Narrative Models: Narratology Meets Artificial Intelligence

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Abstract

This paper reports on research cooperation on narrative models in the framework of automated Story Generation. Within this framework, narrative models in Artificial Intelligence (AI) and the Humanities are considered both from the point of view of AI and the point of view of the Humanities. In order to provide other researchers, especially those interested in Computational Literary Analysis, with insights from literary narrative generation, existing Story Generation systems are reviewed and their underlying models of narrative are discussed. The existing gap between narrative models in different disciplines is analysed. We conclude that a methodological combination of description, analysis and generation holds the potential for a mutually beneficial qualitative breakthrough in research on narrative models.

1. Introduction

This paper reports on research cooperation on narrative models in the framework of automated Story Generation. The cooperation involves the *Story Generator Algorithms* project conducted at the Universities of Hamburg and Munich, in close association with the *Narratology Research Group* at the University of Hamburg, and the TSTL initiative (The Story Telling Laboratory) at the *Natural Interaction based on Language* research group of the Universidad Complutense de Madrid. The background of the authors ranges from literary studies over linguistics to computer science. The German group works on theoretical investigations of Story Generation and Computational Narratology. The central aim of this project is to evaluate the impact of automated systems on traditional research into narrative, also called Narratology. The Madrid group carries out research on the design and implementation of Story Generation applications, with a special emphasis on formal modelling of the knowledge that may be required.

On a small scale, the two teams started working towards an aim similar to that of the *Workshop Towards Computational Models of Literary Analysis*, and tried to bring together their today still relatively independent research enterprises. With respect to the topic of this workshop, we would therefore like to bring forward two points:

1. although narrative analysis and generation necessarily use different techniques in practice, they can share the abstract models underlying any theoretical and practical research on narrative;
2. cooperation across the borders of our respective scientific disciplines shows that the challenges and obstacles encountered in both computational generation and computational analysis of narratives are closely related to conceptual key problems discussed in Narratology.

The main purpose of this paper is to provide the emerging community of Computational Literary Analysis with insights from narrative generation and Narratology, and to identify potential common topics based on a discussion of narrative models. The potential offered by adopting this interdisciplinary perspective on narrative phenomena has been pointed out by Ryan (1991). Like Ryan, we are convinced that different communities dealing with narrative models can learn from each other, and that efforts can be joined, but we are also aware of the fact that communication problems might arise. This concern is reflected in the structure of the paper: Sections 2 and 3 deal with narrative models in Artificial Intelligence (AI) and in the Humanities, seen from a Humanities perspective. They are mirrored by Sections 4 to 5, where the same areas are discussed from an AI viewpoint. The paper is rounded up by a conclusion in Section 6.

2. Narrative Models in AI – Seen from the Humanities

2.1. Main Approaches and Inspirations

Artificial Intelligence uses two techniques in Story Generation: planning/problem solving, and production grammars. Specific rules used in their algorithms might be influenced by insights from literary studies or other fields (e.g. psychology of reading and writing).

Each Story Generator pretty much relies on only one work in narrative theory, if at all. For example, the idea of implementing the generator MINSTREL (Turner, 1994) ultimately goes back to Vladimir Propp's *Morphology of the Folktale* (1968), which was first published in Russian in 1927. Turner was intrigued by Propp's "morphology", i.e., "a description of the tale according to its component parts and the relationship of these components to each other and to the whole" (Propp, 1968:19). The general description of fairy tales, derived by Propp from a corpus of 100 Russian tales, can be interpreted as a story grammar (Turner, 1994:1–2). When Propp invented his fairy tale morphology, the core idea underlying his description was that of character functions that allow to abstract from concrete acts performed by individual characters. Incidentally, this primacy of action over characters had already been proposed in Aristotle's Poetics. Propp took this idea further and formulated his own findings as follows:

> “1. Functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled. They constitute the fundamental components of a tale.
> 2. The number of functions known to the fairy tale is limited.” (Propp, 1968:21)

