists and/or the story environment, as in the case of the well known Erasmatron engine [Crawford 2005]. Some rule based applications do take into consideration not only a narrative effect on isolated rules, but also on the structure of the whole set. This narrative structure goes from the implementation of simple narrative concepts such as the "conflict" [Szilas 1999] to more complex implementations, such as narrative functions that help shape the story dynamically by rule ranking based on its narrative impact ([Szilas et Al. 2003], [Szilas and Rety 2004]) or by analyzing a story progress based on the dramatic "tension" and simulating possible future situations in terms of user interaction ([Mateas and Stern 2000], [Mateas and Stern 2003]).

- Goal based Applications: In Goal based applications, a goal event or events are 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 or events. Planners and their variations are commonly used for these applications and, due to the nature of most planners, events have to be annotated with a set of pre and/or post conditions. The simplest form of application basically deals with narrative generation based on presentational goals [Callaway and Lester 2002]. However, one of the most widely used planners is the Hierarchical Task Network (HTN) planner, whose structure is used to conveniently organize story events, making the story construction process much easier [Young 2001], but being fully aware of the actions of the user. Since these actions may not be in the control of the application all the time, some of these actions might alter the narrative quality of the story during the planning process. In some cases, this problem has been solved by classifying the actions of the user in order to know beforehand which kinds of actions may be disruptive [Riedl et Al. 2003], or by including a proactive calculation of the possible future actions of the user, so they can be avoided [Riedl and

Young 2004]. By taking this HTN structure to its limits, some researchers have developed very complex stories regarding action selection capabilities, in the form of optional events in order to reach the goal [Cavazza et Al. 2002], or the addition of enormous amount of event content to generate longer story experiences [Charles and Cavazza 2004].

- State Transition based Applications: State Transition based applications define events as states that specify the current contextual situation in a particular point of the story. Bayesian Networks, Finite State Machines, and their variations are commonly used as storytelling engines. Therefore, events must be annotated to fit the requirements for nodes in the network or machine. Story nodes amount for the content of the story and their complexity range from simple pre-generated scripts for agent manipulation [Gebhard et Al. 2003] to free motion and interactive experiences using virtual reality technology [Swartout et Al. 2001]. In order to enforce narrative quality into these kinds of applications, several external functions are embedded into the network or machine in order to regulate the selection of nodes at any particular moment in the story. In some cases, a utility function is used to regulate the traverse from a node to another based on its maximization [Mott and Lester 2006]. Others separate the states that represent story events into story levels to reflect the different stages in the telling of the story and implement a desirability factor to determine the next level based on the previous input [Silva et Al. 2003]. More complex schemas allow the inclusion of time transition constraint factors to minimize the disruption in the flow of the story caused by the user's actions. These systems use a predictive model of the user's actions in order to maintain the coherence in the plot [Magerko 2005].

- Template based Applications: In Template based applications, events are selected to fit story templates and permutated to create new narrative experiences based on those templates. Since the story template constrains which and how events are presented, these events must be annotated to determine their role in the context of the whole template. Very different and diverse techniques have been used in order to implement the story templates without being constrained to a particular technology or methodology. One of the first applications to implement templates used this concept to group story events with similar characteristics in order to get new stories based on the permutations of events in each group [Elliot et Al. 1998]. Later, some applications have made use of more complex ideas like the concept of genetic algorithms using the permutations of events like in a gene scenario to create story variations [Ong and Leggett 2004]. Templates, in other applications, reflect more well known schemas like Case Based Reasoning paradigm (CBR) [Gervas et Al. 2005], or domino formation concepts in which story events are selected only from a pool that would match the ending scene of the previous event [Wolff et Al. 2004]. Templates are normally used by applications that deal with a specific topic, which constrains their use in other contexts. For instance, some applications have created a situation based on the 'bullying' topic and organized the actions in the story according to it [Sobral et Al. 2003].

- Script based Applications: Script based applications are a particular case of template based applications in which stories are described using a high level language. The application, then, present the events in the way specified by such scripts. Some scripts languages are based on common standards, while others reflect a more proprietary character. Standard specifications like the Synchronized Multimedia Integration Language [SMIL 1998] has been used to define event sequencing processes for presentational purposes [Andre et Al. 2005], and, in other cases, content specification standards like the Global Document Annotation [GDA] were used to organize the content which later would be used to generate animated stories for a Storybook application [Sumi and Tanaka 2005b]. In the case of proprietary languages, their purposes vary from story flow control [Rocchi and Zancanaro 2004] to character definitions and interrelationships [Sgouros et Al. 1997].

- Emergent Narrative based Applications: Emergent Narrative based applications rely on the fact that a story can arise without any authorial control in terms of plot and only by the interaction of the users, who are protagonists in the story by impersonating the characters that taken part in the story. Massive Multiplayer Online Games or MMOGs are based on this concept. Since there is no control over the actions of the user, a story, in its strictest sense, is hard to obtain, and the developers of these applications have applied constraints in terms of episodes to ensure the continuity of the story flow and the maximization of the user's immersive experience. In the storytelling field, some applications use the impersonation process of the user to achieve a desired learning objective, embedding the emergency into stories with role limitation, depending on the character the user chooses to impersonate [Paiva et Al. 2001].

- Semantic Organization based Applications: Semantically organized events using primarily RST have been used in applications that present multimedia content, but most of them use only a very limited set of relations. Since rhetorically structured content was mainly used for organizational purposes, these applications do not deal with the narrative implications that rhetorical relations have in storytelling-like presentations. As an example, some applications have used rhetorical relations to organize their content based on its discourse properties [Callaway et Al. 2005], or in more complex organizations like ontologies for each aspect of story-like presentations [Geurts et Al. 2003]. The use of rhetorical relations in narrative generation or event sequencing has been very limited in comparison to the use of the same relations in event organizational aspects. In some cases, story presentations were hard coded into a set of fixed rules, which mapped a small set of rhetorical relations to another set of spatio-temporal relations, that is, relations concerning space and time exclusively [Little et Al. 2002], while others have used a very simple relation based narrative scheme but taking one relation (the Sequence relation) as the main driver for story generation [Rutledge et Al. 2000].

2.2 Model Classification based on Event Interaction

Most interactive paradigms in storytelling models are of the obtrusive type since it is clearly the best way to know the preferences of the user, although few researchers deal with the problem of the disruption in the user experience due to this type of interaction. Based on the Event Interaction attribute of a storytelling model, the current state of the art research work can be classified as:

- Story Generation only Applications: In this kind of applications, no interactivity is offered and their main focus is the generation of text documents or multimedia presentations. Examples of these are [Callaway and Lester 2002], [Andre et Al. 2005], and [Geurts et Al. 2003].

- User Text Processing Applications: These applications deal mainly with the processing of the utterances of the users in natural language form, and engage themselves into a dialog-like interaction. Some examples of these systems are [Figa and Tarau 2003] and [Tarau and Figa 2004].

- Parameter or Query based Applications: These kinds of applications base their interactivity in the control parameters or values that have to be fixed before the story is played to manage story content change or event sequencing. The specification of these parameters varies greatly from application to application. In general, control parameters can be stored in the form of a user information profile ([Callaway et Al. 2005], [Rocchi and Zancanaro 2004]), queries [Gervas et Al. 2005], preferences or choices for the story attributes [Szilas 1999], or complete user models with time based parameters [Szilas 2003].

- Menu and Interruption based Applications: In these kinds of applications, a menu based interaction is used in order to ask users about their particular preferences. The options that may appear on the menu vary according to the desired outcome of the choice in terms of story tuning and the technology behind the storytelling engine. Among these options, we can find options for story flow interruption ([Gebhard et Al. 2003]), story sequence control, not in terms of story event, but in terms of story flow ([Sumi and Tanaka 2005a]), presentation type choice ([Little et Al. 2002]), direct scene selection ([Silva et Al. 2003]), indirect scene selection through parameter options ([Sobral et Al. 2003]), or action selection ([Crawford 2005], [Szilas 2003]).

- Multimodal User Action Processing Applications: These kinds of applications make use of the full range of possibilities that normal and special hardware gives them in order to have several distinct sources for interaction accuracy and enhance the user's involvement in the story. Among these interactions we find physical action and voice command processing ([Riedl and Young 2004], [Swartout et Al. 2001]), multimedia character impersonation ([Paiva et Al. 2001]), virtual reality interaction ([Cavazza et Al. 2002]), or game-like interaction ([Mateas and Stern 2003]).

Even though the results obtained by the applications described above are impressive from the story telling point of view, the cohesion between event content and storytelling engine and the level of obtrusiveness in the interaction process makes the task of adapting their models to other domains rather difficult. My solution proposes a storytelling model based on generalized concepts, which are independent of the topic domain, and the inclusion of an unobtrusive interaction paradigm using the perceived interest of the user.

Chapter Three: Attributes for a Generalized Semantic Storytelling Model

To ensure the general quality of our storytelling model, each of its components was carefully analyzed and defined in order to make it suitable for any type of storytelling application. This analysis was based on the following factors: (1) story content and organization, (2) story thematic, (3) story characters, and (4) story variability. For story content and organization, we addressed the problem of content diversification in a story event (i.e. different types of content in an event), and how to overcome the constraint of temporal linkage through the use of rhetorical relations. Story thematic refers to the fact that stories are about something or deal with something; in other words, they have a topic. Topics in the form of thematic structures are important because they help regulate expectations with respect to the course of action in the story [Tan 1996] and, therefore, they are useful to define the internal boundaries of a story regarding its content. Stories are also about characters (or agents), since events in any story must be determined by the intentional states of the characters taking part in it. Even though the definition of "character" for a story can vary from implementation to implementation, ranging from human characters as actors to inanimate characters as in the case of slide presentations, the agency concept is always implemented in storytelling applications since characters, as conveyors and/or receptors of actions and emotions, must be present in a story to ensure that its Intentional State Entailment property [Bruner 1991b] is authenticated. Finally, story variability refers to the different possibilities in terms of story content that the model provides in order to shape the story during the telling process. In this section, we will detail the attributes that were taken into consideration in order to provide generality to our model: the roles of story event and rhetorical relations (story content and organization), the notion of story concepts (story thematic), agents and their role in the rhetorical relations (story characters), and the definition of nucleus and satellite events (story variability).

3.1 Story Event

A Story Event is defined as the minimum unit by which a story or part of it can be told. Any Event defined in our model corresponds to an object and is uniquely identified in order to comply with the Particularity property of narratives [Bruner 1991b], which states that events must be composed of happenings that are unique and not repeated in other events. Since the content of each event is expected to vary from application to application, our Event object has no internal structure. Rather, it is left to the criteria of the author of the story the organization of the content inside the object to achieve maximum flexibility for his or her intended storytelling implementation. Figure 5 shows an example of an event definition for our test story in OWL as well as descriptions for its main components.

Name of the Event

```
<owlx: Individual owlx: name="#BREAKING_DOWN">
  <owlx: type owlx: name="#Event"/>
  <owlx: DataPropertyValue owlx: property="#hasAction">
    <owlx: DataValue owlx: datatype="&xsd; string">
      FILE@@http: //localhost/arturo/isrst/events/Breaking_Down.txt
    </owlx: DataValue>
  </owlx: DataPropertyValue>
</owlx: Individual>
```

Content of the Event specified in a file

Figure 5: Example of an Event Definition in OWL

In our web implementation, we defined events by simply making a reference to an external text file in which the actual event content is stored. This definition allow us to have a less cluttered and ordered OWL representation of the story. The content of the event is specified through a proprietary language called Event Specification Language (ESL). This language contains an appropriate set of instructions for multimedia content manipulation (text, audio, and video file processing) and synchronization. The details concerning ESL and event file content will be explained in Section 6.1.

3.2 Rhetorical Relations

In the real world, 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 [Bruner 1991b], which refers to the fact that events have a temporal relation between them (i.e. one event happens before, at the same time, or after another). This relationship is normally taken for granted in most storytelling applications and researchers have tried to enrich this temporal synchronization of events by modifying the mechanisms by which events are displayed one after the other.

Nevertheless, temporal relations are only one aspect in the process of telling a story. Event temporization refers 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. 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" [Crawford 2005]. 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 ones constrained by time linking.

Natural text is considered 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 analysis on which kinds of relations can be defined between blocks of text in a narrative. The Rhetorical Structure Theory (RST) [Mann and Thompson 1987] is the most accepted theory, since it was created as a tool for computer text generation and its study has sparked the development of a full linguistic theory on its own. In the next subsections, I will present brief background information on this theory and how the relations proposed by this theory were applied to ISRST.

3.2.1 The Rhetorical Structure Theory

The Rhetorical Structure Theory (RST) was developed as part of studies of computer-based text generation. Part of the team that worked on these studies, namely William Mann, Sandy Thompson, and Christian Matthiessen noted that there was no available theory of discourse structure or function that provided enough detail to guide programmers. Responding to this lack, RST was developed from analyses of several different types of text sources.

RST offers an explanation of the coherence of texts. One formulation of coherence is that it is the absence of non-sequiturs and gaps. That is, for every part of a coherent text, there is some function, some plausible reason for its presence, evident to readers, and furthermore, there is no sense that some parts are somehow missing. RST is intended to describe texts, rather than the processes of creating or reading and understanding them. It addresses text organization by means of relations that hold between parts of a text, and explains coherence by postulating a hierarchical, connected structure of texts, in which every part of a text has a role, a function to play, with respect to other parts in the text.

RST also provides a systematic way for an analyst (also called observer or judge) to annotate a text. If the annotation involves an entire text, or a fairly independent fragment, then the analyst seeks to find an annotation that includes every part of the text in one connected whole. An analysis is usually built by reading the text and constructing a diagram based on such text. Figure 6 presents an example of a small text and its correspondent RST based analysis.

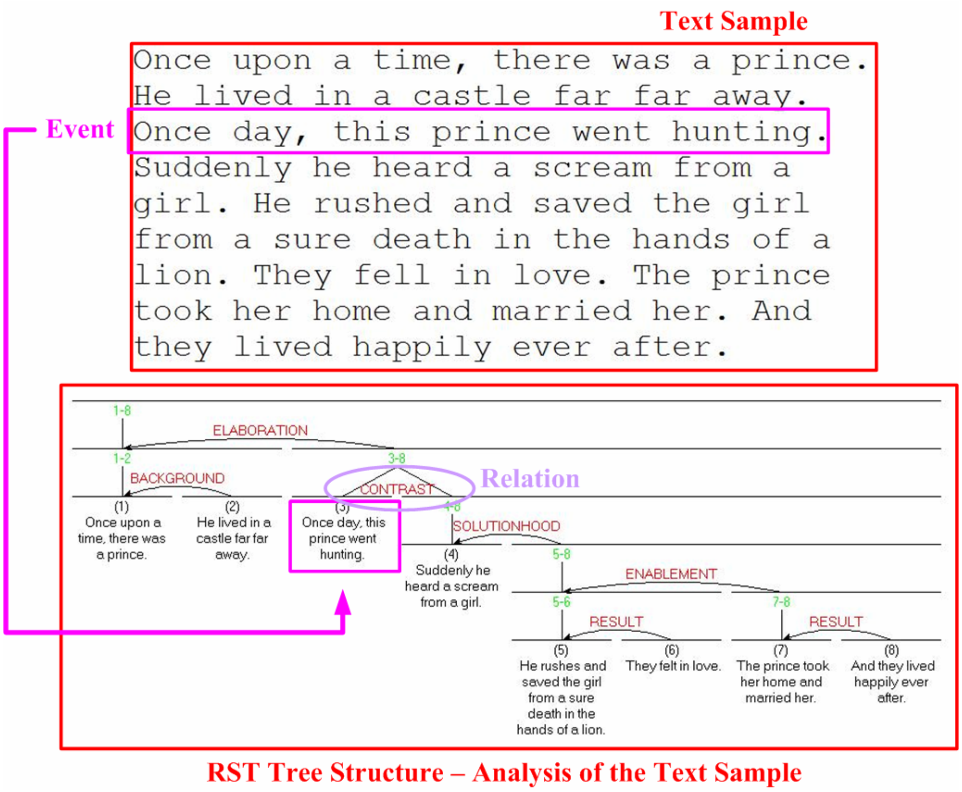


Figure 6: RST Text Sample Analysis

RST relations are defined in terms of four fields: (1) Constraints on the nucleus; (2) Constraints on the satellite; (3) Constraints on the combination of nucleus and satellite; and (4) Effect (achieved on the text receiver). To specify each field for any instance of a particular relation, the analyst must make plausibility judgments, based on context and the intentions of the writer. All relations are defined in terms of the four fields. Definitions are based on functional and semantic criteria, not on morphological or syntactic signals, because no reliable or unambiguous signal for any of the relations was found. Different lists of relations exist for RST. The original set defined in by Mann included 24 relations, and it was dubbed the “Classical RST”.

RST establishes two different types of units. Nuclei are considered as the most important parts of a text, whereas satellites contribute to the nuclei and are secondary. For instance, in an Elaboration relation, the nucleus is considered to be the basic information, and the satellite contains additional information about the nucleus. The nucleus is more essential to the writer’s purpose than the satellite. The satellite is often incomprehensible without the nucleus, whereas a text where the satellites have been deleted can be understood to a certain extent. The hierarchy principle in RST is part of this nucleus-satellite distinction. RST relations are applied recursively to a text, until all units in that text are constituents in an RST relation. This is because the effect to be achieved with a particular relation may need to be expressed in a complex unit that includes other relations. The effect of one particular text can be summarized in one top-level relation, but decomposed in further relations that contribute to that effect. The result of such analyses is that RST structures are typically represented as trees, with one top-level relation that encompasses other relations at lower levels.

