The Need for Multi-Aspectual Representation of Narratives in Modelling their Creative Process*

Pablo Gervás[1] and Carlos León[2]

1 **Instituto de Tecnología del Conocimiento**
Universidad Complutense de Madrid, 28040 Madrid, Spain
`pgervas@ucm.es`

2 **Facultad de Informática**
Universidad Complutense de Madrid, 28040 Madrid, Spain
`cleon@fdi.ucm.es`

Abstract

Existing approaches to narrative construction tend to apply basic engineering principles of system design which rely on identifying the most relevant feature of the domain for the problem at hand, and postulating an initial representation of the problem space organised around such a principal feature. Some features that have been favoured in the past include: causality, linear discourse, underlying structure, and character behavior. The present paper defends the need for simultaneous consideration of as many as possible of these aspects when attempting to model the process of creating narratives, together with some mechanism for distributing the weight of the decision processes across them. Humans faced with narrative construction may shift from views based on characters to views based on structure, then consider causality, and later also take into account the shape of discourse. This behavior can be related to the process of representational re-description of constraints as described in existing literature on cognitive models of the writing task. The paper discusses how existing computational models of narrative construction address this phenomenon, and argues for a computational model of narrative explicitly based on multiple aspects.

1998 ACM Subject Classification F.4.1 Knowledge Representation Formalisms and Methods

Keywords and phrases Narrative construction, creative process, conceptual representation of narrative

Digital Object Identifier 10.4230/OASIcs.xxx.yyy.p

1 Introduction

Existing approaches to narrative generation tend to apply basic engineering principles of system design which rely on identifying the most relevant feature of the domain for the problem at hand, and postulating an initial representation of the problem space organised around such a principal feature. Additional features of the problem can then be considered as further constraints on the problem. Or, in cases where the simple formulation of the problem is complex enough, they may be postponed for later consideration. The idea being that a first approximation to the problem based on a single feature is a valuable contribution in itself. This is acceptable indeed as a first approximation, but the argument presented in this paper is that for progress to be made towards better modelling of the human narrative

* This work was partially supported by FP7 WHIM project Grant Agreement 611560.

Computational Models of Narrative.
Editor: Mark Finlayson Editor; pp. 1–16
OpenAccess Series in Informatics
Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

capacity, the integration of models of the different features or aspects observed in narrative must be attempted.

Engineering approaches of this type have been applied to the problem of narrative generation, and a number of particular aspects of narrative have been favoured as focal points of these research efforts. These aspects include the linear sequence of discourse, causality links between elements in the story, the underlying structure of the narrative in narratological terms, or the behaviour of characters and their interaction with one another.

It is easy to understand why the task of generating narrative has been addressed in such a fragmented way. Each particular approach leads to a representation of narrative that is conceptually different from the others. Each of the selected AI techniques relies on the specific representation over which it can operate easily. Success in terms of results on particular features of narrative needs to be measured over the corresponding representation. Current expectations on quick turn-around for scientific publications, or pressure for PhD theses to be finished in short periods of time, work against the decision to consider more than one such representation in a single approach.

The present paper addresses the problem of postulating a representation of narrative that combines several of the possible views on narrative into a representation capable of explicit reformulation. This representation should be capable of: representing explicitly all the features considered relevant for the automated treatment of narrative, shifting from one view to another, providing input data in formats valid for the application of those AI technologies that have been deemed good models of some aspect of narrative processing, allowing the application of metrics that measure the various relevant aspects of narrative, and generating specialized views of the narrative according to the set of features under consideration.

2 Related Work

Existing work on conceptual representation of narrative in terms amenable to computation can be found in two separate fields: in efforts to establish models of cognitive process related to narrative, and in efforts to review and classify existing systems for the generation of narrative.

2.1 Related Work on Theoretical Models of Cognition

Although a full review of the literature on cognitive and psychological models of the creative writing process is beyond the scope of this paper, three ideas from the field are reviewed to provide the basis for the arguments presented later in the paper. They are: Sharples' model of writing as a creative design process [40], Karmiloff-Smith's concept of Representation Redescription as a model of the role of representation in progressive acquisition of expertise [20], and the work by Trabasso et al in modelling the inferences made by readers in understanding stories [44].