This allows Propp to define such generic character functions as AN INTERDICTION IS ADDRESSED TO THE HERO or THE VILLAIN RECEIVES INFORMATION ABOUT HIS VICTIM, which abstract from individual details of the actions they subsume (e.g., kind of interdiction, way of uttering it, name and nature of hero, etc.). Based on his corpus, Propp worked out a formula that describes all possible combinations and sequences of character functions in a fairy tale. Directly or indirectly, Propp’s work inspired numerous Story Generators and interactive narrative systems (cf. Section 4 below). His ideas are easily accessible, but what his *Morphology* describes are really only some of the principles of story structure, without any relation to aesthetic values or effects, discourse organization, or surface representation in natural language. Therefore, his ideas are usually combined with other approaches in implemented Story Generators, or even considered only as a starting point, but without actual relevance for the implemented product, as in MINSTREL: “I did eventually write a computer program that tells stories. But [...] Propp’s intriguing little grammar was nowhere to be seen.” (Turner, 1994:2).

Propp is also mentioned as a precursor, or as the “primogenitor” of story grammars, by (Bringsjord & Ferrucci, 2000:154). These authors use story grammars in the Thorndyke (1977) notation for formalizing the knowledge of their Story Generator BRUTUS. A well-known story grammar similar to Thorndyke’s is the one developed by Rumelhart (1975) with the aim of serving as a basis for a (cognitive) theory of story summarization (see. Figure 1).

(1) Story → Setting + Episode
(2) Setting → (State)*
(3) Episode → Event + Reaction
(4) Event → {Episode|Change-of-state|Action|Event + Event}
(5) Reaction → Internal Response + Overt Responsee
(6) Internal Response → {Emotion|Desire}
(7) Overt Response → {Action|(Attempt)*}
(8) Attempt → Plan + Application
(9) Application → (Preaction)* + Action + Consequence
(10) Preaction → Subgoal + (Attempt)*
(11) Consequence → {Reaction|Event}

Figure 1: Rules of Rumelhart’s (1975) Story Grammar

Very few fully implemented stand-alone Story Generators take an approach completely different from that of story grammars. Instead of grammars, MINSTREL uses problem solving in the form of case-based reasoning and introduces the meta-level author goals *theme*, *drama*, *consistency*, and *presentation* (Turner, 1994). MEXICA (Pérez y Pérez & Sharples, 2001), on the other hand, is a Story Generator influenced by a psychological account of creative writing, the so-called cycle of cognitive engagement and reflection (Sharples, 1999). Instead of planning a story towards an explicit goal, MEXICA starts with an initial action around which it builds more and more actions, referring and comparing to a corpus of *previous stories*. The creation process switches between engagement and reflection: during engagement, actions are selected. The reflection stage checks the story (fragment) for coherence and, if necessary, introduces more actions to fulfill all preconditions of the previously retrieved actions. Also, the interestingness of a story is ensured by requiring it to display certain features: especially, it must show a given pattern of tension, which is also calculated based on the previous stories.

2.2. General Strengths and Weaknesses

This subsection is further subdivided into two parts, according to the classical narratological subdivision of narratives into two representational domains. These domains can be referred to by the French terms *histoire* (“story”, “content”, or “what is told”) and *discours* (“text”, “presentation”, or “how it is told”). Subsection 2.2.1. presents strengths and weaknesses of AI systems concerning the *histoire* domain of narrative; AI system performance in the *discours* domain is then discussed in Subsection 2.2.2.

2.2.1. The *histoire* domain

From the examples introduced in Subsection 2.1 above, it becomes obvious that in Story Generation, much effort is spent on designing a model of the narrative world.

> “To a certain extent a story is a model of a tiny world, peopled with story characters, natural forces, locations, and inanimate objects. To understand these things and their interrelationships requires a tremendous amount of knowledge that humans take for granted.” (Turner, 1994:4)

As far as the narrated world is concerned, MINSTREL has to have detailed knowledge about actions (“acts”), states and beliefs, as well as character goals, and the relationships between them. The set of relationships includes, for example, *motivation* (a state can motivate a goal) and *evidence* (a state can also be an evidence for a belief). Turner reports that MINSTREL’s knowledge about the narrated world and its case base correspond to “one or two short stories about King Arthur” (Turner, 1994:8). Accordingly, MINSTREL’s world comprises a class hierarchy of “Story Things” containing genre-typical classes such as LANCE, SWORD, HERMIT, and DRAGON (Turner, 1994:50). Whether actions, states and beliefs are equally hierarchically structured is not directly clear from Turner’s book. They seem, however, to show a very flat organization: for example, all actions are direct children of the class ACT.