As the major benefits of the RST theory, we can point out that: (1) it proposes a different view of text organization than most linguistic theories, and a more complete one than most theories of discourse, (2) RST points to a tight relation between relations and coherence in text, thus constituting a way of explaining coherence, and (3) it provides a characterization of text relations that has been implemented in different systems, and for applications as diverse as text generation and summarization.

3.2.2 The Relation between RST and ISRST

It can be noticed that rhetorical relations are useful to describe not only semantic relations between blocks 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 organization of those pieces of information in the text, but also the meaning that those events had in the mental story pattern of the author of such text. Nevertheless, even though the way by which events are linked in a story are, in general, consistent with the definition of the complete set of RST relations, the use of such set results impractical for the purpose of event content creation, since most people normally make use of a much smaller set of relations when they construct and remember stories.

Most narratologists agree that the most important rhetorical relation between events is the causal one (e.g. [Bruner 1991a]). Nevertheless, we may argue that this is not the only relation that is taken into consideration when human beings create story patterns in their minds. As discussed by Ed Tan in [Tan 1996], when we observe sequences of actions in a film, “the cognitive concern corresponds broadly to the assimilation of the action observed into a canonical narrative structure. This concern is also satisfied by a wealth of different relationships other than causal ones within the ultimate cognitive representation of the narrative”. Given the fact that a set of different types of relations help assimilate the content of a story, it is plausible to assume that the same set of relations may also be used to create such content. Therefore, we selected the most appropriate rhetorical relations taking into consideration the flexibility and unambiguity of their semantic definitions.

For the current version of ISRST, the following relations were considered:

- *Background*: In this relation, one event A is referred as the context in which another event B happens. Event A may be located in the past of event B, but it does not necessarily entice a cause and effect relation.
- *Cause*: In this relation, one event is identified as the cause of another. The cause relation is one of the main relations in the ontology because it is the relation between events that most people clearly distinguish.
- *Purpose*: This relation reflects the necessity for one event to be shown before another can be shown. Even though it is in direct relation with the Cause relation, its use is different since it implies a condition for advancing in the story, which will be discussed in Section 5.3.1.
- *Result*: This relation indicates that an event is shown as a direct consequence of another event. It is also linked to the Purpose relation, but has more immediate and final connotations. This relation is mostly used to indicate the presentation of final events in part of the story or the story itself.
- *Contrast*: For any story to have narrative quality, it must show some kind of conflict between two or more events [Bordwell 1986]. Conflicts, implemented as contrasts, give stories the opportunity to enhance their audiences' interest by creating narrative tension.
- *Solutionhood*: This relation provides a way to define how a Contrast relation will be solved.
- *Elaboration*: In this relation, an event is shown to give more details about another event.
- *Evaluation*: This relation provides a way to state a final conclusion about one event. It is helpful for authors to convey a final message or thought to the story.

- *Sequence*: This relation establishes a linear temporal link between two events. This relation is useful to enforce sequencing in stories, but it should not be used as the primary way to link events.

3.3 Story Concepts

Stories are always developed around a particular concept. Concepts are important because they help regulate expectations with respect to the course of action in the story [Tan 1996] and, therefore, are useful to define the internal boundaries of a story regarding its content. These internal boundaries, normally conceived in the form of scenes or episodes, are understood to be the smallest units for concept association. Nevertheless, concepts themselves are not isolated, since the internal boundaries that make up a story are related to one another, not only by semantic relations, but also by a transition in concepts that determines the smoothness of the story in terms of knowledge presentation. In order to implement this transition in ISRST, we have created a graph-like structure of directed linked concepts known as the Story Concept Network. Figure 7 shows the logical design schema of a common Story Concept Network.

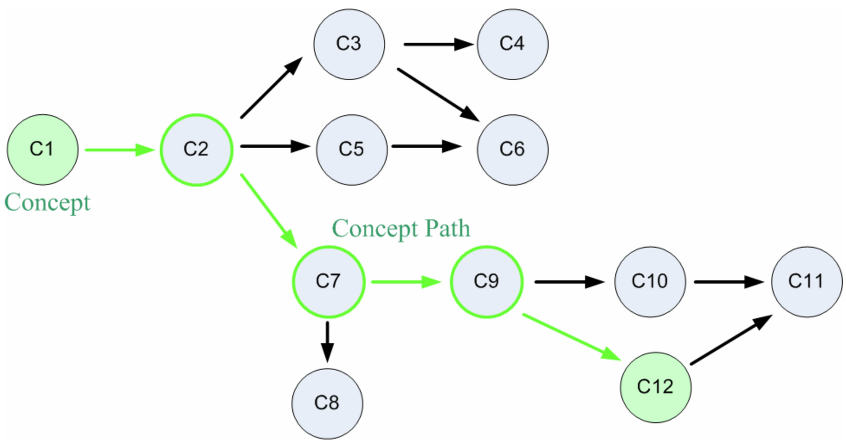


Figure 7: Logical Design Schema of a Story Concept Network

In a Story Concept Network, each node represents a concept and each link represents a directed relation that defines the dependency in terms of knowledge precondition between the two connected concepts. For instance, since C1 is directly connected to C2, it is said that C1 must come before C2 in the story for it to be coherent in terms of knowledge presentation. In the case of two Concept nodes that are not directly connected, a logical transition in the network between these two nodes must exist in order to guarantee such coherence. This transition is known as the Concept Path. If we generate a story in which concepts C1 and C12 must be present, the concept path formed by the intermediate nodes C2, C7, and C9 must also be included to ensure a smooth flow of knowledge for the whole story.

The main advantage for the implementation of this schema lies in the fact that it allows a flexible generation of stories based on concept pre-selection (i.e. a story can be defined as a collection of key Concepts and the Concept Path is automatically generated), and on-the-fly concept rearrangement (i.e. a story can modify its set of Concepts in real time, provoking changes in the Concept Path in real time also). Even though directed links are the simplest way to link Concepts, it accurately represents the dependency and precedence relations that are to exist between knowledge-based nodes.

3.4 Agents and their Role in Semantic Relations

Stories are about characters. Even though some storytelling implementations such as slide presentation systems do not have characters or actors in them, the content of the stories in these systems normally has one or more entities in which the user focus his or her attention and, therefore, develop interest. Even if entities in a story are not alive characters, they act as target objects for the attention of the user, since understanding those entities can produce in him or her not only pleasure in terms of knowledge acquisition, but also expectations of huge gains in satisfaction due to his or her empathy towards them. In ISRST, we define these entities as Agents. Like the Event definition, an Agent definition refers to a general concept regarding an animate or inanimate entity into which a user pours his or her attention and, therefore, shows interest.

In the general definition of story, events are constituted by agents that perform or acknowledge certain actions either by themselves or in groups. Nevertheless, the consequences of the actions in those events can be attributed to agents that were not necessarily the originators of those actions. For instance, if an event represents the actions of an agent A, the consequences of such actions are applied only to that agent. But if an event represents an agent A talking about an agent B, the consequences of the actions of agent A (the source) also affect agent B (the object), even if agent B is not present in the event.

Therefore, events in a story can be interpreted in different ways depending on the agents that are the focus of the consequences of the actions that occur inside such events. This concept is defined in ISRST as the Agent's Point of View (POV). POVs are also useful to study the preferences of the user towards a determined agent based on interest and approach interactivity from a more personal and involving perspective.

Even though agents act and develop in the context of events, their points of view are better defined not by the content of the events themselves, but by the relation that joins such events. This perspective gives us the possibility to appropriately generalize the Event object and to create suitable interaction points that can be used by the ISRST engine to determine the most interesting way to shape the story. In ISRST we consider relations as unidirectional because this helps us recognize which event constitutes the explained relation of which event. In this context, our representation of a relation R between 2 events A and B from the point of view of an agent X is given by the construction:

$$A \xrightarrow{R(X)} B$$

which is read as: The event A is the R of the event B applied to or regarding an agent X. In this case: A is considered the Origin of the rhetorical relation R and B is considered the Destiny. For instance, if we have two events A and B which are related by the BACKGROUND relation with an agent X as the parameter of the relation, this means that the event A is the background regarding the agent X of the event B. With this approach, not only are we able to have several background relations to one specific event, but also it gives the narrative engine the opportunity to take into consideration the interest of the user when selecting events that are associated to relations with particularly interesting agents.

3.5 Nucleus and Satellite Events

Any story is normally constructed from what Bordwell [Bordwell 1986] referred to as a fabula and organized into two types of information: syuzhet (main plot events) and “excess” (events that contain extra information). Some of this extra information contained in the story is frequently used to add narrative tension and stimulate the interest of the user in different ways. Therefore, it is plausible to assume that any extra information can be considered a “satellite” (optional) to the most important information or main plot, which constitutes the “nucleus” (mandatory).

In the context of RST based analyses of texts, nucleus and satellite components of a relation are defined to identify which information is absolutely necessary (nucleus) to understand the text and which information is additional (satellite) and can be omitted without losing the meaning. By performing an extrapolation of these concepts into ISRST, we allow story authors to organize their content based on its importance to the development of the story. This specification is exclusively applied to events and scenes.

Nucleus events (or scenes) must always be presented in a story, but in the case of satellite events (or scenes), the engine must decide which events (scenes) are to be presented according to the user's level of interest. In general, a good story must include the necessary nucleus information to fulfill its objective as a story and enough satellite information to provide variety for the event selection process.

In this chapter, I have defined and detailed the attributes that any generic and semantic storytelling model must deal with from the point of view of static concepts. In the next chapter I will present a detailed background regarding the role of interest in my model and why it was the primary choice for interaction paradigm.

Chapter Four: The Role of User Interest in the Storytelling Process

Even today, any cinema visitors who are in a position to observe their fellow film spectators will see reactions that are not too different from those of the primal filmgoers, and if we fail to be intrigued by the apparent irrationality of these emotional reactions, then we will at any rate be struck by their intensity. Today's cinema audiences, too, are often surprised at the force of the emotion that grips them. Their surprise is triggered by the fact that they know well that what they are seeing is a series of images projected onto a screen: in other words, an illusion.

There is another interesting side to the emotions evoked by a film, and that is the sheer diversity of those feelings. Apparently, every conceivable human emotion, whether shunned or sought after in everyday life, is capable of providing entertainment when experienced in cinema. And again we are struck by the suspicion that what filmgoers experience is a very special kind of reality. Nevertheless, while viewers may themselves be convinced that what they feel is true emotion, that feeling is not necessarily consistent with an objective definition of the term. Therefore, we must ask ourselves to what extent the reality, which is the source of any emotion, is itself subjective and dependent on the good will of the viewer. In this context, a much simpler criterion for assessing the authenticity of the feeling evoked by films is the degree to which it resembles that experienced by the subject in the real world outside the cinema.

On the basis of empirical observation, it is safe to say that the response to films is fairly unanimous within a given body of viewers. There seems to be a plan governing the course of our feeling, and we know from sources other than the film itself that this is indeed so. Films are designed to produce a particular effect and, as artefacts, they display both a functional design and a certain consistency. That orderly structure and consistency are reflected in the systematics of the affective reactions of the viewers. In other words, films, to the extent that it is seen as a narrative, systematically manipulates fictional situations and aspects of those situations in such a way that they fulfill the requirements for the creation, maintenance, and modulation of emotions. In short, to narrate is to produce emotion. In this context, narration is seen as the process by which fictional events are presented in an ordered and temporally structured manner, thereby producing a certain effect upon the viewer.

In order to limit its scope, this definition is determined by the specification of two key concepts: the film and the viewer. Traditional films have several distinctive characteristics that identify them as such. Their prime one is that the ambiguity and uncertainty that it creates are subject to qualitative restrictions, with the narration being as straightforward as possible. Among other characteristics are included:

- Uncertainties or gaps in the information that the viewer is given concerning the action are always temporary.
- There is usually a happy ending.
- The source of the causality lies in the main characters.
- Wherever possible, the narrative presents the events in chronological order.
- The viewer sees and hears only as much as is functionally necessary at a particular time.
- It is always clear whether one is witnessing an objective or a subjective scene.

Most film viewers have at the very least a strong intuitive feeling about what does not appeal to them, and it is not necessary to be a true film enthusiast to know approximately what type of film you are looking for. Preferences are determined by specific film characteristics, which are called norms. Norms, as part of the theory of film narration, corresponds to attitudes, that is, affectively charged preferences on the part of an audience, that have been formed during a learning process encompassing a great many films. Films or film types may be seen as systems of norms, while audiences are groups of spectators characterized by certain attitudes. Therefore, we can say that each film or type of film has its natural viewer, which is defined as a viewer that voluntarily watches a film with an open mind, that is, non-analytically, and generally makes no effort to escape the attraction of the fictional world portrayed in the screen.

4.1 The Satisfaction of Film Viewing

Filmgoers do not passively experience the stream of sounds and images reaching them. They search out those aspects that appeal to them. A feeling subject – not necessarily intentionally – selects from the incoming information something that affects him, something that matters, something that immediately and spontaneously strikes him as significant. In this context, there are two sources of primary satisfaction specific to the traditional film: the first is the fictional world depicted by the film; the second derives from the technical-stylistic qualities of the medium.

Viewers may derive pleasure from the free and unencumbered contemplation of other people. It is known from practical experience that the traditional film, regardless of the genre, gives viewers the impression that they are seeing others without being seen themselves. In other words, the fact that the members of the audience are fascinated by – or even lose themselves in – the fictional world would appear to be one of the most important primary motives for satisfaction. For the viewer, the most important elements of the film as artefact are plot and style. The plot is generally constructed in such a way that the viewer in presented with an often complicated sequence of events in which the fictional action alternately progresses and stagnates. As a result, the viewer, who is constantly striving for a more complete overview of, and a better insight into, the overall action, is alternately frustrated and rewarded. The film experience is, therefore, like a game in that the viewer, driven by cognitive curiosity, takes pleasure in discovering order for his own sake and not for any use that might be made of the knowledge thus obtained.

In conclusion, if all the various primary motivational attributes of the traditional film could be reduced to a single, most comprehensive motive, it would be “tension reduction”, which is the regulation of affect on the part of the viewer, a small-scale emotional catharsis, admittedly in the most limited and specific sense of the word. A traditional film creates a specific emotional tension but then goes on to resolve that tension. From the perspective of the viewer, it could be said that what all natural viewers of traditional films have in common is their desire to experience emotion as intensely and as abundantly as possible, within the safe margins of guided fantasy and a closed episode.

4.2 The Relation between Film and Emotion

One of the major incentives for watching traditional films is the emotional experience they offer. However, not all emotions will be welcomed by all viewers at any arbitrary point in the film. There are certain – largely unwritten – rules that limit the emotional effect produced by films, with emotion being the consciousness of a change in action readiness, which is experienced and motivated or caused by situations that have been appraised in a specific manner [Frijda 1986].

The feature film has an enormous potential for manipulating the meaning of events taking place. Therefore, emotions may be said to be controlled as to strength and quality, for each emotion has its own unique situational meaning structure [Frijda 1988]. The perceptual and cognitive basis for the inevitability of situational meaning is that the traditional film creates the illusion of being present in the fictional world. In film theory this is known as the diegetic effect. In terms of emotion theory, the diegetic effect implies that the situational meaning structure in film viewing is related primarily to the situation in the fictional world.

Many – perhaps even the majority – of the emotions evoked by feature films may be characterized as fortune-of-others emotions [Ortony et Al. 1988]. Just as in the traditional novel and traditional drama, the events in the fictional world are determined by characters who act in a more or less purposeful fashion and whose mental life is more or less comprehensible to the viewer. The intensity of the emotion is also determined by the parameters of the situational meaning, which the cinematic technique allows to attain maximum values. These include not only objectivity but also such aspects as closedness.

A traditional film is also a story, which means that knowledge is conveyed. And yet a film audience is barely aware of the process by which this takes place. In general, the narrative process is concealed behind the diegetic effect, or more precisely, behind the apparent objectivity of events. Narrative determines both the nature and the intensity of emotions through a careful dosage of information by means of the parameters of the situational meaning. The most elementary formula to which a story, that is, a series of events in the fictional world, can be reduced is a characteristic course of events and the overall organization of the story is reflected in the characteristic emotion of the viewer, which is conceived as an overall process. The viewer, then, undergoes an emotion episode (i.e. a continuous emotion sequence resulting from the more or less continuous impact of one given event or series of events).

4.3 Interest and its Principles

The act of watching any feature film is accompanied by interest and the origin of its nature and intensity can be found in the characterization of this phenomenon as emotional. Intense interest in the action on the screen is the result of or even part of an emotion and this very fact makes it difficult to suppress, being that interest is seen as a basic emotion (i.e. one that cannot be reduced to one or more other emotions).

Interest is defined as "the inclination to call on resources from a limited capacity and to employ them for the elaboration of a stimulus, under the influence of the promises which are inherent in the present situation with respect to expected situations" [Tan 1996]. Interest during the act of watching films is of a hedonically positive tone because the promises imply the realization of the concerns involved, even though this may only take place at a later stage. Moreover, during the act of watching a film, interest is marked by the inclination to devote one's full attention to the stimulus, at the cost of all other matters, including the completion of motor programs.