2.1.1 Cognitive Models of the Creative Writing Process

Margaret Boden [6] formulated the creative process in terms of search in a universe of concepts. However, she specifies that the creative process of a particular creator does not traverse the complete universe, but only a conceptual space, a subset of the universe particular to that creator and the procedures he is employing. Such a conceptual space would be defined by a set of constructive rules. The strategies for traversing this conceptual space in search of ideas would also be encoded as a set of rules.

Sharples [40] presents a description of writing understood as a problem-solving process where the writer is both a creative thinker and a designer of text. For Sharples, the universe of concepts to be explored in the domain of writing could be established in a generative way by exhaustively applying the rules of grammar that define the set of well-formed sentences. The conceptual space on which a writer operates is a subset of this universe identified by a set of constraints which define what is appropriate to the task at hand. Sharples explains that the use of a conceptual space "eases the burden of writing by limiting the scope of search through long term memory to those concepts and schemas that are appropriate to the task" [40, p. 3]. To Sharples, the imposition of these constraints enables creativity in the sense that he identifies creativity in writing (in contrast with simple novelty) with the application of processes that manipulate these constraints, thereby exploring and transforming the conceptual space that they define. Sharples provides a specification of what he envisages these constraints to be. Constraints on the writing task are described as "a combination of the given task, external resources, and the writer's knowledge and experience" [40, p. 1]. He also mentions they can be external (essay topic, previously written material, a set of publishers guidelines. . .) or internal (schemas, inter-related concepts, genres, and knowledge of language that form the writer's conceptual spaces).

A special example of this kind of constraint on the writing task is the use of *primary generators*. Sharples observes that expert novelists, when describing what initiated their writing, often mention ideas that can be interpreted as primary generators. It is a fundamental starting point, providing a mental construct around which to form the text. He goes even further to affirm that "The skill of a great writer is to create a generator that is manageable enough to be realised in the mind, yet sufficiently powerful to spawn the entire text" [40, p. 15]. With respect to the way such constraints may be iteratively modified during the writing process, Sharples explains, that primary generators may be rejected or modified during the process, as the writer gains more insight into the problem.

Sharples also provides a description of how the typical writer alternates between the simple task of exploring the conceptual space defined by a given set of constraints and the more complex task of modifying such constraints to transform the conceptual space. Sharples proposes a cyclic process moving through two different phases: engagement and reflection. During the engagement phase the constraints are taken as given and the conceptual space defined by them is simply explored, progressively generating new material. During the reflection phase, the generated material is revised and constraints may be transformed as a result of this revision. Sharples also provides a model of how the reflection phase may be analysed in terms of specific operations on the various elements. People produce grammatically correct linguistic utterances without being aware of the rules of grammar, but to explore and transform conceptual spaces one needs to call up constraints and schemas as explicit entities, and work on them in a deliberate fashion. For the mind to be able to manipulate the constraints, they have to be subjected to a process of "representational redescription" [20], re-representing knowledge that was previously embedded in effective procedures as elements susceptible of manipulation.

The problem is that beginners addressing such a cognitive task do not have a vocabulary to describe mental processes to themselves. To learn, they must develop "a coherent mental framework of plans, operators, genres and text types that can guide the process of knowledge integration and transformation" [40, p. 5]. Experts tend to have such a mental framework that underlies and supports their writing efforts. For beginners, the problem must be addressed with the aid of general knowledge about how to design artefacts, how to transform mental structures and how to solve problems. Because this is difficult to do in the head, some writers resort to capturing the ideas involved in paper, as sketches, lists, plans, notes etc. These external representations stand for mental structures, and they are easier to manipulate. The writer can then explore different ways of structuring the content, apply systematic transformations, establish priorities, and reorder or cluster items. The task of writing addressed in these terms is much closer to recognised design tasks.