Given the present-day existence of large ontologies (e.g., SUMO[1]) and lexical semantic databases (e.g., WordNet[2]), the knowledge MINSTREL and other Story Generators dispose of seems very restricted. This can be partly explained by the fact that the Story Generation systems did not have any knowledge beforehand; the entire encoding was done from scratch, in a representation format that was suitable for the individual formalisms and procedures of the system.

Probably the most remarkable achievement of knowledge encoding in MINSTREL and MEXICA is the

[1] http://ontology.teknowledge.com/ [10 April, 2006]
[2] http://wordnet.princeton.edu/ [10 April, 2006]

representation of preconditions and consequences of action classes, or actions in the case-base (corpus). Their existence makes it possible to flexibly combine states and actions, instantiated by characters and possibly other "Story-Things" filling their slots, and to control whether the invented combination is possible according to the laws of the narrated world.

On the other hand, this achievement also shows why large-scale resources would represent a semantic "overkill" for these systems, or – to put it the other way round – a relational scarcity. It is currently simply impossible to create a case-base or a corpus of previous stories in the abstract representation format needed by the systems, which would illustrate *general* knowledge about concepts such as LOVE, REVENGE, and ANGER, not restricted to a small domain (for example, the narrative world King Arthur lives in, the presumed world of the old inhabitants of Mexico, etc.). If Computational Literary Analysis ever arrives at the stage of advanced Story Understanding, capable of turning natural language stories into abstract semantic representation, also Story Generation might become a more prosperous field. Still, even the Story Generation community alone is far from having a common representation format, currently preventing such knowledge exchange.

As far as the *histoire* domain is concerned, we believe that the Humanities can learn something from Story Generation. The necessarily clear-cut definitions in the systems allow their designers to "grasp" such notions as EVENT vs. EXISTENT, or the causal relations *effect* and *motivation* (cf. Chatman, 1978), which refer to phenomena within the *histoire* domain. If the Story Generation system works, the designer has achieved – among other things – one of the possible consistent representations of this narrative domain.

2.2.2. The *discours* domain

Narrative models used in Story Generation are much less developed where the *discours* domain, the way of telling, is concerned. Usually, when a Story Generator has created an abstract representation of a story, it sends it directly to a front-end that generates natural language text. In BRUTUS, on the other hand, story grammars and natural language grammars are closely intertwined; actually, a high-level story grammar is broken down into paragraph grammars, which are broken down into sentences types or "literary augmented sentence grammars" (Bringsjord & Ferrucci, 2000:194). In other words, the language generation process used in BRUTUS is "all about choosing words" (and nothing more) because "the story outline is a map identifying the sequence of sentence types that will be used to tell the story" (Bringsjord & Ferrucci, 2000:196). Words are grouped into classes according to certain features, including their function in literary narrative, and the sentence grammar indicates from which group of words the Natural Language Generation (NLG) module is allowed to choose. For example, the nouns *brick*, *greens*, and *youth* are classified as ICONIC FEATURES of *university*, allowing for the production of Example (1).

(1) Dave Striver loved the university. He loved its ivy-covered clocktowers, its ancient and sturdy brick, and its sun-splashed verdant greens and eager youth.

Another example is the linking of modifiers to nouns by the relation BIZARRO-MODIFIER. Using this relation, *bleeding* has been encoded as a modifier of the nouns *sun*, *plants*, *clothes*, *tombs*, and *eyes*. This literary-linguistic knowledge is used in the production of Example (2).

(2) Hart's eyes were like big bleeding suns.

Whereas the technique used in BRUTUS illustrates some stylistic devices such as analogy or "the bizarre", used especially in literary narrative (as opposed to factual narrative), the actual NLG process reminds much more of template filling than of full-fledged NLG (Reiter & Dale, 2000) with its document structuring, microplanning, and surface realization phases.