Interest, as an emotional structure, bases its definition in the fulfillment of four principles in the context of film watching:

- Principle 1: The appreciation of a film after it has been completely processed must be distinguished from momentary interest. Momentary values of interest are influenced by the stimulus of elements presented earlier in the film but only to the extent these are available in the memory of the subject. Similarly, these values are influenced by expectations about what is to come to the extent that the expectations are based on elements already received and are actually active in the subject's memory.

- Principle 2: There is a positive relation between interest at any given moment and the anticipated increase in the future net return (i.e. interest expectation) expected at any moment. From the beginning of the story, the viewer has a preference for a certain development; that preference is determined by the desire for cognitive closure, one that does justice to the viewer's sympathies and values. As the film narrative proceeds, these preferences become stronger, and the viewer forms a more and more detailed image of what the final solution might be.

- Principle 3: Interest at any given moment throughout the film presentation time is (a) positively related to the prospect of the greatest possible background net return (i.e. base interest expectation) and (b) higher, the more favourably, the greatest possible foreground net return (i.e. current interest expectation) of the present action sequence compares with the foreground net return already gained, the foreground net return always weighing more heavily that the background net return. Past and future, in this case, refer to the time taken up by the act of watching the film – which is the same as the presentation time – and not to the fictional time in the diegetic world and the relationship between foreground and background net return is such that the background net return determines the relatively stable baseline value of interest, while the foreground net return causes the more rapid fluctuations around this value.

- Principle 4: The action tendency inherent in interest raises the investment and this increase, in turn, has a positive effect on interest by increasing the contrast between net return already gained and the maximum future return that can be expected. In other words, the higher the interest, the greater the active participation of the viewer in the

> reception process, which results in an increase in the previously mentioned cognitive and emotional processes. By looking back in the story presentation time, we can say that the more effort that has been put into the return that has been gained, the more pleasure it affords. And by looking forward in the story presentation time, the investment enhances the appeal of the anticipated return, which, in turn, increases the willingness to invest.

One of the most important consequences of the operation of these principles is that during the act of watching a traditional film, interest tends to steadily increase, due to the fact that the narrative postpones closure. And interest is also subject to inertia, meaning that at some point in the film, interest reaches an intensity value that makes it improbable, if not impossible, for it to drop back to zero.

Traditional cinema initiates two episodes: the first is that of the film narrative, in which a film story develops along the structured lines of Balance, a Complication, and the Restoration of the Balance. The second is an emotion episode on the part of the viewer, in which interest dominates. Interest, being an emotion, makes it possible relational action, even if the action is only cognitive. It makes the viewer willing to make a true effort: to devote one's attention to the film, to go along with the narrative, to form an idea of a story that is often recounted in a highly fragmented manner. As the ever-present and self-enhancing emotion, interest dominates the affect structure of the traditional film as a permanent emotion.

4.4 Interest in Thematic Structures

Thematic structures (i.e. story structure based on themes) are useful to regulate the viewer's expectations with respect to the course of action in the story. Themes come to be appreciated through social learning mediated by a dominant supply in oral stories, news narratives, fiction books, television drama, and feature films and these different themes have various learned and intrinsic interest values, which determine the number of meaningful inferences the viewer will make at any particular point in the processing of a story. Thematic structures are the only ones capable of explaining the mechanism of interest when they promise not only complications but also satisfactory outcomes.

The thematic structure must offer at least a minimal, real possibility that solutions will be found in the complications, with a solution simply meaning that complications have smoothed over, contrasts reconciled, and unpleasantness rendered bearable. Themes hold out to viewers the promise of emotions, which are precisely the emotions they are waiting for: those generated by the complications in the story and their resolution. A theme enhances the potential inclination of the viewer to invest interest because there is an automatically recognized concern that is shared by the viewer in the real world.

4.5 Character Empathy and Interest

As a film viewer, one does not only entertain the illusion that one is present in the scene – the diegetic effect – but also one may even feel that to a greater or lesser degree the adventures of the protagonist are actually happening to oneself. As a result, the processes of empathy involved in the viewing of a traditional film make up a large proportion of the determinants of interest. This empathy, or character identification, requires no in-depth psychological explanation, because, given the diegetic effect, it flows directly from the viewer's attention to, and comprehension of, the film. Viewers are justified in seeing the comprehension of characters as a guided impression formation that extends to the entire film narrative.

An empathetic emotion is characterized by the valence of the events in relation to the concerns of the protagonist, with empathy being all the cognitive operations on the part of the viewer that lead to a more complete understanding of the situational meaning for the character. Because the viewer cannot share the concerns of all the characters – by the very nature of the narrative, these are mutually contradictory – the empathetic emotions felt by the viewer often do not correspond to the feelings of any particular character. And yet these emotions may be seen as empathetic, because their quality is determined by the viewer's understanding of the situational meaning for the character.

In the context of empathetic emotions, there are three major emotions that normally arise in every traditional film:

- Sympathy: Sympathy is, alongside interest, the most important sensation evoked by the traditional film. Sympathy is a positive emotion, a pleasurable experience, as when one entertains warm feelings for one of the characters. These feelings of sympathy can be measured by asking subjects to rate their warm feeling on a numerical scale, since it is a very notorious and long lasting emotion, which is accompanied by physiological arousal and intensified by the real or imaginary experience of a romantic, friendly, or family relationship.

- Admiration: In this case, superiority, rather than equality, is an element of the imaginary situational meaning structure for the character. Admiration may also be accompanied by symbolic activity, such as imitation.

- Compassion: In this case, the character is perceived as inferior by the viewer. The action tendency in the viewer involves an inclination to protect, to help, and to console.

Sympathy, admiration, and compassion appear in a variety of combinations during the watching of traditional films. To the three major empathetic emotions may be added others, such as gratitude, anger, envy, contempt, embarrassment, etc. These often complement the first three, forming a response to attendant features of the situation that evokes sympathy, compassion, or admiration. In the traditional film, the promise of an improvement in the situation of the protagonist never drops to absolute zero and, thanks to that promise, every empathetic emotion is accompanied by interest, the urge to know what will happen next.

4.6 Normal Interest Pattern in a Story

Taking into consideration all the aspects regarding interest that have been detailed in the previous section, the course of interest in a story (i.e. the evolution of a viewer's interest during the presentation of a story) are determined by these characteristics:

- Interest always increases in the course of a story as a whole.
- It is not until the end of the story that interest again decreases, when the final results of the last episode are made known.
- The level of interest may vary considerably from one episode to the next. All stories display not only moments of high tension but also scenes of repose, intermezzi that gives the viewers a chance to catch their breath
- The conventional scene often begins with some form of introduction. As a result, the beginning of a scene is accompanied by a fall in interest, after which interest rises again

> and then falls again, though not reaching its initial value. The characteristic course of interest within the scene would then take the form of an “n”, whereby the vertical on the right is higher than the one on the left.

In this chapter, I have reviewed some of the main concepts that describe interest as one of the most important, if not the most important, emotional attribute in any narrative. In the next chapter, I will detail how the concepts defined until now are implemented in my storytelling model.

Chapter Five: The ISRST Semantic Ontology Model

Taking into consideration the conceptual ideas described in the previous chapters, I identified the main objects that were to be considered in the ISRST model in order to create my semantic storytelling framework. As a result, I created my ISRST Ontology Model with the following main classes:

- Concept: A Concept defines a specific topic that a story or part of it may refer about.
- Event: An Event is defined as a single piece of meaningful information worthy of being presented. See Section 6.1 for more details on how events are constructed in ISRST.
- Relation: A Relation is the rhetorical binding between two entities (Event or Scene), which refers to a specific semantic meaning.
- Agent: An Agent is an entity in a story that is used as an interest target.
- Origin and Destiny: This pair of classes defines the position of a determined Event or Scene in a Relation.
- Scene: A Scene is defined as a graph-like structure composed of Relations. This class defines the minimum level of organization in which a story arises.
- Episode: An Episode is defined as the associative object between a Scene and a Concept.
- Story: A Story class frames the whole story and is composed of one or more Episodes.

The ExitPoint, EntryPoint, RelationType, and InfoType classes are used to specify the exit and entry points of a Scene, the name of a relation in the Relation class, and the type of information (Nucleus or Satellite) of the content referenced in the Origin and Destiny objects. The complete diagram for the ontology model is shown in the next figure.

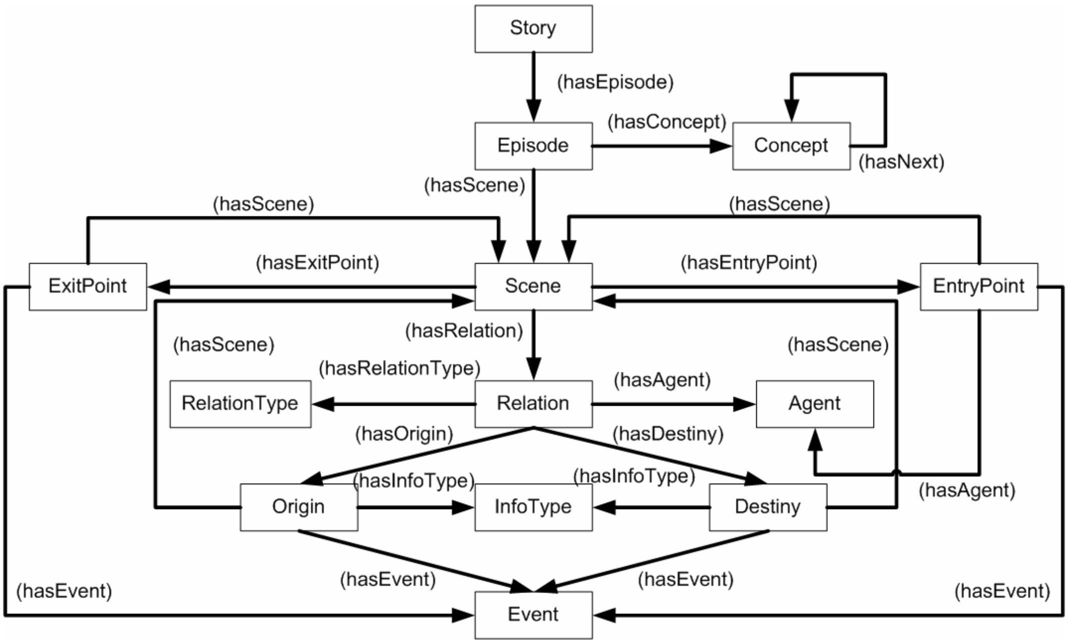


Figure 8: The ISRST Ontology Class Diagram

In the next sections, I will give a detailed insight on some of the main classes and their contribution to the story construction and presentation processes in ISRST.

5.1 The ISRST Scene Structure

RST not only proposes the use of rhetorical relations to link two events together, but also defines the whole structure with which the related events are to be organized. Due to the fact that RST was mainly created to deal with hierarchical analyses of text, the structure used in RST for event organization was the tree (See Figure 6). In my first storytelling ontology model known as SRST, I exactly reproduced the RST tree for my event organization model. Nevertheless, this structure presented a serious challenge not only to content creation, but also to interactivity. In terms of content creation, a tree structure does not give the author enough flexibility and clarity to create his or her story content; for instance, when he or she wants to define alternative beginnings and/or endings. In terms of interactivity, a tree structure gives us only the possibility of one entry and one exit point in the story at any moment (i.e. the root of the tree or sub tree), which limits the ability of the engine to have more variety in terms of event selection. For a more detailed explanation about the functional characteristics of SRST, refer to my other publications.

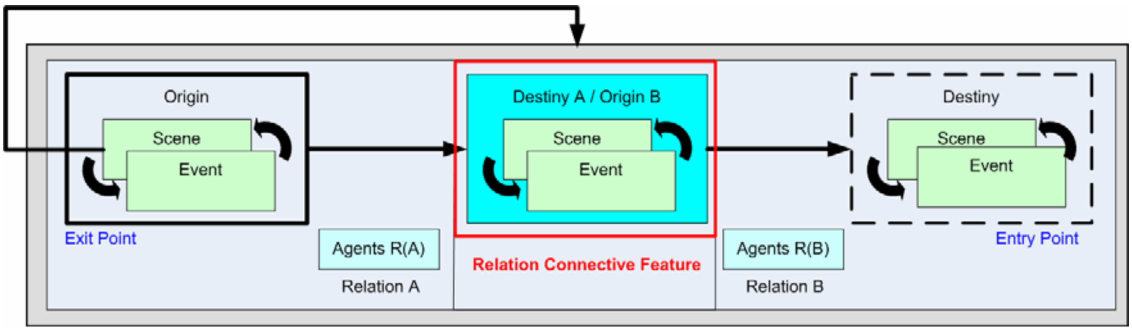


Figure 9: ISRST Scene Structure - Logical Design Diagram

To overcome these inconveniences in ISRST, I designed a more flexible event organization structure called Scene which is based on the capability to associate any two events by using a relation, including in it as many relations as desired. Hence, the Scene structure was implemented as a directed graph in which each node represents either an Event or another Scene (inside an Origin or Destiny object) and each link represents the relation that joins any two of these nodes. Figure 9 shows the logical design diagram for the Scene structure, and Figure 10 shows its general schema written in XML.

This structure provides not only the most convenient way to implement the majority of the conceptual ideas described above, but also the most flexible organization capable of supporting a highly dynamic story event sequencing process.

```
<Scene>
   <hasEntryPoint>(Reference of Event or Scene)
      <hasAgent rdf:resource="(object of agent)" />
        .
        .
   </hasEntryPoint>
   <hasExitPoint>(References of Events or Scenes)</hasExitPoint>
   <hasRelation>
      <Relation ID = "(Relation ID)">
         <hasRelationType rdf:resource="(object of relation type)"/>
         <hasOrigin>
            <Origin>
              <hasInfoType>(NUCLEUS or SATELLITE)</hasInfoType>
              [<Scene> ... </Scene>]

              [<Event>
                 <rdfs:comment rdf:datatype="XMLSchema#string">(Whatever the Event)</rdfs:comment>
              </Event>]
            </Origin>
         </hasOrigin>
         <hasDestiny>
            <Destiny>
              <hasInfoType>(NUCLEUS or SATELLITE)</hasInfoType>
              [<Scene> ... </Scene>]

              [<Event>
                 <rdfs:comment rdf:datatype="XMLSchema#string">(Whatever the Event)</rdfs:comment>
              </Event>]
            </Destiny>
         </hasDestiny>
         <hasAgent rdf:resource="(object of agent)" />
                        .
                        .
      <Relation>
   </hasRelation>
   <hasRelation> ... </hasRelation>
      .
      .
</Scene>
```

Figure 10: General Schema of the ISRST Scene Structure

A Scene is primarily composed by one or more Relations, which are the objects that represent the relation concept defined in Sections 3.1 and 3.4. To fully identify these Relation objects, we defined four attributes that must be specified for each one of them:

- The Relation's Name: This indicates the type of relation that links events or scenes (e.g. BACKGROUND, CAUSE, etc.)
- The Relation's Directionality: This is determined through the specification of the Origin and Destiny components. These objects can reference as their content either an event or another scene, which provides construction flexibility through the use of recursion.
- Nucleus and Satellite Properties: Both the Origin and Destiny objects must define if their content is of Nucleus type (mandatory) or Satellite type (optional).
- The Relation's Agency: A Relation object must specify one or more agents as POV attributes of the Relation (e.g. Agents R(A) and Agents R(B) in the diagram, which are also specified by the hasAgent tag in the XML schema).

In order to connect two relations in a scene, the origin component of one relation must match the destiny component of the other. By using this connective feature of the scene structure, we can generate complex links of relations to describe stories. Connections between relations are important for story coherence and event sequencing, which is performed using the narrative concept of Advancing the Story, explained in Section 5.3.1.

Additionally to the relation list, a scene makes use of two other attributes that help the storytelling engine deliver the scene content: the Entry Point and the Exit Point attributes.

The Entry Point specifies the first event (or scene) that is going to be delivered at the beginning of the Scene. This definition does not imply that the scene must begin with any specific relation, but only defines the starting position from which relations will be selected when the storytelling process commences. The Entry Point also defines the agents to which the effects of the first event (or scene) will be applied. This allows the story author to define a starting position in terms of agent empathy so that ISRST may be able to begin the computation of the user's interest based on this first assumption.

In contrast, the Exit Point is defined exclusively by the event (or scene) in which the scene ends. As a rule, each scene must contain a unique entry point, but may have one of more exit points. This characteristic of the scene structure allows the creation of different story lines inside the scene itself, giving the story author enough flexibility in terms of alternative content selectiveness.

5.2 Story, Episodes, and Concepts in ISRST

Even though the flexibility of the scene structure allows us to create rather complex interconnections between events and other scenes through relations, this feature is not enough to deal with the Story Concept Network idea because of the recursive nature of the scene structure itself. If concepts were to be implemented at the scene level, a story author might find himself or herself in the position of specifying concepts even for nested scenes, which results impractical and does not reflect the true meaning of what a Story Concept is.

Therefore, in addition to the Scene object, the ISRST model defines the Story, Episode, and Concept objects that establish the framework for the creation of scene based stories and give support for the specification of Concept Networks. In ISRST, a Concept object is uniquely associated with an Episode object, which, in turn, can contain one or more Scene objects. The advantage of using an Episode object as a proxy between the Concept and Scene objects lies in the fact that an Episode not only clearly specifies the boundary between concept and content in a story, but also demarcates its emotive boundaries, which is useful when dealing with content authoring and interest associations to agents.