2.1.2 Representational Re-description in Progressive Acquisition of Expertise

The arguments outlined above with respect to how Sharples models the differences between beginners and experts suggests further consideration of the role of the evolution of representation in the progressive acquisition of expertise. In this respect, Karmiloff-Smith [20] proposes a model of evolving representation called Representational Redescription model.

This model analyses the development of behavioural mastery in a given domain – meaning consistenly succesful performance in the domain – in terms of how knowledge about the domain is represented internally by the individual. The model considers three phases of learning. During the first phase the individual focuses on his interaction with the environment, and represents these in the form of raw data received from outside. This may lead to an initial achievement of behavioural mastery. Over the second phase, internal representations are abstracted from the raw data, and processing may start to focus on them. As a result of this introspection, features of the environment may temporarily be disregarded and, as a result, observed behaviour may deteriorate. However, this leads to a recuperation of a more flexible achievement of behavioural mastery, by then based on having achieved reconciliation between internal representation and external data.

This model describes four different levels of cognitive representation: *implicit*, focused on the process itself; *explicit level one* in which basic aggregation of raw data present in the implicit level is performed in terms of data storage but may not yet be accessible to the cognitive system for manipulation operations; *explicit level two*, in which structures from the first explicit level are converted into schemas and thereby become available; and *explicit level three*, a final and "cross-system" representation of concepts that can be verbalized and are fully integrated in a more general cognitive system.

2.1.3 Models of Narrative Understanding

According to Trabasso et al [44], comprehension of a story is seen as the construction of a causal network by the provision by the user of causal relations between the different events of a story. This network representation determines the overall unity and coherence of the story.

Graesser et al [18] describe a constructionist theory that accounts for the knowledge-based inferences that are constructed when readers comprehend narrative text. In doing so, readers build a referential situation model (a mental representation of the people, setting, actions, and events that are mentioned in explicit clauses or that are filled in inferentially by world knowledge) of what the text is about [7]. The meaning representation so built must: address the reader's goals, be coherent at both local and global levels, and explain why actions, events and states are mentioned in the text.

Graesser et al list 13 types of inference that a reader is likely to make on trying to understand a text. The full set of inference types and their description is given in Table 1.

Type of inference	Brief description
Class 1: Referential	Word or phrase referentially tied to previous element or constituent in text
Class 2: Case structure role assignment	Noun phrase assigned to particular case structure role, e.g. agent, object…
Class 3: Causal antecedent	Inference is on a causal bridge between current action (or event or state) and previous context
Class 4: Superordinate goal	Inference is a goal motivating an agent's intentional action
Class 5: Thematic	Main point or moral of the text
Class 6: Character emotional reaction	Emotion experienced by a character caused by or in response to an action or event
Class 7: Causal consequence	Forecasted causal chain, including physical events and new plans by the agents
Class 8: Instantiation of noun category	Exemplar that instantiates an explicit noun or case role required by a verb
Class 9: Instrument	Object, part of body or resources used when an agent executes an intentional action
Class 10: Subordinate goal action	Goal, plan or action that specifies how an agent's actoin is achieved
Class 11: State	A state not causally related to plot (agent's knowledge or beliefs, object properties, spatial location of entities)
Class 12: Emotion of reader	Emotion that the reader experiences when reading the text
Class 13: Author's intent	Author's attitude or motive in writing

Table 1 Types of inference made during narrative understanding, after [18].

2.2 Existing Taxonomies of Dynamic Computational Models of Narrative

There are a number of computational models of narrative that address the dynamic nature of the processes involved in the construction of narratives.

Such models have been reviewed in the past by many authors into taxonomies based on different aspects. Although these classification efforts do not necessarily consider the issue of what features of narrative are represented explicitly in each case, these taxonomies highlight some of the differences in focus between the various systems, and may provide a starting point for our discussion.