The use of inflexible techniques for Natural language rendering of automatically generated narratives might as well be due to the fact that very few attempts exist to make Natural Language Generators fit for (literary) narrative input. The only Natural Language Generator that explicitly aims at this goal is STORYBOOK (Callaway & Lester, 2002). However, STORYBOOK uses a proprietary input representation, the so-called *narrative stream* format, and, to our knowledge, there are no interfaces to the output of implemented Story Generators. The input to STORYBOOK, then, is mainly encoded by hand.

Narrative discourse techniques such as large-scale ellipsis, flashback, repetition, summary, or changes in perspective are not used explicitly or purposefully in Story Generation. In our research, we have not yet encountered any system that would include a narrative discourse middleware able to produce variation at this stage. The architecture of a narratologically enhanced generator, which would be more aware of *discours* phenomena of narrative, is sketched in (Lönneker, 2005). The same paper also contains an example of how the discourse structurer might handle the phenomenon of "embedded" narratives.

3. Narrative Models in the Humanities – A Self-Assessment

Within the Humanities, different disciplines have developed narrative models. Our review concentrates on those proposed by linguists and literary scholars because in the history of Narratology as a discipline, linguistic and literary approaches have been more or less intertwined.

3.1. Linguistics

In linguistics, text-grammar-based models of narrative were popular in the 1970s, under the influence of Artifical Intelligence (cf. e.g. van Dijk, 1972; van Dijk, 1980). Whether or not they might be an adequate model of the cognitive processing of narratives has been discussed at length in (Wilensky, 1983). In our opinition, well-defined discourse relations that co-ordinate or sub-ordinate text segments, which have been proposed by Longacre (1983) and Mann & Thompson (1988), among others, might be a better choice. Discourse relations can be used to build a text representation either top down or bottom up, and are currently popular in computational linguistic approaches to discourse.

3.2. Literary Studies

In literary studies, encompassing theories of the general structure of narrative have been proposed only by a few scholars. In the early days of Narratology, which was born under the influence of structuralism and formalism, aspects of both *histoire* and *discours* domain of narrative were treated. Sometimes, the textual form – a part of the *discours* domain, or the surface representation of "narrative units" (Todorov, 1969:16) – is even considered irrelevant, as already in Propp's work. For example, (Todorov, 1969) develops an inventory of relations between *histoire* units, parts of which are reproduced in Figure 2.

(I) Temporal relations	
1. Emphasis:	a(X) + ... + a(X)
2. Inversion:	a(X) + ... + ¬a(X)
[...]	
(II) Causal relations	
1. Modification	[...]
2. Desire	[...]
3. Motivation	a(X) ⇒ PROP
4. Result	PROP ⇒ a(X)
5. Punishment	b(X) ⇒ c(Y,X)

Figure 2: Relations between two propositions (PROP), based on Todorov (1969)

Later, and especially with the broad reception of the – still structuralist – publications by Gérard Genette, the focus shifted towards *discours*, including many aspects of surface (re-)presentation in natural language. In this approach, an investigation of the underlying *histoire* is undertaken only in view of a better analysis and explanation of *discours* phenomena. Since the 1990s, cognitive approaches to Narratology have been proposed, but – so far – none of the sketched models is as encompassing and as widely recognized as those developed by the structuralist generation.

3.3. Problems for Story Generation

Working out which of the above mentioned models of narrative could be useful in practical Story Generation, we noticed a number of problems. Some of them are presented in the remainder of this Subsection. After an introductory general remark (3.3.1.), two clusters of points are mentioned that hinder a fast and clear-cut formalization of narrative models, as discussed in literary theory: Terminological issues (3.3.2.) and (upwards or downwards) scalability (3.3.3.).

3.3.1. General

In general, most Humanities models of narrative contain formalizations only at very abstract levels, if at all. By formalizations, we mean here a representation in some logic language (e.g., predicate calculus) or other structured representation, including tables, graphs, etc. Indeed, most works dealing with narrative and not going back directly to the structuralist tradition are composed in "plain prose". Especially, there seems to be a tendency to apply formal notions to the abstract *histoire* level only. Phenomena at *discours* level that apply to the *structure* of discourse (e.g., discourse relations) are sometimes formalized in linguistics and are usually described in words only – sometimes accompanied by tables – by literary scholars (Genette, 1980). Where models are based on the *discours* (text) layer of a narrative or include it, genuine Humanities models usually lack formality, though their descriptions might offer a variety of authentic examples.