5.3 Narrative Properties in ISRST

So far, I have discussed and defined the components that are necessary to create a full semantic storytelling model. Nevertheless, these components only specify how a story is to be organized, but not how a story is to be presented or how narrative principles can be applied in order to convey the content of the story structure in a story-like manner. In this section, I will discuss the two principles implemented in ISRST that add the narrative quality to the model: the concept of Advancing the Story, which deals with the transition process inside a relation, and the concept of Relation Narrative Template, which deals with the transition process between relations.

5.3.1 The Concept of Advancing the Story

Most rhetorical relations do not clearly imply a temporal attribute between the events they relate (e.g. the background event is not necessarily shown before the event that refers to it). Therefore, I defined a concept that would allow us to make a sequence, in terms of time, of the events that are joined by rhetorical relations known as Advancing the Story. The purpose of this concept is to allow the story engine to move through the graph structure created by all the Relation objects in a particular scene, establishing the conditions by which the engine can traverse from one component of the relation to the other.

Given a relation specified by $A \xrightarrow{R(X)} B$, I defined the concept of Advancing the Story through the Relation R if the story's current position, being located at the event/scene B goes to show the contents of the event/scene A through the relation R(X) and moves the story's current position to A. In other words, at any moment in the presentation of the story, ISRST analyzes all the incoming relations to the current event/scene (i.e. the relations that have the event/scene specified as their destiny component), and moves to the origin of the relation that includes the event that will be shown next. This concept may seem contradictory since ISRST appears to be going backwards in the relation, but we defined this way of processing because:

- It gives a unified model for creating relations in a story. For instance, the CAUSE relation is normally understood as a relation that goes from A to B, but the ELABORATION relation is better understood as a relation that goes from B to A. Since different relations have different ways in which their directionality can be interpreted, the definition of a unique advancing paradigm simplifies the understanding of this concept.

- Not all relations follow the pattern of advancing described above. For example, the CAUSE relation indicates that event A is the cause of event B, but does not necessarily imply that the story moves forward when going to A. These special cases are dealt accordingly, but if we were to specify any relation by its pseudo-temporal attribute, we may end up having a non-uniform model for content creation. From our point of view, it is much better if these particularities are dealt by ISRST and not by the story author.

Since not all rhetorical relations have the capacity of moving the story forward, I also used the concept of advancing the story to categorize our relations based on this ability. In ISRST, I defined a relation as advancing when it allows the flow of the story to continue from the destiny to the origin of that relation, and as non-advancing when, even though the event or scene in the origin has already been presented, the story's current position remains the same. The following rhetorical relations were defined as advancing in ISRST: CONTRAST, SOLUTIONHOOD, EVALUATION, SEQUENCE, PURPOSE, and RESULT.

5.3.2 The Concept of Relation Narrative Template

In a general sense, stories follow a fixed narrative structure that consists on an introduction or explanation of the current state of affairs, a conflict or a change of such state, a resolution of the conflict, and a conclusion, and this is the template agreed by most narratologists [Bordwell 1986]. In order to integrate this concept of narrative template in ISRST, we also performed a classification in our set of rhetorical relations to determine which ones belong either exclusively or generally to each of its phases.

Nevertheless, I also took into consideration the fact that each phase must allow the proper relations for the story to advance, and therefore, not go against the Concept of Advancing the Story. Hence, my implemented narrative structure contemplates the following narrative phases:

- *Story Introduction*: Only the BACKGROUND relation is used to specify the introduction of a story. The complexity of an introduction phase will come from the fact that a background relation can link either an event or a full scene structure, which may have its own background. The non-advancing quality of the BACKGROUND relation defines precisely what a story introduction is compared to the idea of moving the story forward.

- *Story Conflict*: Only the CONTRAST relation is considered as the initiator of conflict, or the crisis introducer. Again, the contrast relation can associate either two events or two scenes for more complex constructions.
- *Story Resolution*: Only the SOLUTIONHOOD relation is considered as the initiator for the path to climax in the story
- *Story Conclusion*: Only the EVALUATION relation is considered as the initiator for the final conclusion or epilogue of the story

The remaining relations are classified as Generic Relations. They can be included in any phase of the story, and be used to define more complex structures in terms of relations inside each phase. These relations are: SEQUENCE, ELABORATION, PURPOSE, RESULT, and CAUSE.

5.4 User Interaction in ISRST

Interactivity in storytelling has been implemented in several different ways. Some models regard interactivity as a simple set of menu choices that are presented during the story and others make use of more complex hardware in order to give users a true immersive experience. This view of interactivity concentrates on what users can do and manipulate inside the environment of the story, but not on the layout of the story itself. Even though users have a lot of freedom in most applications like RPGs (Role Playing Games) to shape the story in terms of content as they wish, it can be argued that almost none of these systems attempt to map these interactions to the actual feeling of interest of the user which relates to how he or she wants the story to be shaped, not only in event content, but also in event sequencing.

The view of interactivity that ISRST implements addresses the fact that users must be able to "select" which events to see in the story based on their interest as the story progresses. Interest, being a long lasting emotion, can shape the sequencing of the story in terms of what the user believes to feel at a particular moment. Even though a story can elicit several kinds of short lived emotions like joy, anger, and so on, interest remains as the sole emotion that can accurately determine whether a story is following the right path from the users' point of view [Tan 1996]. In ISRST, interest based interaction was designed to fulfill two major aspects of interest evaluation in storytelling:

- *Overall Interest Evaluation*, based on Zillmann's hedonistic theory of the affect regulation function of entertainment [Zillmann 1988], measures general levels of user interest for the whole story experience. The hedonistic theory states that in the case of extreme understimulation (too little interest), users display certain preference for potentially arousing stimuli and in the case of extreme overstimulation (too much interest), the reverse effect is perceived. In other words, the interest of the user should be kept inside some boundaries in order to not disturb his or her experience in the story.

- *Agent Interest Evaluation*, which is based on the fact that the processes of identification or empathy towards a character involved in the viewing of a story make up a large proportion of the determinants of interest [Tan 1996]. Since character (agent) empathy is one of the major components of the user's interest in any story, ISRST isolates this special case from the overall evaluation to properly emphasize the contribution of the user's affective interest. Nevertheless, this type of interest evaluation has almost no effect when there are no empathetic characters present. Thus, in the case of storytelling applications like slide presentations, only the overall evaluation is considered for practical purposes.

In ISRST, the measure of interest is done in a rather direct way by asking users to directly input their interest to the application stored in the form of a numerical value whose range goes from 0 (the lowest value of interest) to 10 (the highest value of interest). Since ISRST was conceived to be deployed as a web application from the beginning, the acquisition of this value is performed using hardware normally available for a web user (e.g. keyboard or mouse). This hardware constraint can be seen as a limitation because of its obtrusiveness, compared to other more sophisticated methods that try to detect the interest of the user, like the use of bio-signals or gaze tracking. Nevertheless, I concluded that my method to collect interest values is the most appropriate for the model because:

- The use of bio-signals to determine user interest is rather ambiguous since real time assessment of physiological data has several problems, such as finding an appropriate baseline (i.e. a condition against which physiological change can be compared), and how the intensity of an emotion, in this case interest, is reflected in the physiological data [Levenson 1988].
- Even though visual attention, accurately detected by gaze tracking algorithms, is highly correlated to some aspects that define interest in a user, the interest defined for stories is more closely related to the emotional aspect than to the visual attention, especially when this interest is directed to a specific entity in the story (e.g. an agent).
- Unlike emotions like joy, sadness, and the like, interest is a rather long lived emotion which can be accurately measured by direct questioning to the user [Tan 1996]. Most

storytelling systems acknowledge this fact when they provide obtrusive interfaces like menu selection or voice commands.

In the next subsections, I will describe in detail the two types of interest evaluation performed by ISRST.

5.4.1 Overall Interest Evaluation

According to the first principle of interest proposed by Ed Tan, momentary values of interest must be influenced by the stimulus elements presented earlier in the story, but only to the extent that these are available in the memory of the user [Tan 1996]. In other words, the true interest of the user at a particular point in a story depends not only on the current interest value at that point, but also on the contribution of previous interest values to the experience. Previous interest values, also known as background interest, define their contribution, not as an isolated set of values, but as a trend that indicates the evolution of the user's interest throughout the whole story experience. When a new interest value is detected from the user, a new background interest is calculated based on how this value affects the previous interest trend. A schema on how this calculation is performed is shown in Figure 11.

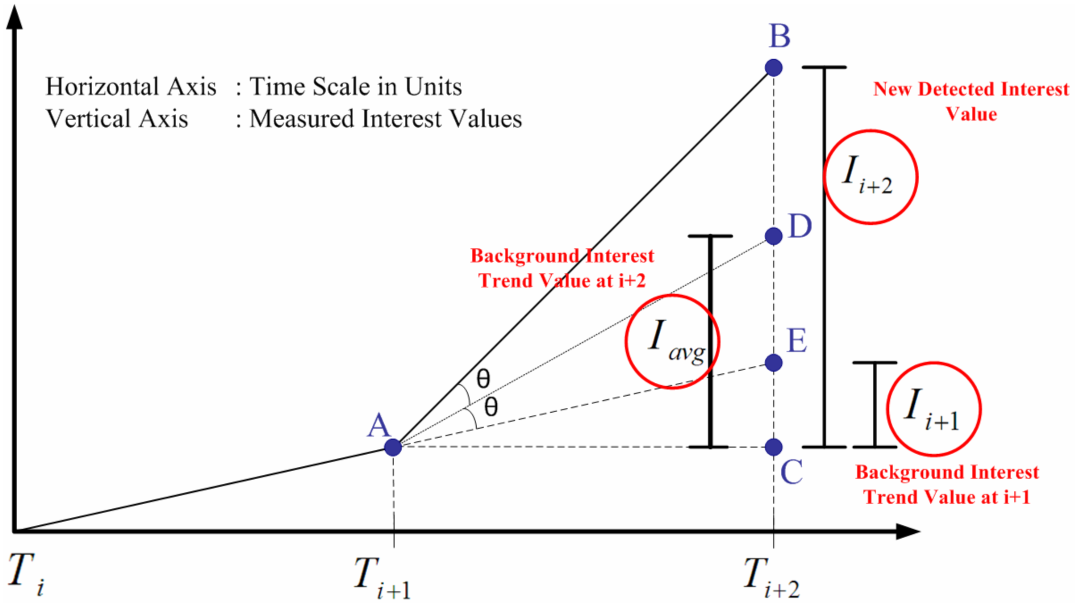


Figure 11: Background Interest Trend Calculation

At some time T_{i+1}, a background interest trend value, defined as I_{i+1}, represents the averaged trend value of the contribution of previous interest values that range from T_0 up to T_{i+1}. When a new interest value I_{i+2} is detected from the user at time T_{i+2}, the new background interest trend value at that point (I_{avg}) is obtained by calculating the slope average between I_{i+2} and I_{i+1}. In this case, the slope average accurately reflects the real contribution of the new interest value by modifying the background interest, not in number, but in orientation. According to the diagram above, the new background interest trend value is calculated using the following formula (assuming the time intervals constant):

$$I_{avg} = \tan\left(\frac{\arctan(I_{i+1}) + \arctan(I_{i+2})}{2}\right)$$

Geometrically speaking, this value represents the distance CD formed when the line that bisects the angle formed by both the old background interest value and the new interest value (angle

BAE) intersects the segment CE. In ISRST, I call this value the Overall Interest Value, and it is calculated every time a new interest value from the user is input in the application.

5.4.2 Agent Interest Evaluation

Interest values are not only influenced by previous stimulus presented in the story, but also by expectations about what is to come to the extent that the expectations are based on elements already received and are actually active in the user's memory. Most of these active elements are represented by the characters or agents that take part as actors in each event, since empathetic emotions, such as interest, are characterized by the valence of the events in relation to the concerns of the characters [Tan 1996]. Therefore, it is plausible to assume that if the user has certain level of interest while a particular set of agents bear the consequences of the actions in the event that is currently being shown, that level of interest can be attached not only to the overall feeling of the story, but also to each of the affected agents.

In order to implement this feature in ISRST, each agent is associated to a value that indicates the overall absolute average of interest calculated by averaging all the individual interest values that the user conveyed when that agent was active (i.e. was being shown or was bearer of an action's consequences) in the story. Unlike the Overall Interest Evaluation case, the Agent Interest Evaluation is performed on absolute numerical interest values and not on trends, since what determines the user's interest in an agent is not dependant on the smoothness of the flow in the story, but on empathetic emotions (e.g. sympathy for the agent) that tend to be more fluctuating.

In ISRST, I call this value the Agent Interest Value, which is also calculated every time a new interest value from the user is input in the application.

5.5 Telling an Interesting Story in ISRST

The main processes of the ISRST engine were constructed under a principle of strict modularity, which allowed me to have a very clear separation between the visual component of the application and the story ontology reasoning component. This distinction is primordial not only to have a properly defined functional division, but also to guarantee the independency of the model itself. Therefore, to isolate the event sequencing process of a story from the actual presentation process, the ontology component of the ISRST engine encapsulates in it all the complexity of the story structure and its status variables and provides an interface whose sole function is to deliver the appropriate next event taking into consideration the changes in the environment of the user and the story.

The diagram of the algorithm for that interface is shown in Figure 12.

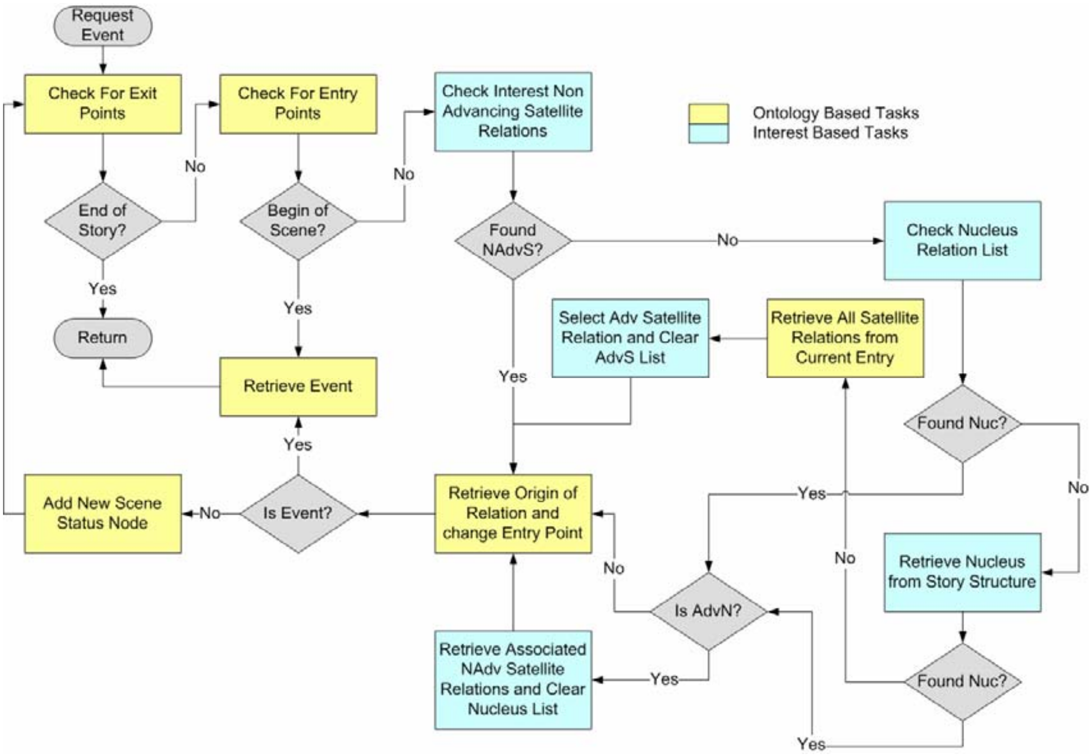


Figure 12: The Event Retrieval Function Diagram

In order to select the most appropriate next event, the ISRST ontology component (OC) performs the following procedures and decisions:

- Check if an Exit Point on the currently active Scene has been reached. As part of the set of internal variables that the OC stores is a queue of objects called `SceneStatusList`, which stores the information about the scenes that the story will show. When an exit point has been reached, the OC removes the correspondent Scene object in the queue and searches for its parent scene recursively upwards until it finds one with a current position that is not an exit point itself. If the OC cannot find any parent scene, it means that it has reached the end of the whole story and, therefore, returns a token confirming such condition.

- Check if the current position in the active scene corresponds to the entry point of that scene. If the OC detects that no event from that Scene has been previously shown, it retrieves the object indicated by the entry point. If the object is an Event, it establishes it as the function's return value. If the object is a Scene, the OC stores the information of the currently active scene object in the `SceneStatusList` queue and sets the new scene object as the currently active one. The OC performs this process recursively until a valid entry point in the form of an event can be found. If no event is found, the OC returns a token indicating a story structure error (i.e. invalid entry point in the scene).