Bailey [4] distinguishes between the following models of story construction (in his case particularly applied to story generation):

author models in which the task of generation is approached from the perspective of a (human) author, and an attempt is made to model actual processes undergone by human authors during the creation of a story (cites as examples [24, 13, 45] and an early paper by [34]),

story models in which story generation proceeds from an abstract representation of the story as a structural (or linguistic) artefact (cites as examples [12, 39, 33, 26]),

world models in which the task of constructing a story is addressed obliquely, by constructing a "world" and the characters within it and imbuing them with sufficient agency and complexity that their action become representable as a story (cites as examples [28, 31]),

reader models in which the story generation process is guided by a model of the story in terms of its effects on the cognitive processing of the story by an imagined reader.

Gervás et al [17] group story generation approaches within Artificial Intelligence into two groups, based on the techniques they employ:

planning/problem solving in which narratives are modelled as either a goal state to reach by applying story-construction operators or the result of story actions that the characters perform (cites as examples [45, 34]),

production grammars that model a narrative by defining the structural constituents of a story (cites as examples [39, 8, 43].

O'Neil [32] breaks down computational models of story generation into:

search based approaches which create stories by exploring the set of possible sequences of actions, typically comparing the generated story against some heuristic of quality [28, 24, 38, 36],

adaptation based approaches which use their knowledge of other stories to modify these stories into new ones [45, 34, 16].

Niehaus [30] distinguishes between:

simulations or emergent systems that primarily simulate the narrative world (cites as examples [2, 10, 19, 28, 35]),

deliberative systems those that primarily deliberate over the choice of narrative elements and events (cites as examples [3, 11, 25, 45, 27, 38]).

Niehaus explains that some recent simulation systems attempt to employ complex models of characters, and that deliberative systems tend to be guided by a set of narrative rules which define desirable stories [30]. Such narrative rules can be made to capture different features of narrative: classical plot structure, character dynamics, or even the experience of the reader.

This proliferation of different taxonomies all aimed at categorizing the field of narrative generation systems can be taken as an indication that the nature of the domain involves more aspects than can be accounted for in a single simple taxonomy. Whereas efforts of synthesis may be appropriate to summarise the field for purposes of communication, the present paper applies an effort of analysis in an attempt to understand this underlying complexity.

3 Aspects of Narrative in Terms of their Representation

This section establishes a number of significant aspects of narrative that can be drawn from the existing theoretical model of cognition related to narrative described in Section 2.1, and for each one of those it explores how they have been chosen as explicit focus of representation efforts in the past.

To clarify what is meant by an aspect in this context, each of the main aspects of narrative that have been chosen as explicit focus of representation efforts in the past are described briefly. In each case, some relevant examples are cited, though many more exist.

3.1 Selecting Relevant Aspects of Narrative

The set of inferences described by Graesser et al [18] constitute a good reference for the basic elements that need to be considered during the process of constructing a narrative.

The 13 types of inference may be roughly grouped into the following categories: inferences needed to make basic sense of the language in which the text is written (referential, case structure role assignment, instantiation of noun category, instrument, state), inferences need to work out the causal relations between events in the text (causal antecedent, causal consequence, subordinate goal action), inferences need to work out the motivations of agents in the text (superordinate goal), inferences concerning the overall point or moral of the text (thematic), inferences concerning emotions (character emotional reaction, emotion of reader), and inferences concerning the goals pursued by the author in writing the text (author's intent).

It seems plausible to consider that these different types of inference might be a starting point for representing the constraints on the writing task that Sharples describes. The vocabulary that an expert writer develops over time would allow explicit representation of an ongoing draft along all these different dimensions. In contrast, a novice might have his vocabulary restricted to a subset of these.

Additional axes of representation of an ongoing draft might come about if the author is familiar with concepts of narratology. As this type of work may be extremely diverse in nature, and every author is free to pick out a particular model or theory as additional tool to help him in his task, no attempt has been made to review these extensively in the paper. Nevertheless, it is important to consider that such models of the structure of narrative may play a significant role in providing additional dimensions of representation of a draft during the process of constructing a narrative. Issues like narrative arc [1, 15], the hero's journey [9], or the morphology of the folk tale [37] may be used to analyse an ongoing draft and as additional vocabulary in which to phrase constraints on the process of construction.