Perhaps one of the most vexing problems confronted by Humanists in their attempts at modelling narrative is the fact that the empirical notion of narrative per se is, at least in part, of a historical (rather than a universal) nature. A natural reader's processing of a symbolic representation as a 'narrative' is influenced by idiosyncratic choices, particularly where it comes to the decoding of semantic markers. For the natural reader, choices for 'making sense' of something as a narrative abound already at the fundamental level of *histoire*. The highly combinatory and constructive nature of processing information as *events* and *actions* has been demonstrated in (Meister, 2003). It remains to be seen whether the methodological restrictions inherent in computational approaches will allow for the design of models that can truly capture this level of empirical complexity, or whether an idealized notion of 'narrative' has to be used as a frame of reference.

3.3.2. Terminology and Granularity

Many critics have commented on parts of the literary narrative models mentioned in Section 3.2. above, and similar ones. The criticism led to further developments of the models as well as to proposals of contrasting terminology. For example, regarding narrative *discours* techniques, we still witness undecided discussions about terminology, but we also encounter extremely fine-grained terminological subdistinctions. The latter case can be observed with the numerous subtypes of anachronies (such as flashback) introduced by Genette (1980) and further developed by Ireland (2001).

Nevertheless, there is also still a certain degree of remaining fuzziness in the models. Often, this is detected only when formalising them. An example is the question whether an inner narration ("embedded" narration) can be told in indirect speech, or whether it is necessarily presented in direct speech (cf. Lönneker, 2005).

Even terminological gaps do still exist. For example, presenting one and the same event several times, but in different ways (for example, from different points of view), is called repeating narrative by Genette (1980). But the technique of repeatedly presenting *variants* of an event does not seem to have a name, although it can be an important trait of certain narratives, including films.

3.3.3. Scalability

Linguistic models of discourse are usually applied to texts containing a couple of sentences, up to several pages. Their appropriateness can be directly tested on such relatively short texts. Whether they scale to long works, for example to a novel, is in general not known because they have not been applied to these texts, which would involve a huge amount of work.

Models of literary texts, on the other hand, deal with texts that span over hundreds or thousands of pages; their explanations resort either to mini-scale examples (snippets of real works) or to summaries. Today, it is nearly impossible to empirically test models of literary texts because it is difficult to map them onto the text of actual works, or to "down-scale" them. Generation and analysis could work together here in order to see what representation of the texts is necessary to meet the models, or vice versa.

In order to illustrate the difference between linguistic and literary approaches, consider the example of a flashback. Linguistically seen, it might seem mandatory that this anachrony be indicated by surface markers such as conjunctions, adverbs, or a tense shift. However, in a large-scale work, it is possible that one or more entire chapters constitute a flashback to the surrounding text, and that this relationship is indicated exclusively by contextual markers, including semantic knowledge and world knowledge (e.g., a character who was at first an old man reappears as a student in the flashback).

4. Narrative Models in the Humanities – Seen from AI

Most current efforts on narrative modelling in the Humanities have yet to permeate to AI research. Two possible lines of thought may be followed to study the situation: one is to consider which narrative models from the Humanities are being considered in AI, and another is to try to identify the reasons why AI researchers lack motivation for extending their exploration of narrative models in the Humanities.

4.1. Models under Consideration

Of the many theories of narrative developed in the Humanities, only a few have bridged the gap to become tools in the hands of AI researchers. Of these, Propp's *Morphology of the Folktale* (1968), mentioned in Section 2.1. above, is the most extended one, having been applied in several AI systems for Story Generation, including Automatic Novel Writing (Klein et al., 1973), Geist (Grasbon & Braun, 2001), OPIATE (Fairclough, 2004) or ProtoPropp (Díaz-Agudo, Gervás & Peinado, 2004). Propp's system of character functions as narrative modules has been exploited by AI researchers well beyond its intended purpose, both in terms of its use as a kind of grammar for generating new stories and in terms of its applicability to domains wildly different from the Russian folk tales from which it arose.