- If a valid current position is found (i.e. an event in the scene that has already been shown), the next event is determined based not only on the story structure criteria, but also on the registered interest values from the user. In this context, the classification of relations in advancing and non-advancing plays a very important role to determine which content can move the story forward and which content provides additional information to satisfy the hedonistic attribute of the user's interest. By combining the analysis of this classification with the nucleus-satellite property of the components of the relations and the user's interest values, the OC makes a structured search for the next event, giving priority to the interest of the user over the narrative-wise predefined sequencing of the story itself. The steps that the OC performs are:

    - Check for Non Advancing Satellite Relations: The first step in order to select the next Event in a story is to analyze the current level of the user's interest, by performing an Overall Interest Evaluation (see Section 5.4.1 for details on how to calculate the overall interest). When the overall interest trend average falls inside the range of normal threshold values defined as parameters in ISRST, this step is skipped. Nevertheless, when this average falls outside the range, the OC assumes that the user needs additional and non essential information to keep him or her from being overstimulated or understimulated. A Relation that contains non essential information (Non Advancing Satellite Relation) is a relation that (1) has a satellite origin entity, and (2) does not move forward the story. These two requirements are necessary for the OC to be able to maintain the coherence in the main story. In order to select the best relation, the list in which this non essential information is stored, called the `SatelliteNAdvList`, is ordered by the following criteria in this order: Agent Interest, Relation Proximity, and Relation Template (see Section 5.5.1 for more details on the ordering criteria). Once the list is ordered, the OC picks the topmost relation as its first candidate. The only difference between the understimulation and overstimulation cases lies in the way the list is ordered by the Agent Interest criterion. For understimulation it is regarded as more pleasurable for the user if the selected relation contains an agent in which he or she has the most interest in, whereas for overstimulation, it is assumed that a relation with an agent in which he or she has the least interest in could help the user calm down and enjoy other agents of the story as well.

- Check for Nucleus Relations: If the Overall Interest Evaluation regarded the user's interest as stable (i.e. within normal interest threshold values), the OC checks from the current position for any relations that have nucleus origin entities in them (i.e. Nucleus Relation). The main requirement for the selection of nucleus relations is that they all must be presented, regardless of the user's level of interest. Therefore, in order to decide which nucleus relations come first, found relations are stored in a list called `NucleusList` and sorted by the following criteria in this order: Non Advancing – Advancing Order, Relation Template, and Agent Interest. Unlike the previous case, the emphasis of the order is in the priority of non advancing relations over advancing relations and the narrative quality of the relations, since all the nucleus events in the relations must be shown. Nevertheless, if a nucleus relation that is of the advancing type is found and presented, all other relations in the `NucleusList` list are discarded in order to maintain the coherence of the story structure, which has a higher priority. At this point, before the story moves forward, all the satellite non advancing relations that are also found from this current position are stored in the `SatelliteNAdvList` list for further reference.

- Check for Advancing Satellite Relations: If no nucleus relations were found, the OC looks for advancing satellite relations in order to move the story forward. An Advancing Satellite Relation is a relation that (1) has a satellite origin entity, and (2) moves forward the story. The process for selecting from these types of relations (which are stored in a list called `SatelliteAdvList`) is similar to the process for selecting Non Advancing Satellite Relations (minus the ordering by the Relation Proximity criterion). The main difference lies in the fact that, since the selection involves only advancing relations; once a relation is chosen, the other relations in the list are to be discarded in order to maintain the coherence of the story structure, as in the case of the Nucleus Relations processing.

- Once a relation has been selected by any of these three procedures, the OC retrieves the origin entity of the relation, and modifies the current position of the scene if the relation is of the advancing type. If the retrieved entity is an event, it is established as the function's return value. If it is a scene, it is inserted into the `SceneStatusList` queue and the function is called again. If no relation was retrieved, this indicates a story structure error and the function returns a token indicating such condition.

In the next section, we will detail the criteria by which the ordering of the relation lists is performed.

5.5.1 Ordering Criteria for Relation Lists

Depending on which type of relation list the OC extracts the information from, the list needs to be ordered using a determined criteria, so that the OC can find and select the best relation from that list. The implementation of these criteria in ISRST is based on narrative considerations (Section 5.3.2) and the role that interest plays during the story telling process (Section 5.4). The three main ways to order a relation list in ISRST are:

- Relation Template Ordering: The relation list is ordered by the sequence of phases defined in the relation narrative template. In other words, the relations that belong to the Background phase come first, then the relations that belong to the Conflict phase, followed by the relations that belong to the Resolution phase, and, finally, the relations that belong to the Conclusion phase. The purpose of the Relation Template Ordering is to enforce a narrative quality into the relations in the list. When more than one relation is found for a specific phase, the non advancing relations take precedence over the advancing ones.

- Agent Interest Ordering: The relation list is ordered based on the registered level of interest for each of the agents that are active (i.e. are being presented) and defined as part of the relation. The OC orders the internal list of agents based first on their active status and second, on their interest average values. This ordered agent list is then used as a template to order the relation list (i.e. the relations that have agents that are ranked first in the ordered agent list come first)

- Relation Proximity Ordering: The Relation Proximity concept is defined as the distance in relation steps that exists between the previously selected relation associated with the current position and any other relation in the list. The definition of relation step is based on the concept of Advancing the Story. For instance, if a relation in the list was stored before the story advanced N relations (through advancing relations only), then the Relation Proximity factor for the stored relation is N. This factor measures the antiquity of the information in the relation and is useful when the OC needs to decide what type of old information the user would be more incline to accept as part of the natural flow of the story.

In this chapter, I have described the major components and concepts of ISRST and its value in the context of semantic narrative and storytelling paradigms. In the next chapter, I will present the web application that shows the full capabilities of the ISRST model.

Chapter Six: The ISRST Application – Implementing on the Web

The ISRST Application is a fully functional Java based system that implements the concepts from the ISRST model. This application is temporally available for public test at [Nakasone and Ishizuka 2007].

In this section, I will detail the technical features of our ISRST implementation, emphasizing the following aspects: (1) The Presentation Module, which deals with Event specification and presentation in the Web, (2) The Ontology Reasoning Module, and (3) Additional features of the implementation like interest server logging for test studies.

6.1 The Presentation Module

One of the main objectives in the development of ISRST was to provide a flexible way to present different types of story content using a simple interface that could be deployed on the Web for widespread use. For this reason, each major component of the story presentation module was carefully designed or selected to achieve this purpose.

The Presentation module consists on a visual applet that display the story events and additional support Java archives or JARs that enhance its capability to process different types of multimedia content. The next figure shows a screenshot of the application and its main visual components.

Figure 13: ISRST Application - Main Screen

The Presentation Module has four main components:

- The Main Presentation Area: In this area, the content of the story is presented to the user. The current version of my application provides support for the following types of content: text, still images, audio files, and video files. In order to provide the story author with a flexible way to make use of these types of media in any possible combination, I developed the Event Specification Language (ESL), which allows the author to create instruction script files that can generate very complex multimedia events. An example of an ESL file with some implemented commands and the type of provided functionality is shown in Figure 14. Most of this functionality is supported by the standard Java Virtual Machine (my application was implemented using JDK 6.0) except the audio file processing capability (provided by a customized version of JLayer [JLayer]) and the video file processing capability (provided by the Java Media Framework [JMF]). See Appendix A for more information on the supported instructions in ESL and their syntax.

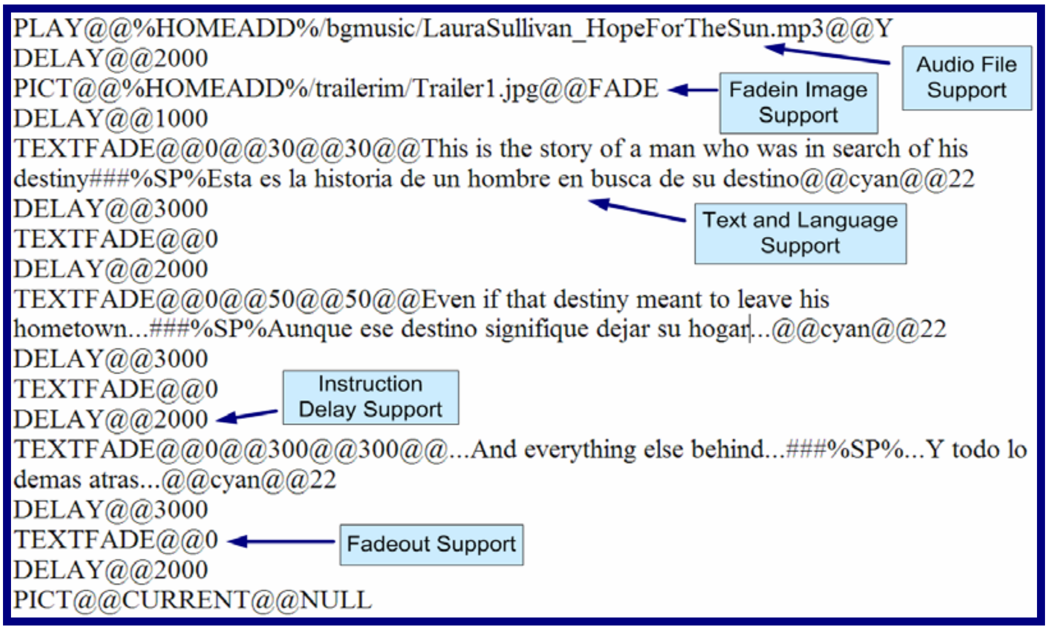


Figure 14: An ESL file sample

- The Story Control Buttons: These buttons are used to start, pause, or stop the execution of the story presentation and provide all the functionality that is needed to control the application.

- The Dialog Speed Selector: In some cases, the speed at which text lines are presented can be too fast or too slow to read for certain users, which can alter his or her level of satisfaction in the story and change it into frustration over the technical aspect of the application. To overcome this problem, this control was introduced to let the user select the speed of the text in the story, which ranges from Slowest (which is about 60% slower than the normal speed defined by the story author) to Fastest (which is about 60% faster than the normal speed).

- The Interest Indicator Bar: In this area of the screen, the interest values detected from the user will be displayed as a gradient of colors, going from the blue color (which indicates the lowest value of interest) to the red color (which indicates the highest value of interest), but internally, this is translated into our predefined numerical scale. Interest values are input into the application by moving the mouse wheel up or down; up indicating increase of interest, and down indicating decrease of it. The detected values are, then, sent asynchronously to the Ontology Reasoning Module to be processed and stored. This method to detect user interest was selected because the display of actual numerical values for interest on the screen may make the user too worried about trying to estimate accurately the level of his or her interest, which could affect his or her experience in the story. A gradient of colors, on the other hand, provides exactly the same functionality, giving a more abstract, but less distracting, way for the user to express his or her feelings.

6.2 The Ontology Reasoning Module

The Ontology module is in charge of the management of the story ontology and provides the reasoning capability to determine the course of the story based on the interest of the user and the story structure itself. ISRST uses the Kaon2 Reasoning Engine [Kaon2], downloaded as a component of the client part of the application, to deal with the specific manipulation of the ontology files that constitute the storytelling model.

This module is the core component of ISRST and performs the following tasks:

- The Initialization Process, which includes the ontology file and story instantiation and the application parameter loading.
- Concept path calculation from story episodes.
- Asynchronous recording of interest log entries.
- Event retrieval based on the process described in Section 5.5.

6.3 Additional Implemented Features

One of the objectives of the ISRST web implementation was to conduct a test of the functionality of the application, and compare it against the level of satisfaction of its users. In order to make the implementation of the tests more flexible, I have also developed additional non functional features that helped me accomplish this goal.

- ISRST Application Parameterization: ISRST was designed to support a large range of configurable parameters that control the reasoning process in the story structure and the interest measurement. Among the different parameters that can be manipulated are: the categorization of advancing relations, the relation proximity distance threshold, the maximum and minimum thresholds for interest values, and the way to choose satellite relations based on interest values.

- Interest Server Logging: Even though the application itself runs on the client side, the interest values that are captured from the user are automatically sent to a server, where it is stored in text files. This allowed me to assess the performance and usability of ISRST regarding the user interest in the application.

- Questionnaire Logging: When the user has finished testing our application, a small questionnaire is presented concerning both the content of the story and the non functional aspects of the application itself. Given the long lasting characteristic of the interest emotion, the use of questionnaires to measure interest has proven to be stable across several conditions of use and provides a good differentiation [Tan 1996].

- Language Support: The very definition of the ESL in text support allows me the possibility to provide content in different languages using the same story and event structure.

6.4 ISRST Design Diagram

In conclusion, Figure 15 shows the complete design diagram for my Web based ISRST Application. In this diagram, I present the main components of the whole ISRST technical solution:

- The Presentation Module: In this module, I implemented the following functionality:
  - The Interest Storing and Logging Module, which is in charge of capturing the values input by the user in regular intervals of time (which can be adjusted accordingly), and sent those values to the Ontology Reasoning Module to be processed along with the event selection process.

- The Story Control Module, which is in charge of controlling the presentation of the story itself through the story control buttons, as well as initializing and finalizing the story telling process.
- The Command Synchronization Component, which is in charge of synchronizing the execution of the ESL instructions
- The Story Visual Component, which is in charge of displaying the results of the execution of the ESL instructions and the definition and instantiation of the appropriate multimedia objects for this purpose.

- The Ontology Reasoning Module: In this module, I implemented the following functionality:
  - The Interest Storing and Logging Module, which is similar to its Presentation Module equivalent, but in this case, its functionality consists on storing the values and making the calculations for overall and agent interest. Also, it is in charge of sending the values to be stored in the server side of the application.
  - The Ontology Initialization and Event Retrieval, which is in charge of initializing the ontology files and retrieve the events in sequence based on the story ontology specifications and the stored interest values.
  - The Story Status Module, which is the core component for the Ontology Reasoning Module, and in charge of storing the status of the whole story telling process at any moment.

- The Support Modules: In this module, I included the following functionality:
  - The audio and video support through the use of external components like Java Media Framework for video and JLayer for audio.

- o The reasoning support given by the Kaon2 Reasoning Engine component.

- The Server Side: The server side of the application was mainly used for storage purposes. Here, I kept the story ontology files, the interest logs and scripts, and the configuration parameter for the client side of ISRST.

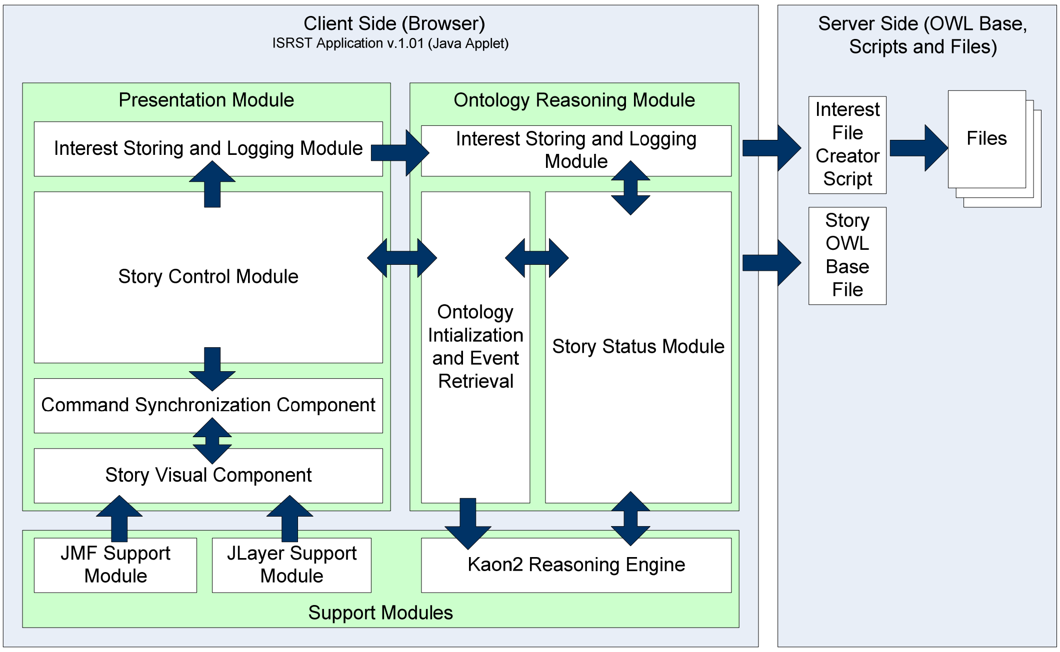


Figure 15: ISRST Application Design Diagram

Chapter Seven: ISRST Story Testing and Analysis

In this chapter, I will describe the story that was used to test my application in a real environment, along with the results I have obtained.

7.1 "When Your Heart Takes Over" – A Real Dramatic Story for ISRST

"When Your Heart Takes Over" (WYHTO) is a dramatic story created for the ISRST application in order to (1) test the full potential of the Ontology Reasoning Module in a real setting, and (2) provide our testing community of users with an engaging and well-constructed story, based on a solid premise and richly developed characters [Egri 1972]. The main objective for the creation of WYHTO was to test the ability of the engine to utilize the registered interest values from the user to select an outcome that is the most satisfying and pleasant for him or her in terms of affective closeness or sympathy for the character included in that particular outcome.