At a different level of detail, another favourite is the three-act restorative structure. This model, derived from Joseph Campbell's analysis of the structure of myths, is a dominant formula for structuring narrative in commercial cinema (Vogler, 1998). It has had a great impact on another branch of computer research which is related with narrative: the design of story-based video games. This type of game provides a skeletal plot for the player to follow. At an abstract level, the software of such a video game acts as a Story Generator: when the user has run the software to its completion – i.e. to the end of the game – a "story" has been generated, usually as a result of collaborative work between the software and the player. For various reasons arising from the interactive nature of these applications, the model proposed by Campbell for a *heroic quest* has been widely used. Heroic quests are well-suited to videogames because in them the player can discover the obstacles at the same time as the hero, and they tend to map progress through the quest onto progress through physical space, which is easy to model. Software of this kind usually has all the ingredients of a three-act restorative structure:

1. a central protagonist,
2. a conflict introduced in the first act,
3. a second act propelled by the hero's false resolution of this dilemma,
4. and a third act in which the dilemma is resolved once and for all.

More complex narrative models are considered in recent research efforts in interactive storytelling. For instance, some effort has been made to model works oriented to the film industry such as McKee (1997), which is used as inspiration underlying the technology of the interactive drama Façade (Mateas & Stern, 2003). McKee's model focuses on the interplay between characters and events – story events impact the characters, and the characters impact events. This interplay leads to a meaningful emotional experience for the audience. He considers a structure of narrative based on acts, sequences, scenes, and beats. Beats are seen as the atoms of this structure, and they consist of a *pair of action and reaction* by characters in the story. This provides a reference model for the way in which the characters in Façade interact with one another and the player, how they react emotionally, and how their actions affect the player.

Another source that is also being considered in AI is the work of Chatman (1978). This model constitutes a step up from the models of Propp or Campbell in the sense it considers a wider range of media, from literature to film. From the point of view of the AI researcher in search for a model, the greatest advantage of Chatman's approach is his effort to identify a common core of elementary artefacts involved in several approaches to narrative theory. Chatman studies the distinction between story and discourse (in the sense of *histoire* and *discours*, cf. Section 2.2. above), and he proposes ways of decomposing each of these domains into elementary units. His idea of structuring story and discourse in terms of *nuclei* and attached *satellites* provides a very good way of organising internally the knowledge entities that computational systems rely on for conceptual representation.

4.2. The Obstacles in Considering More Complex Models

Given the number of alternative theories that have not received this degree of attention, it may be interesting to consider what makes AI researchers opt for what are in context very simplistic models. Often, the most significant reason behind a particular choice of theory is that AI researchers find it easier to work with models that a previous researcher has already translated to AI jargon and applied in some previous computer program. Another important factor is that AI research in complex topics such as Story Generation usually applies a method of successive approximations, starting from the simplest possible model and exploring it until all its possibilities have been exhausted.

However, the most important obstacles can be found in the differences in purpose – when trying to model narrative – between Humanities and AI. In order to be applicable for AI research, a model of narrative must be capable of accounting for the elementary communication issues behind narrative. It must identify clearly the simplest basic elements with which the narrator operates. Definitions must be clear cut, and susceptible of computational treatment. They must not allow various possible interpretations.

In an effort to cover as much as possible of the infinite range of human expression, narrative theories in the Humanities move at a level of abstraction which is prohibitely expensive to represent in computational terms, and which precludes all possibilities of pragmatically efficient computation. Narrative models in the Humanities usually arise within a given school of thought. There is little consensus across different schools on what the basic elements of narrative are – events?, motifs?, ... – and how they are defined. Different theories that agree on the importance of a given element may provide definitions for it that imply radically different design decisions from a computational point of view.

For the AI researcher looking for a model of narrative to use when developing a computational system, this situation presents various problems. On one hand, there are a large number of different theories. On the other hand, the set of ontological commitments on which each theory is based may not be explicit in the formulation, but implicit in the particular school of thought in which the theory arises. This information is crucial when deciding on the appropriateness of a given theory for a specific purpose, but it is usually unavailable to researchers without a complete narratological background.

Faced with this panorama, AI researchers gravitate towards narrative models which seem closest to their needs. These usually happen to be either very early attempts – such as Propp's – or models that focus on one very specific type of narrative – like Campbell's work on the hero's journey. This type of model may fulfill the requirements for developing computational solutions.

5. Narrative Models in AI – A Self-Assessment

In AI there is a long standing tradition in terms of research efforts in Story Generation. It started in the early days, with the same optimism and ingenuity that characterised early efforts at natural language processing and other simulations of human behaviour. Subsequent realization of the difficulties involved led to periods during which no research was undertaken on this area. But periodically the topic recovers strength. There was a big boom in the 1990s, around the concept of Narrative Intelligence (Mateas & Sengers, 1999). And there is a more recent effort concerned with the role of interaction and storytelling in the field of virtual environments (Mateas & Stern, 2003; Grasbon & Braun, 2001; Fairclough, 2004), applying these results to videogames, pedagogical applications, etc.

In order to treat computationally – or simply attempt to reproduce – a given phenomenon, the elements involved in it must be represented in some manner susceptible of computational treatment and a certain process or algorithm must be applied to it. In virtue of this, *every implemented Story Generator carries an implicit model of narrative*, irrespective of whether it is explicitly based on a given theoretical model of narrative. Such implicit models cover two different aspects. On one hand, they must provide some representation of stories, which can be interpreted as a particular model of what a story is. On the other hand, they must define a specific process for generating the story, which can be interpreted as a model of the actual process of Story Generation.

Bailey (1999) distinguishes between three different approaches to automated Story Generation:

1. **Author models.** Here, an attempt is made to model the way a human author goes about the task of creating a story. MINSTREL and MEXICA would be classed as examples of this approach.
2. **Story models.** They are based on an abstract representation of the story as a structural (or linguistic) artefact. Systems based on story grammars fall under this category.
3. **World models.** In these models, generating a story is seen as constructing a world governed by realistic rules and peopled with characters with individual goals. The story arises from recording how the characters go about achieving their goals. Tale-Spin (Meehan, 1977), the classic Story Generator inspired on Aesop's fables, operated in this way.

To this initial classification, Bailey adds his own (the fourth) approach, based on modelling the response that a story draws from a given reader.

Additionally, the fact that many of the new storytelling systems are based on interactive environments adds another dimension to the narrative. In these systems, the members of the audience become themselves characters in the story, so the role of authorship is progressively becoming distributed between the interactors and the designers. This may be considered as the fifth possible approach to model Story Generation.

Each type of system focuses on a different aspect of Story Generation, but *they must all provide implicit solutions to all other aspects* – however simple those solutions may be.

5.1. Representations of Stories in AI Systems

The narrative models currently in use in AI approaches to narrative generally present a simplistic approach to the representation of stories in several senses.

5.1.1. Linear versus Branching Stories

On one hand, they tend to consider a story as a linear sequence. This is true of the rendition of a story as text, but, conceptually, stories beyond the simplest joke have several branches whenever more than one character is doing something relevant to the story in different places at the same time. Additionally, the chronological order of events in the story (*histoire*) may be transgressed when a particular *discours* is generated for it. More elaborate models of narrative need to be contemplated to account for this complex nature of a branching and partially-ordered *histoire*, and the processes involved in converting it into a linear – possibly anachronical – discours.

5.1.2. The Role of Causality

World models concentrate on a concept of story that gives a central role to the causality relations between the events that make it. They tend to rely on planning methods to construct the stories from an initial description of the world and a set of goals to be achieved. Tale-Spin is an early example, but there is a flourishing school of Story Generation research (Mateas & Stern, 2003; Cavazza, Charles & Mead, 2002) still following this approach. However, the planning paradigm is biased towards producing plans in the shape of an inverted tree: a number of branches (causes) all converge towards a final goal (the result). This somehow improves on the linear conception of the fabula, but it is still very restricted. Real stories also include forward branching (each cause may lead to different effects on different characters), and they rarely have one single end point where the goal of the story can be said to be achieved. Most stories, in fact, have no single identifiable goal. The generation approach based on causality representation in the world model also restricts the composition process to backward chaining from a desired goal towards a set of plausible causes. Whereas this may be the way in which some writers work, it is clear that the option of working forward from causes in search of their possible effects – usually applying principles of human nature to guide the way and explore possibilities – should also be considered as a possible model.

Some author models also consider causality as a fundamental aspect of story telling. MINSTREL, for instance, depends on planning techniques, but from the point of view of how an author plans the story that he is constructing. To account for the causality relations in the story, the system includes specific consistency goals.