WYHTO is a story that offers episodic emotion sequences combined with dramatic event intensity which will encourage the user to progressively develop feelings towards the protagonists and, consequently, channel his or her interest in the content of the story in a more precise way. The creation of complex stories like WYHTO demands certain requirements and steps to be performed in order to ensure not only its compatibility with ISRST, but also its coherence as a story from a thematic point of view [Tan 1996]. These are the issues that were considered during the creation of WYHTO:

- The thematic approach was devised from the point of view of a traditional feature film, which implies a happy ending and the enforcement of intentional behavior in the protagonists [Bruner 1991a].
- A clearly defined episodic organization, which was used to regulate emotions around particular agents in the story. WYHTO consists of four episodes which provide a full 90 minute story experience. This story structure gave me the possibility to unambiguously associate episodic interest with a particular agent in order to determine the satisfying outcome of the story in a precise way.
- A clear identification of the preference of the user in terms of story content. In my case, the outcome of the story was designed taken into consideration the preferences associated with character empathy that might dwell in the user.
- The generation of empathetic emotions towards the characters. In WYHTO, this empathetic emotion in the form of sympathy not only stimulates the user selection for a preferred outcome, but also makes it possible for ISRST to objectively ask for his or her level of interest at any moment in the story.

Figure 16 shows part of the logical design for the first episode of WYHTO, highlighting the structural aspects of it. In this diagram, events are represented by pictures from the actual story and relations by directed arrows. Entry point events (i.e. pictures with red borders) indicate the events from which the scene will start. Exit point events (i.e. pictures with blue borders) indicate the events in which the scene will end. The relation label over each arrow describes the type of relation and the agent(s) that are affected in it.

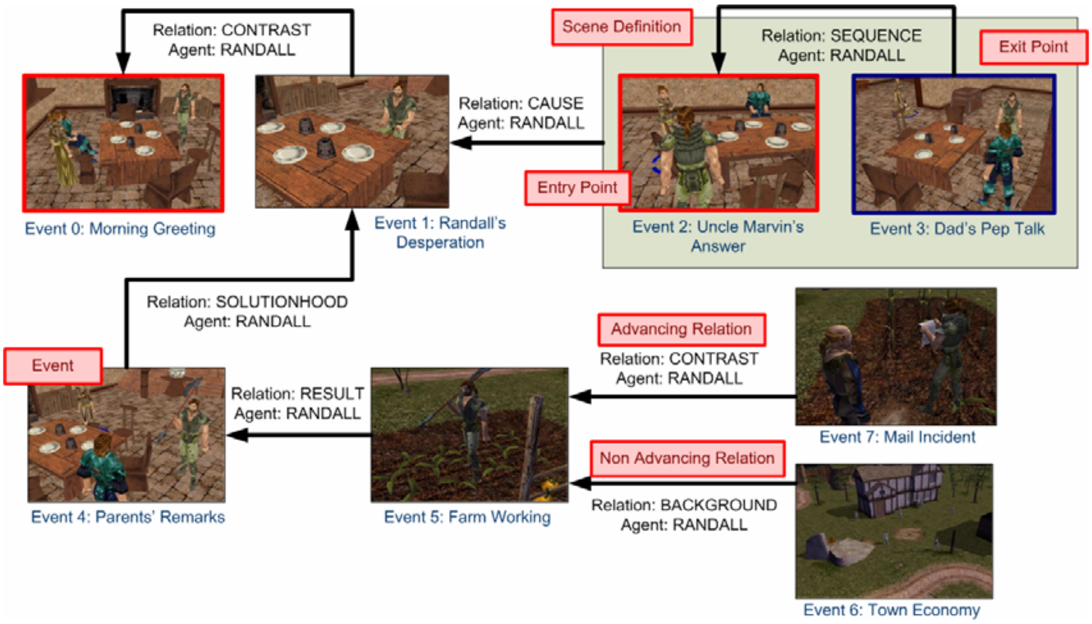


Figure 16: WYHTO Episode 1 - Logical Design Diagram

According to Lang [Lang 1984], dramatic presentations are more effective in producing affect that spoken text. Therefore, to provide a suitable artistic environment to channel the feelings of the users more convincingly, WYHTO events were implemented using the full multimedia capabilities of the presentation module:

- Events were composed of images that were laid using some visual effect techniques like fading.
- Character dialog synchronization which allowed a more dramatic effect in terms of timing
- Background music provided the perfect ambient to perceive the intention of the characters in the story.

7.1.1 Story Data Analysis

WYHTO was purposely designed to enable me to perform a test study in which I could analyze the correlation between the interest of a user in an agent (i.e. agent empathy) and the level of satisfaction in the story given an outcome that emphasizes that particular agent. The results that are given in this section are based on individual experiences. Even though these results cannot be considered statistically significant, I want to emphasize the capacity of the application to deliver interesting stories by showing the experience comparison of a group of people that actually tested this story in its entirety and gave me their extremely valuable comments. Creating interest in the user is not only a matter of crafting a good story, but also giving the story the proper structure so that interest can be aroused, accurately associated to agents, and discerned in order to use it to enhance the experience in the story itself. Therefore, the four-episode structure of WYHTO was defined in order to deal with each of these three aspects, by:

- Providing an episode for interest stabilization (Episode 1). In this episode, the user is encouraged not only to get to know the background of the story, but also to familiarize with the method by which his or her interest is to be measured. This episode is the longest and provides a way for the user to relax and feel comfortable.

- Creating two episodes for interest build-up (Episodes 2 and 3). In the next episodes, the interest values of the user start to be practically associated with agents. In WYHTO, the interest is associated with mainly two Agents, so each episode deals with one particular agent at a time. Since each episode deals only with events that are related to one agent, this allowed me to precisely associate the interest values generated in each episode to that agent.

- Providing an episode that gives a satisfactory outcome based on the interest values measured in the two previous episodes (Episode 4). This final episode provides the climax of the story whose events will be determined based on the preference that the user showed toward one agent or the other and be fulfilling from the point of view of story satisfaction.

For this study, I created two scenarios in order to identify when a high correlation between empathy and satisfactory outcome is more likely to be present.

- Scenario A: The outcome of the story reflects the choice of the user; that is, the agent presented in the outcome episode of the story is the one in which the user showed more interest during the previous episodes.
- Scenario B: The outcome of the story goes against the choice of the user; that is, the agent presented in the outcome episode of the story is not the one in which the user showed more interest during the previous episodes.

My study was carried on with a group of ten people divided into two subgroups. One subgroup tested the application using the Scenario A parameter setting and the other, using the Scenario B parameter setting. Neither of these groups was aware of this discrimination in order to have more objectivity in our study. After the experiment, I compared the overall interest values obtained for the last episode in the story (the outcome episode) with the answers we obtained in our questionnaires about the general user satisfaction about the story.

7.1.1.1 Scenario A – Data Results

The next figure shows the averaged overall interest value calculated for each event in the story. The X axis represents the events in the story which, for the sake of simplicity, were numbered from 0 to 48. The Y axis represents the overall interest value in a scale from 0 to 10, 0 being the lowest interest value, and 10 the highest. The chart distinguishes overall interest values based on the type of ending that the users achieved in the story (i.e. the pink line represents the average of interest values from the users that selected the agent called Laureen as their satisfactory choice, and the blue line represents the average of interest values from the users that selected the agent called Mari as their satisfactory choice). Regardless of the chosen agent, the interest average measured in the outcome episode was 6.60, which indicates a fairly good amount of interest for the pre-selected ending of the story.

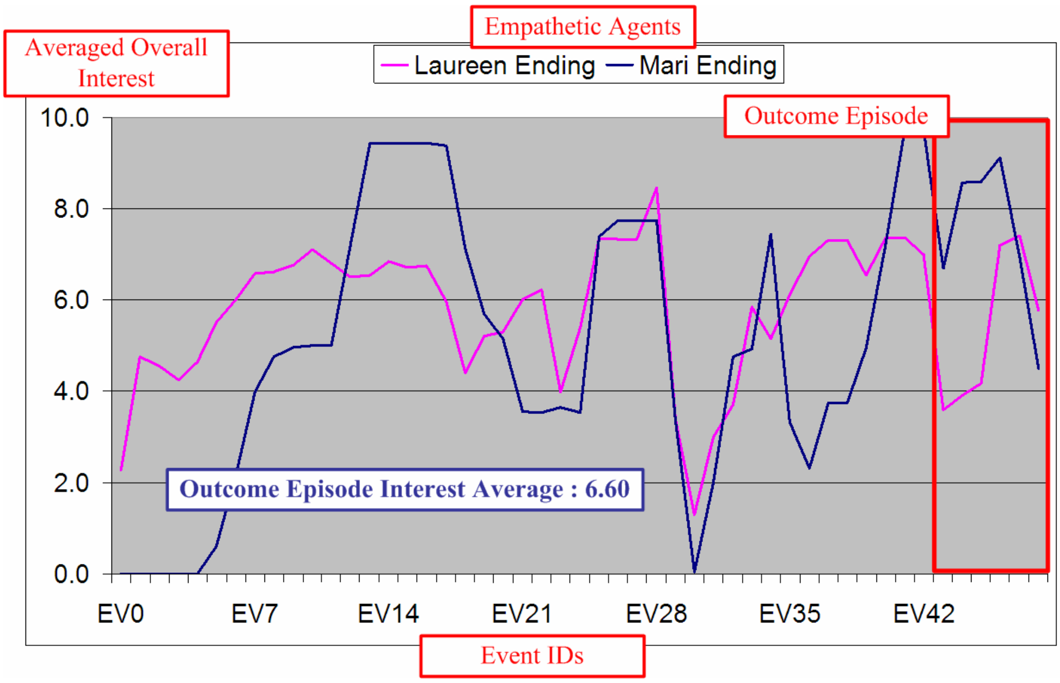


Figure 17: Averaged Overall Interest Value for WYHTO Scenario A

7.1.1.2 Scenario B – Data Results

Similarly to the previous scenario, the next figure also shows the averaged overall interest value calculated for each event in this scenario. Here the interest average measured in the outcome episode was 3.94, which indicates the low level of satisfaction that the users experienced from the pre-selected ending of the story.

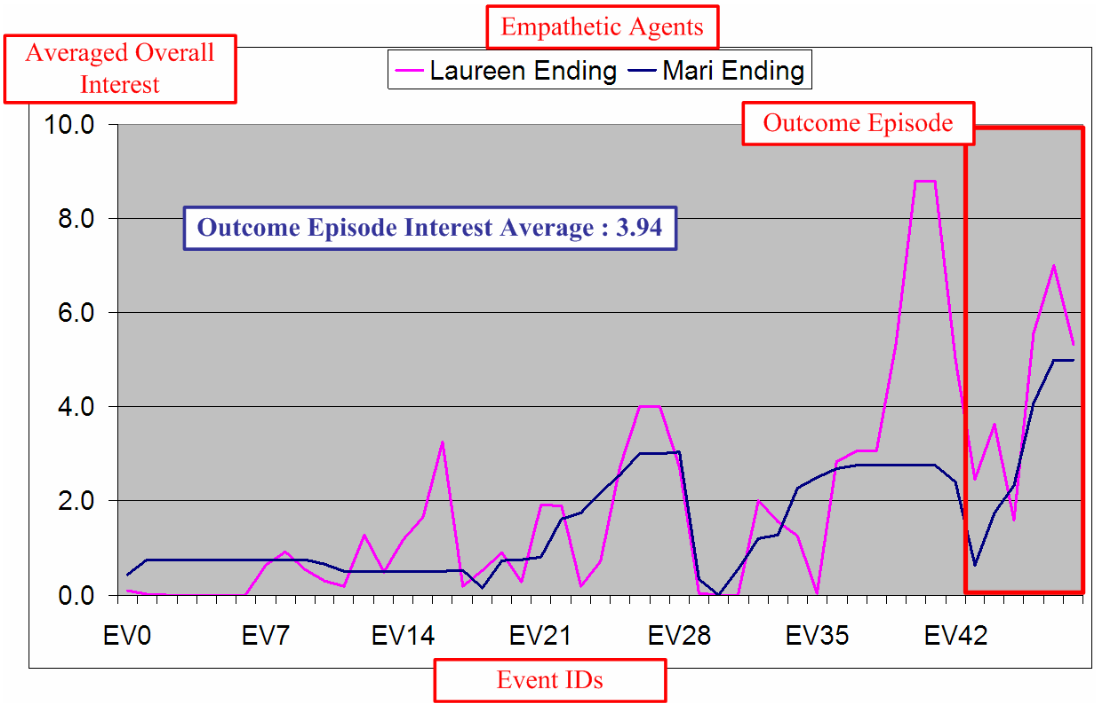


Figure 18: Averaged Overall Interest Value for WYHTO Scenario B

7.1.1.3 Comparative Analysis of both Scenarios

In order to confirm the results obtained by the interest value analyses, I compared the values obtained from our questionnaires in both scenarios to find out if a correlation was also found there. From the set of questions formulated to the user, I analyzed the answers obtained from two of them:

- Overall Enjoyment of the Story: In this question, the user was asked to input his or her level of enjoyment of the story in terms of theme and technical construction. The range of values went from 1 (boring) to 5 (exciting)
- Outcome Satisfaction: In this question, the user was asked to input his or her level of satisfaction with the selected outcome episode. The range of values went from 1 (satisfied) to 3 (not satisfied)

The next table shows the averaged answers from both scenarios.

Questions	Averages Values	
	Scenario A	***Scenario B***
Story Enjoyment	3.95	3.75
Outcome Satisfaction	1.15	2.00

Table 1: Averaged Answers for Scenario Comparison

It can be noticed that the Story Enjoyment values for both scenarios are very similar, which reflects the fact that enjoyment does not only depend on agent empathy, but also from on issues like the topic of the story, the technical implementation (e.g. event pictures, background music, dialog performance), etc. that were not considered in detail for this study. Nevertheless, the Outcome Satisfaction value presents a more distinctive difference, indicating that character empathy detected through interest does have certain influence in the fulfillment of the user's satisfaction.

7.2 "The Scientific Case for Creation" – A Real Presentation Story for ISRST

"The Scientific Case for Creation" (SCC) is a presentation-type story created for the ISRST application in order to test the capabilities of the Ontology Reasoning Module to develop an interest and engaging story based on the emotionless presentation of objective information. The main objective for the creation of SCC was to test the ability of the engine to utilize the registered interest values from the user to select specific details about the information being presented so that his or her interest would remain into an accepted range of interest, denoting satisfaction for such information.

SCC is a presentation story that offers episodic satisfaction sequences based on the conveying of additional information to the mandatory one for each episode. In this case:

- The thematic approach was devised from the point of view of a presentation application, constraining the whole story to one main theme (e.g. evidences for creation) and subdividing such theme into several subtopics (e.g. organic evidence, astronomical evidence, etc.)
- A clearly defined episodic organization, which was used to regulate interest around particular information in the story. SCC consists of two episodes which provide a 30 to

45 minute story experience, depending on the interest shown for each subtopic. This structure gave me the possibility to restrict the use of satellite (optional) information for each presented subtopic.

- A clear identification of the preference of the user in terms of story information.
- The absence of empathetic emotions and characters. In SCC, satisfaction in the story comes from the perspective of presented information.

Figure 19 shows part of the logical design for the first scene in the first episode of SCC, highlighting the structural aspects of it. In this diagram, like in the previous WYHTO diagram, events are represented by pictures from the actual story and relations by directed arrows. Entry point events (i.e. pictures with red borders) indicate the events from which the scene will start. Exit point events (i.e. pictures with blue borders) indicate the events in which the scene will end. The relation label over each arrow describes the type of relation and the agent(s) that are affected in it.

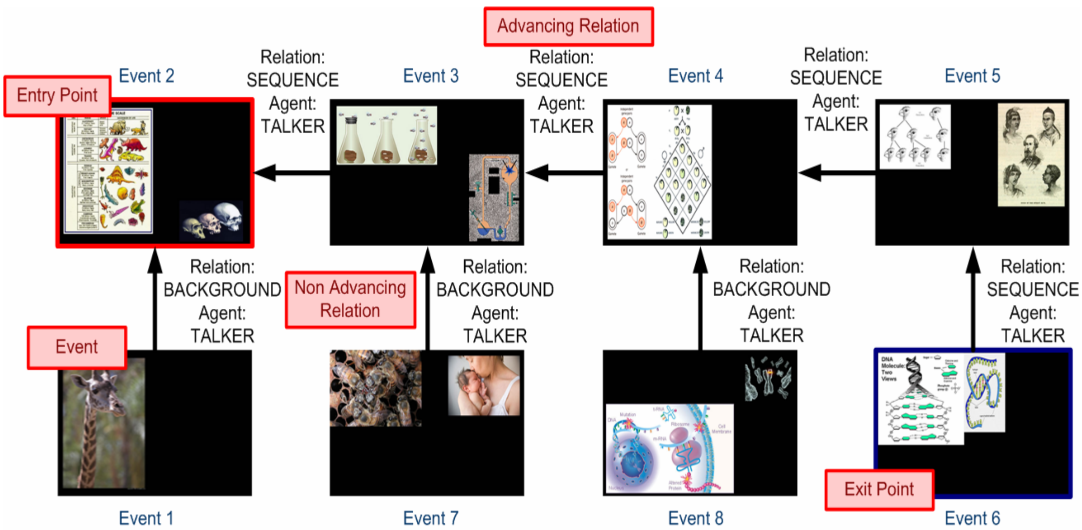


Figure 19: SCC Episode 1, Scene 1 - Logical Design Diagram

7.2.1 Story Data Analysis

SCC was purposely designed to enable me to perform a test study in which I could analyze the correlation between the overall interest of a user and the level of satisfaction in the story given the amount of presented information due to that interest. The results that are given in this section are based on individual experiences. Even though these results cannot be considered statistically significant, as in the case of WYHTO, I want to emphasize the capacity of the application to deliver interesting presentations by showing the experience comparison of people that actually tested this story in its entirety and gave me their extremely valuable comments.