5.1.3. Modelling the Reader

Bailey's (1999) approach is based on the idea that something is a story if and only if some reader identifies it as such when being exposed to it. This defines a story only in terms of a particular reader, but Bailey tries to abstract a general description of what makes all readers recognise something as a story. This requires having some way of modelling and/or measuring the reader's reaction to a story. As Bailey himself confesses in his paper, there is still a gap between existing work on this topic from the point of view of AI and the Humanities, in the sense that there is a large body of literature on the influence of narrative on the reader that has not been applied to AI research.

5.1.4. Representing Mental Images

Certain AI efforts at Story Generation – such as BRUTUS (Bringsjord & Ferrucci, 2000) – consider the important role of modelling the mental images being processed by all the participants in a story. This involves the mental image that the reader forms of the story – which it is feasible to model in a story telling system –, but also the mental images that characters have of one another, and the situations in which they find themselves.

Modelling mental images is subject to a problem of recursion – each character may have a mental image of the mental image that another character has of the mental image that… – which would need to be cut short at the very earliest approximation possible. The alternative of not modelling mental images at all is the simplest solution available, but it runs the risk of producing stories where characters exhibit autistic behaviours.

MEXICA (Pérez y Pérez & Sharples, 2001) takes a small step forward in this direction by considering the emotions of characters and the way in which their oscillations affect the perception of tension in the story.

5.2. Models of the Story Generation Process Implicit in AI Systems

Most existing work on Story Generation tends to focus on composing conceptual representations of stories, based on a given world – with a specific set of locations, characters and objects – which is to be told by some particular simple solution for rendering the concepts as text. However, a human author creating a new story actually works at least three different levels: he *creates a world* in which the story occurs (5.2.1.), he *imagines a story* in that world (5.2.2.), and he selects a particular *way of telling* the story that best presents it to the reader (5.2.3.).

5.2.1. Creating Worlds

The role of the setting in which a story occurs, and the nature and description of the characters that take part in it, is undoubtedly fundamental in human storytelling, and yet it has not been addressed by AI research in the field. Recent attempts have been made to provide story telling systems based on planning with a certain ability for modifying the initial story world that they operate upon (Riedl & Young, 2006), but their ability is restricted to changing the starting position of objects whose initial location has not been explicitly assigned by the user. Although this does improve the kind of narrative that can be generated, it is clearly still very far from the freedom that a human author exercises in making up his settings and characters.

5.2.2. Creating Stories

Most existing Story Generation systems focus on the task of building a story, taking as input a given description of the world and relying on simple natural language transcription modules to convert the story into text. In a sense, this would be consistent with considering Story Generators as content determination modules in a classic Natural Language Generation pipeline (Reiter & Dale, 2000), with subsequent stages accounting for discourse and sentence planning and surface realization.

5.2.3. Telling Stories

STORYBOOK (Callaway, 2002) is an exception in the sense that it focuses on the task of telling the story given a narrative stream already complete (see also Section 2.2.2. above). Callaway actually proposes a generic architecture for a storytelling system in which there is a prior module – a narrative planner – that generates the input (the narrative stream) for STORYBOOK. This narrative planner seems to be concerned with the task of creating a story, but nothing is said about the truly creative task of inventing a specific world in which the story is to take place.

6. Conclusion

Neither the under defined nor the over specific concepts developed in literary theory and Narratology seem good choices for AI formalizations. In the same vein the limited scope of predominantly descriptive linguistic models renders these unsatisfactory. Conversely, Artificial Intelligence approaches in Story Generation are generally based on a highly reductionist concept of 'story' which ignores the Humanities' disciplines insights into the complexity and dynamics of narrative. The reasons for the respective shortcomings of the proposed models, and the problems to adapt most of the models originating outside one's own field have been outlined in this paper.

In our view, a methodological combination of description, analysis and generation – in other words: an inter-disciplinary approach – holds the potential for a mutually beneficial qualitative breakthrough in research on Story Generation, and on narrative models in general. This inter-disciplinary approach might start by identifying those existing narrative models in the Humanities whose set of ontological commitments is better suited for the Story Generation task, and by searching for (or producing) computationally oriented implementations of these models.

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