For this study, one unique scenario has been tested:

- Scenario: The presented information in the story varies according to the level of interest of the user. If that level is below 4 out of 10, additional information is presented to enhance the interest and, therefore, the satisfaction in the story. This minimum threshold value has been obtained through empirical analysis of interest.

7.2.1.1 Scenario Data Results

The next figure shows the averaged overall interest value calculated for each event in the story. The X axis represents the events in the story which, for the sake of simplicity, were numbered from 0 to 30. The Y axis represents the overall interest value in a scale from 0 to 10, 0 being the lowest interest value, and 10 the highest. The interest average measured in the outcome episode was 6.53, which indicates a fairly good amount of interest for the pre-selected content of the story. Moreover, a positive evolution in interest for the explained content can be noticed, reinforcing my case in terms of the appropriateness and timing of the presented information.

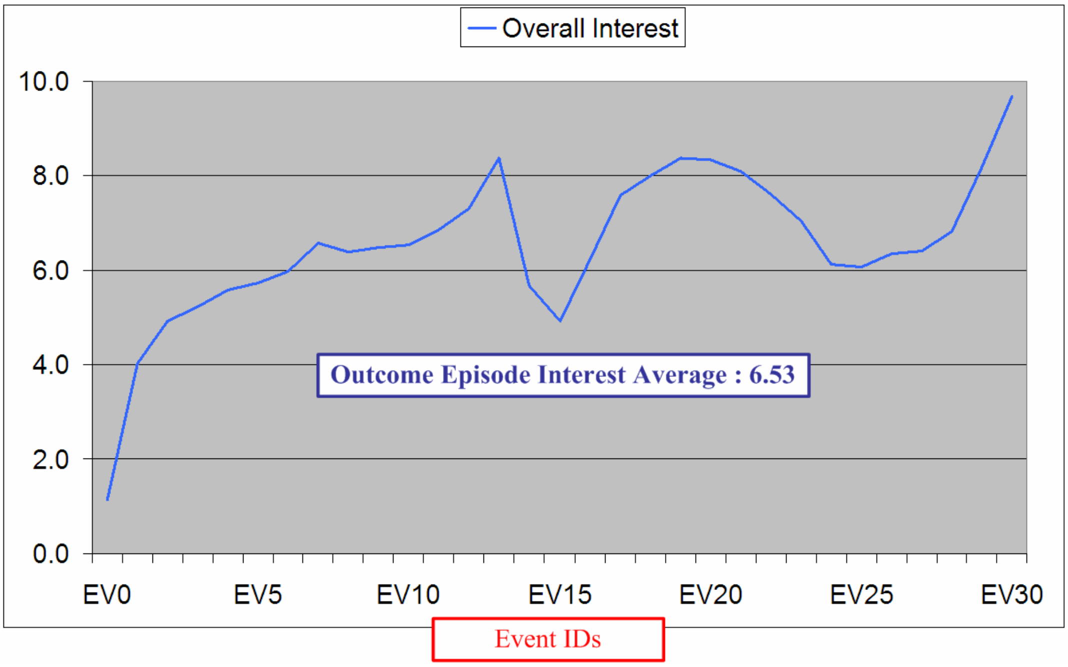


Figure 20: Averaged Overall Interest Value for SCC Scenario

In conclusion, in this chapter I have presented two very different, but equally interesting, real stories that were specifically constructed to test several aspects of my proposed solution, namely:

- “When your Heart takes Over”, to test the ability of the application to correlate agent empathy with story satisfaction, and
- “The Scientific Case for Creation”, to test the ability of the application to correlate overall interest in presented information with story satisfaction.

In the next chapter, I will conclude this thesis by making a summary of my research, and talking about issues for future research directions.

Chapter Eight: Conclusions and Future Research Directions

In this thesis, I have presented ISRST, my proposal for a full semantic storytelling ontology model based on the organization of events using a meaningful subset of relations proposed by the Rhetorical Structure Theory (RST) and narrative principles applied to these RST relations combined with interest measurement to provide a unique interactive storytelling experience. Appropriately selected features give the application a solid base as a storytelling framework and flexibility in story implementation, including:

- The utilization of OWL class structures to define major story components. Although the current functionality is limited to object searching and attribute extraction, the use of this semantic tool gives ISRST the possibility to further encapsulate the model by implementing more complex reasoning inferences involving already implemented classes and real time parameters. In addition, OWL provides to the story author a well-known standard way to create and implement his or her stories.

- The construction of complex multimedia content using ESL. ESL provides not only the way to personalize this content, but also a useful way to synchronize it to enhance a story's presentational effects.

- The ease of web deployment by implementing the whole application in Java. Some extra functionality like online text to speech conversion had to be withheld due to applet restriction issues. Nevertheless, my next version will contemplate the use of signed applets to overcome this technical problem.

- The implementation of a true unobtrusive interaction model through the use of interest, which not only is the most important factor in any user interaction paradigm, but also can be extrapolated to other well known types of interaction methods, such as menu selection, gamepad manipulation, command processing, action perception, etc.

In order to improve ISRST functionality, the following issues have been identified and will be considered for a future version of our application.

- Optimal Parameter Configuration: Fulfilling story experiences can be associated to several conditions, other than the analysis of character empathy from the user's perspective, such as:

    - The relations included in the Relation Template and their order. In this regard, I would like to analyze not only if other relations can be included as exclusive part of the narrative phases, but also if, by extrapolating the association of interest values to relation definitions, I can alter the predetermined narrative order dynamically, so the user will be able to determine the story sequencing from a narrative structure point of view.

    - The threshold values for overall interest trend averages. The current version of ISRST has hard coded values for these thresholds, which was based on empirical studies on interest in feature film presentations [Tan 1996].

    - The ordering of agents based on interest. In a normal scenario case, ISRST was designed to deliver story content based on the maximum value of agent interest, as in WYHTO. In the next version, I would like to implement a dynamic way to select the ordering of agents according to other parameters like the number of agent apparitions, the span of time that has elapsed since the last apparition of an agent, and the relations in which that agent has appeared so far.

- Story Ontology Extension and Interest Association: Even though the Event object was considered a generic definition with no properties attached to it, for the next version of ISRST, I would like to analyze the impact of including some of the following event properties:

    - Location or Place. A Location or Place property will describe the proper physical or virtual space in which the action of the Event takes place. The importance of the Location property lies in the dramatic effect that can be achieved by considering pieces of story shown in determined places and not shown in others. It may also be useful to create some sort of "remembering effect" in the user by showing events that happen in determined locations at some point in the story, based on the level of interest of the user.

    - Prop. A Prop is basically defined as an object in the story around which the plot evolves. For some movies, Props constitute their main motivation. Nevertheless, it is not known if the user interest may be focused solely on a Prop with a significant degree of intensity, enough to guide the story. In order to consider Props, a study may be needed to know if a user can show empathy or sustained interest towards them.

APPENDIX A: ESL LANGUAGE SYNTAX

The current version of ESL supports functionality for multimedia content manipulation and synchronization. This appendix details the functions available in ESL.

MSG: This function displays a message in a dialog box

- Syntax: MSG@@[Message]

REM: It is useful for adding comments to the instruction file. The line that begins with this instruction will not be executed.

- Syntax: REM@@[the message]

VIDEO: Shows a video supported by JMF in the applet.

- Syntax: VIDEO@@[VideoURL]@@[WAIT|NOWAIT|LOOP]

FILE: Opens a file that contains ESL instructions

- Syntax: FILE@@[FileURL]@@[US-ASCII|UTF-16]

PLAY: Plays a MP3 music file

- Syntax:
    - PLAY - Closes player making a fade out
    - PLAY@@[MusicURL]@@[Y|N|W] (Y:loop, N:no loop, W:wait until finish)

DELAY: Waits for a number of milliseconds during the execution of the applet

- Syntax: DELAY@@[Milliseconds]

PICT: Shows a picture in the presentation area of the applet

- Syntax:
  - PICT@@CURRENT@@[NULL|FADE|Alpha] - Erases or fades current picture
  - PICT@@[PictureURL]@@[NORMAL|FADE|Alpha] - Shows a picture in normal, faded mode, or shadowed
- Alpha Value : 0 - Not visible, 255 - Fully visible

TEXT: Shows a piece of text in the presentation area of the applet

- Syntax:
  - TEXT@@[TextSlot] - Erases text in slot
  - TEXT@@[TextSlot]@@X@@Y@@[Text]@@[FontColor]@@[FontSize]
- FontColor and FontSize are optional. The default values are White, size 20.

TEXTFADE: Shows a piece of text like TEXT but with fading effects.

- Syntax:
  - TEXTFADE@@[TextSlot] - Erases text in slot
  - TEXTFADE@@[TextSlot]@@X@@Y@@[Text]@@[FontColor]@@[FontSize]
- FontColor and FontSize are optional. The default values are White, size 20.
- You can specify different languages for [Text] using the following format:
  - [tex1]###[text2]### ... ###[textn]

- One of the pieces of text must be the default text, which is English. This text has no language specification. For the other pieces of text, the language specification goes at the beginning of the text using the following notation:
    - %LANG%[rest of text], where language is a code: SP – Spanish (for now)

- Allowed values for [FontColor]:
    - WHITE, BLUE, CYAN, LIGHTGRAY, MAGENTA, ORANGE, PINK, RED, YELLOW, GREEN, BLACK

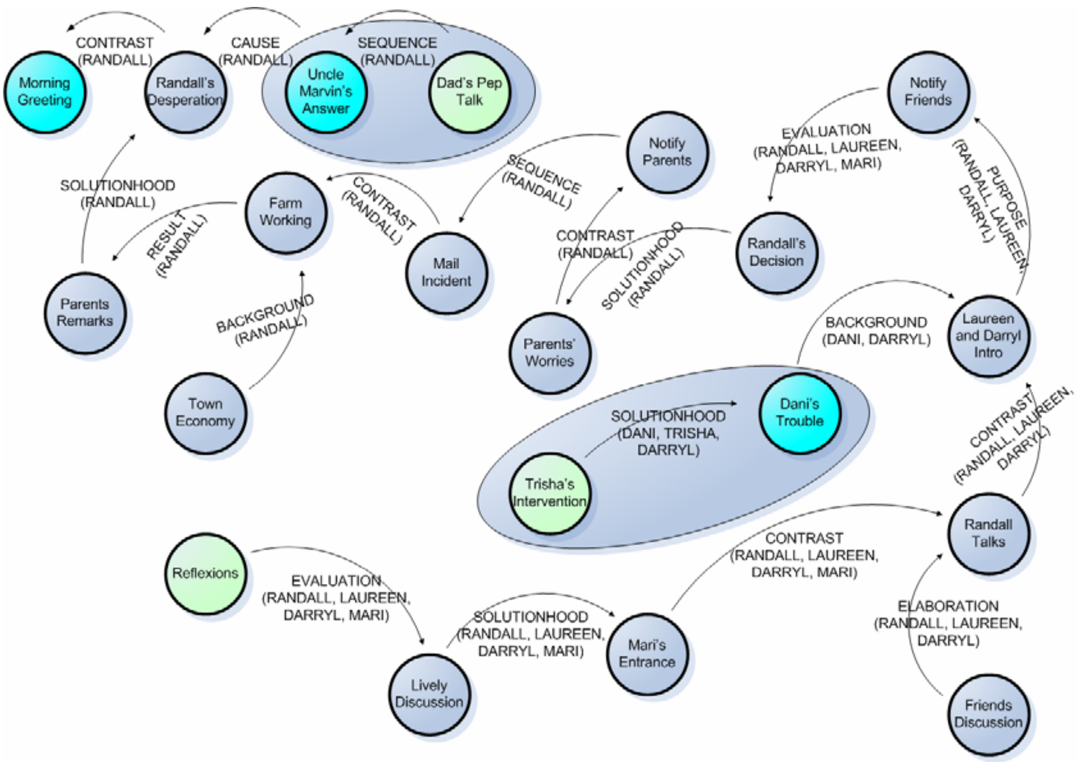
SET: Set application parameters in real time

- Syntax: SET@@[Variable]@@[Value]
- The variables allowed for this instruction are:
    - LINEWRAP [Slot]@@TRUE@@[#cols]@@[#rows] – Activates linewrap functionality for text
    - LINEWRAP [Slot]@@FALSE – Deactivates linewrap functionality for text
    - OPAQUE [TRUE|FALSE] – Set an opaque background for text
    - LANGUAGE [language code] – Change the language code for subsequent pieces of text in the story
    - INTEREST [value 0..1] – Inserts an interest value to the story engine
    - DELAYFACTOR [value 0..1] – Multiply all the millisecond values from DELAY instructions in order to accelerate or decelerate the presentation of the story.
    - SUSPENDLOG [TRUE|FALSE] – Enables or disables the logging of interest values in the server.

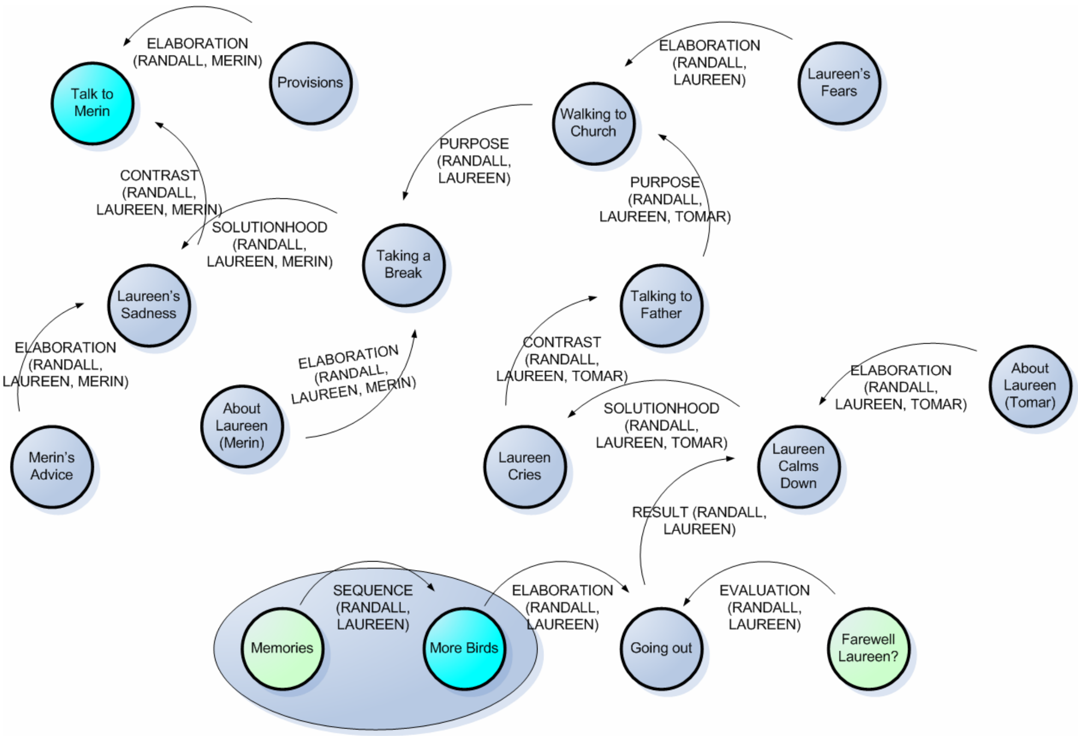
APPENDIX B: WYHTO EPISODE SCHEMAS

This appendix shows the episode schemas for "When Your Heart Takes Over", displaying the events and scenes created for the story. The circles represent the events of the story. Light blue circles indicate the entry points of the scene and light green circles indicate the exit points. Relations are indicated by arrows in which the name of relation is indicated and its agents are written inside parenthesis.

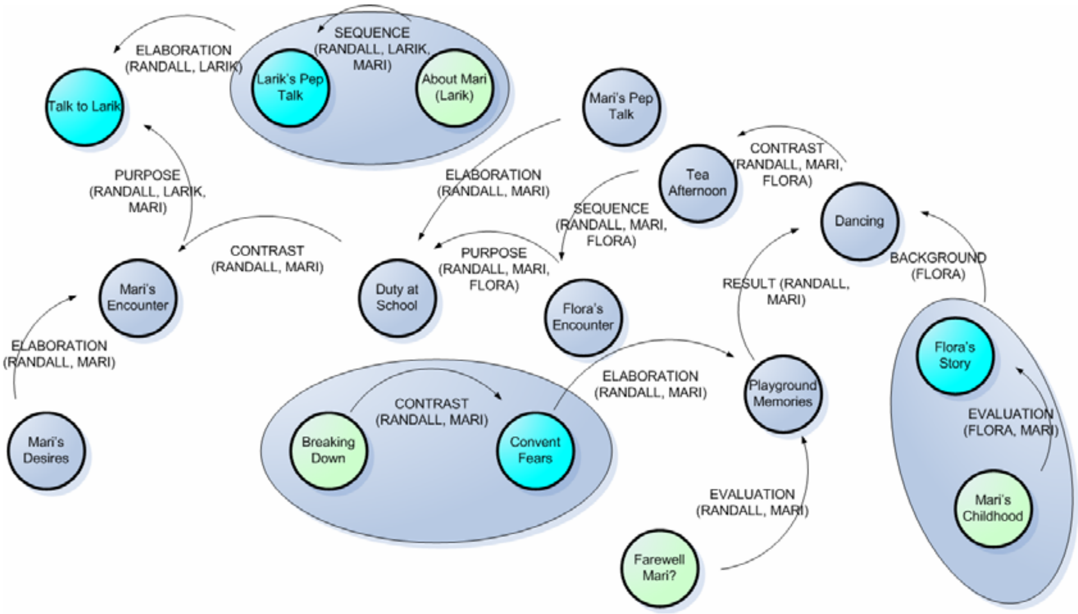
Episode 1: Winds of Change



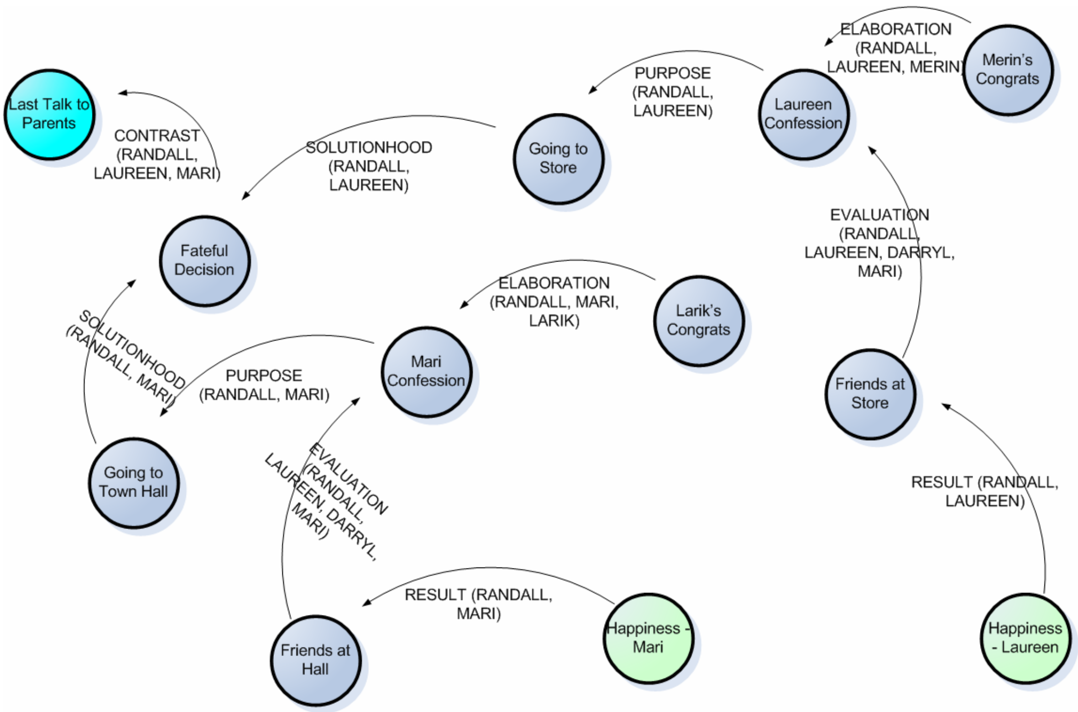
Episode 2: Bodyguard Duties



Episode 3: Royal Grieves



Episode 4: Fateful Decision

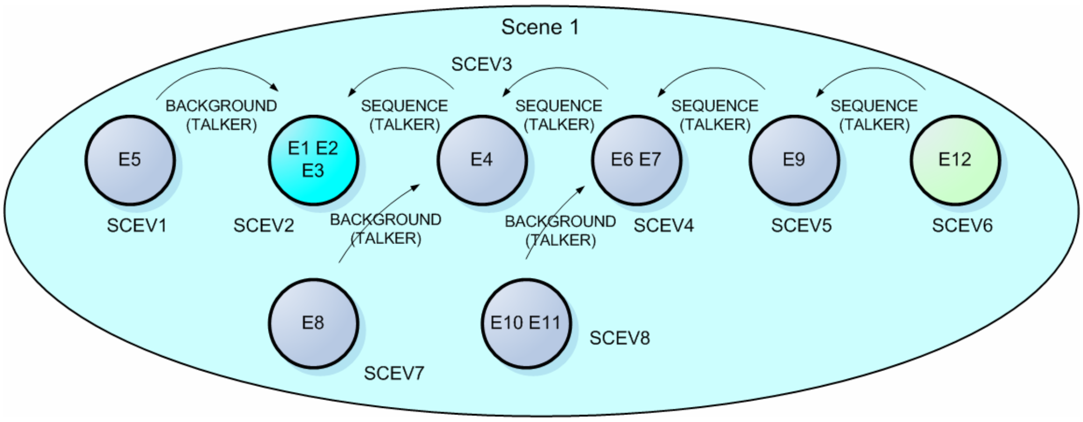


APPENDIX C: SCC EPISODE SCHEMAS

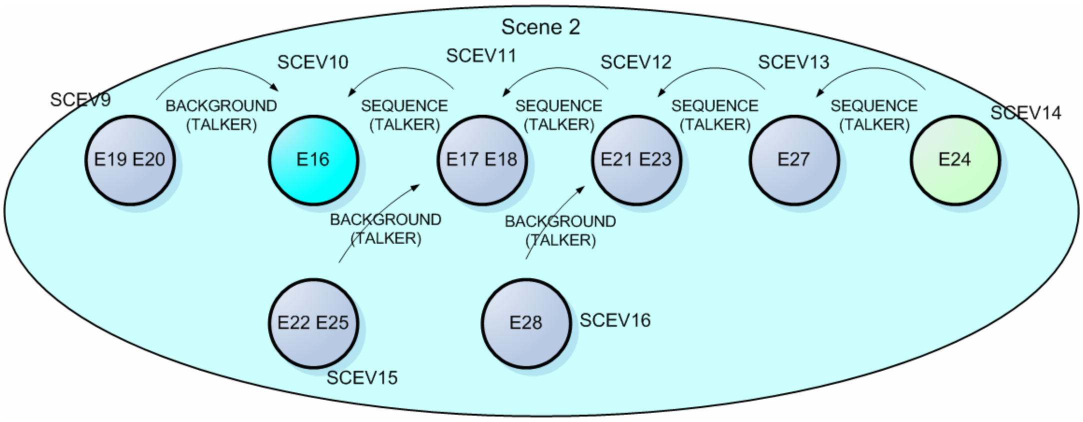
This appendix shows the episode schemas for “The Scientific Case for Creation”, displaying the events and scenes created for the story. The circles represent the events of the story. Light blue circles indicate the entry points of the scene and light green circles indicate the exit points. Relations are indicated by arrows in which the name of relation is indicated and its agents are written inside parenthesis.

Episode 1: Organic Evolution?

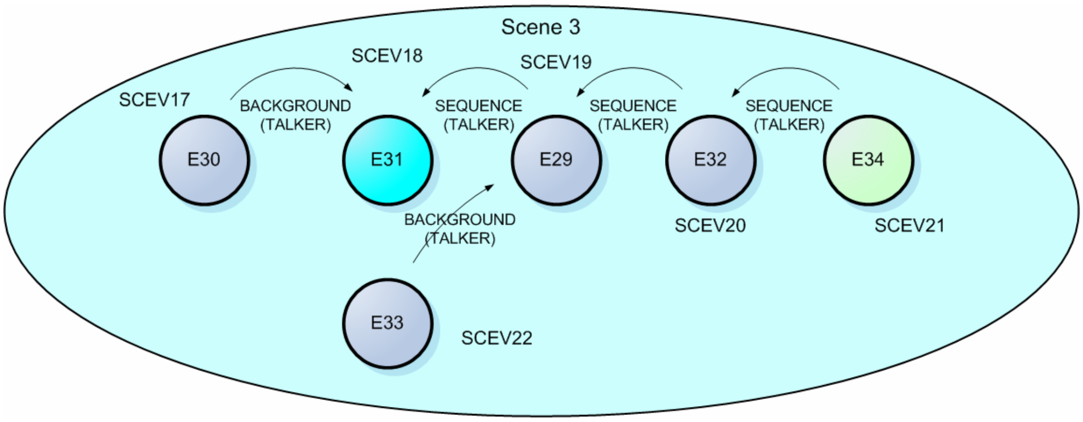
This episode was composed of three major scenes, which clustered the events in the presentation.



SCEV1	Acquired characteristics cannot be inherited and example
SCEV2	The concept of organic evolution or macroevolution
SCEV3	The non observance of spontaneous generation - the law of biogenesis
SCEV4	Mendel's laws of genetics explain genetic variation, not genetic creation
SCEV5	Natural selection does not produce new genes. Darwin observation is selection
SCEV6	The evolution of complex molecules such as DNA and RNA is not supported by experiments
SCEV7	Limitations of the genetic variation prescribed by Mendel's laws were shown in experiments
SCEV8	Mutations are the only proof shown for evolution, but are mostly harmful. They do not account for beneficial evolution.



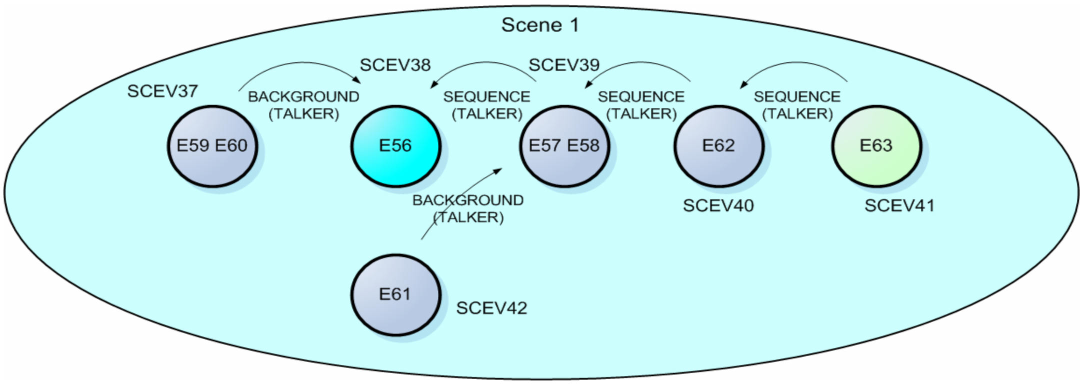
SCEV9	Darwin claimed language evolved, but in fact language devolve
SCEV10	Altruism in conflict with evolution
SCEV11	No evidence for the evolution of language
SCEV12	Coded information that control genes required intelligence. No natural process has ever produced a program or code
SCEV13	Embryos do not repeat evolutionary sequence (e.g. gill slits)
SCEV14	Human organs are not vestigial (e.g. appendix)
SCEV15	Isolated systems do not increase information by themselves. Natural processes are known only to destroy information. Intelligence is needed
SCEV16	Embryologists do not consider this a proof for evolution since Haeckel



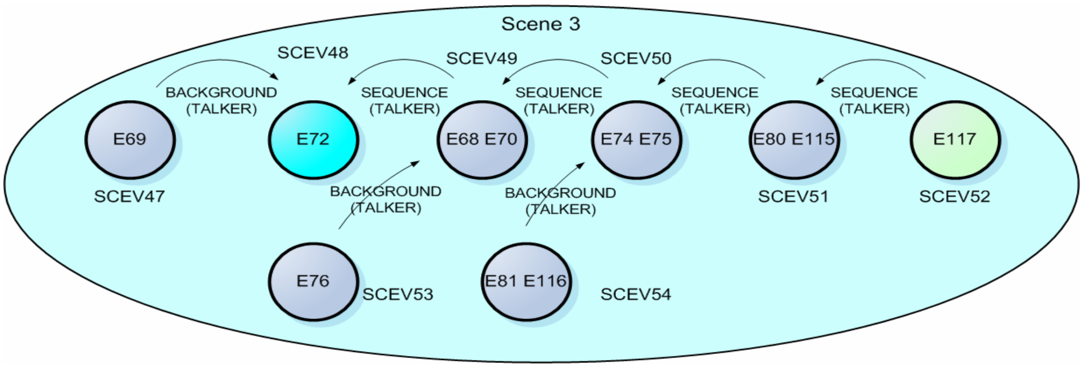
SCEV17	Sedimentary layers of earth were not deposited over millions of years
SCEV18	There are fossil gaps. It is not the links that are missing, but the whole chain
SCEV19	Fossils are a product of rapid burial, not of millions of years of change
SCEV20	Fossil record do not support evolution
SCEV21	Apelike men fossils found were overstated (e.g. Piltdown, Nebraska, Lucy, etc)
SCEV22	Fossils are not found according to the geologic column in many places

<u>Episode 2</u>: Astronomical Evolution?

This episode was composed of four major scenes, which clustered the events in the presentation.

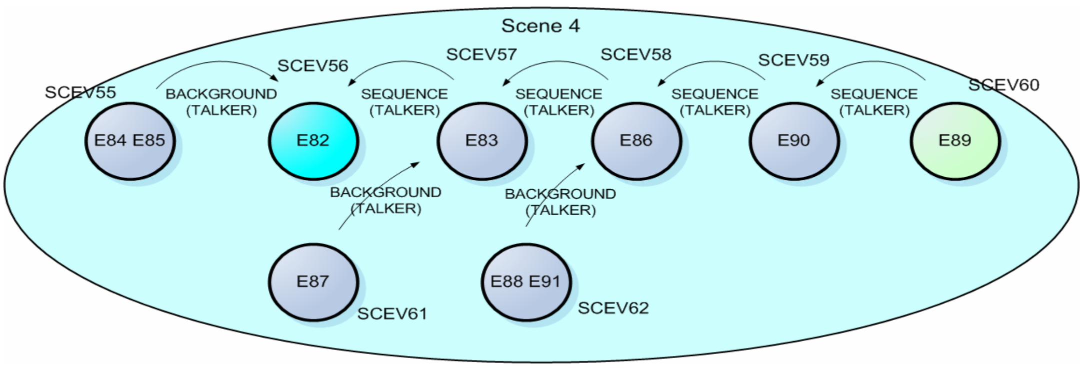


SCEV37	Planetary rings have nothing to do with a planet's evolution
SCEV38	Planets and moons rotations are not accounted in the theory of the formation of the solar system
SCEV39	Planets should not form from the mutual gravitational attraction of particles orbiting the sun
SCEV40	Earth was never a molten planet since heavier elements like gold are found in the surface
SCEV41	Naturalistic theories on the origin of the Earth's Moon are highly speculative and completely inadequate. The moon was created
SCEV42	Venus was never molten, thus it did not evolved, and it is not millions of years old

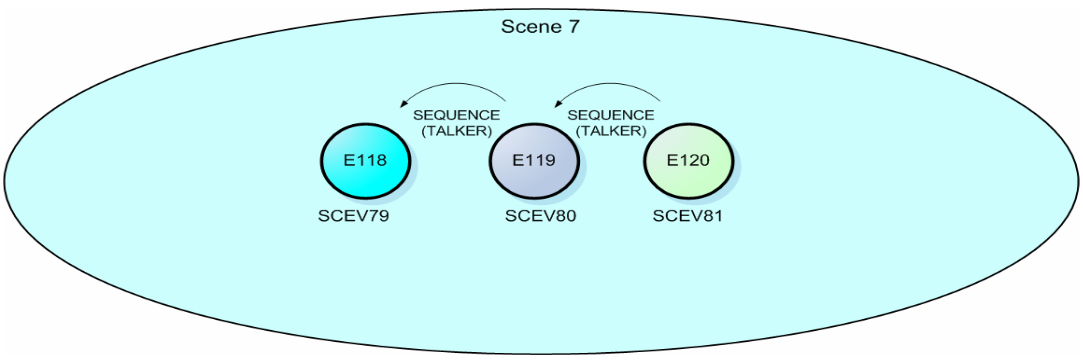


SCEV47	Redshift from galaxies has some strange features inconsistent with the Doppler Effect
SCEV48	Observation assesses that galaxies did not explode from a common point in a huge big bang
SCEV49	Redshift of distant stars does not necessarily indicate stars moving away from us due to the violation of the law of conservation of energy
SCEV50	Evolution does not explain the concentration of heavier atoms like heavy hydrogen in the universe

SCEV51 If spiral galaxies were billions of years old, their arms would be twisted
SCEV52 If the redshift of starlight always indicate a star's velocity, then a universe billions of years old is completely inconsistent with what is observed
SCEV53 Stellar evolutions pattern does not match all stars like binary stars
SCEV54 Galaxies could not have been formed by slow gravitational attraction



SCEV55 Dating of fossils and rocks use circular reasoning
SCEV56 Radioactive decay has not always been constant
SCEV57 Radiometric dating has serious contradictions
SCEV58 Index fossils do not indicate evolution but fossil sorting during the flood
SCEV59 Humanlike footprints have been found in rocks supposedly dated 150-600 millions of years
SCEV60 Human-made instruments have been found encased in coal
SCEV61 The geologic column cannot be found anywhere on the Earth
SCEV62 Coral formations and stalactites were not formed over millions of years



SCEV79 The theory of organic evolution is invalid
SCEV80 All dating techniques presume that a process observed today has always proceeded at its present rate, which is grossly inaccurate.
SCEV81 Everything points out to a young earth, solar system, and universe

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