The representation and processing of texts at the elementary linguistic level has been the subject of many years of research within the field of natural language processing. The basic mechanisms by which language conveys meaning are considered beyond the scope of this paper. However, for the purposes of story construction two specific aspects are considered relevant: the sequence of presentation imposed by a linguistic rendering, and the elementary representation of the activity of agents in terms of actions, interactions, movement between locations. We will refer to the first aspect as *discourse sequence*. Within this aspect we will consider the representation of a story simply a sequence of discourse elements, each of one representing a unit of meaning captured within the system in some conceptual representation. The second aspect we will refer to as *simulation*.

As a result of these considerations, the following list arises of possible dimensions along which to represent aspects of a narrative: the *discourse sequence aspect* – a sequential discourse of conceptually conveyed items –, the *simulation aspect* – a representation of the activity of agents in terms of actions, interactions, mental states, and movement between locations –, the *causal aspect* – a structured representation of causal relations between elements in the story –, the *intentional aspect* – a representation of the motivations of agents –, the *thematic aspect* – a representation of the theme of parts of the story –, the *emotional aspect* – a representation of the emotions involved in or produced by the story –, the *authorial aspect* – a representation of the intentions of the author –, and the *narrative structure aspect* – representations of the story in terms of narratological concepts of story structure –.

The remainder of this section will consider these resulting 8 aspects in terms of how (whether) they have been represented computationally in existing systems. The set of aspects considered here is not meant to be exhaustive. Those aspects that have been reviewed correspond to the ones that have been more frequently chosen explicitly as focal point for computational representations of narrative, but there are others.

3.2 The Discourse Sequence Aspect

A fundamental aspect of narratives is the fact that, whatever the internal complexity of the set of events they refer to, they are usually presented to the reader as a linear sequence of discourse units. Many of the computational approaches to narrative focus on this view as a linear sequence of discourse elements as the main representation of a narrative. These approaches represent stories as a sequence of statements or facts that is incrementally constructed. Over a representation in these terms, procedures are provided for progressively selecting which statement can be added to the draft at each point, to construct a complete story.

These approaches tend to focus on stories focalized on a single character, where a single narrative thread following that character is enough to cover the complete story. In cases where several characters are active at the same time in different locations this type of model may have difficulty in representing story events as they ocur.

Mexica [34] generates linear sequences of actions by explicitly adding content to partial discourses in a computational implementation of the engagement and reflection model [41]. The discourse is constructed by an elaborate selection among actions that can possibly follow according to the current state. This generation is driven not only by knowledge structures defining the domain, but also by explicit curves that model the evolution of narrative tension in a linear discourse in such a way that the produced story lineally matches the objective curve. Many of the systems employing more complex underlying representations include an additional stage for the representation of discourse, with procedures for distilling it from their internal representation.

3.3 The Simulation Aspect

Another important aspect of narrative is the representation of characters, their behaviour, and the internal representation of their mental state, their relations with one another, their motivations, and their beliefs. This aspect has been chosen as focal point for the representation of narratives in some approaches to story generation. Such approaches concentrate on representing characters and rules that may govern their behaviour and interaction in such a way that they can be set in motion as an autonomous (usually agent-based) system.

The Novel Writer system developed by Sheldon [21] relied on a micro-simulation model where the behaviour of individual characters and events were governed by probabilistic rules that progressively changed the state of the simulated world with the flow of the narrative arises from reports on the changing state of the world model. Meehan's TaleSpin [28] models a story as the sequence of actions that characters perform to reach their objectives. The Virtual Storyteller [42] generates stories as the output of a agent-based interaction in which goals, perceptions and relations guide character behavior. The system includes a Director agent that, while not appearing in the story, communicates with the other agents and drives the interaction to look after its narrative features. Façade [27] is a one-act interactive fiction system in which agents interact with the user in natural language. Façade has a strong focus on character behavior definition. Lebowitz's UNIVERSE [23] was the first storytelling system to devote special attention to the creation of characters. The BRUTUS system [8] is described as having included a simulation-process is set in motion, where characters attempt to achieve a set of pre-defined goals and this results in a plot.

Beyond actual generation, the explicit representation of character beliefs, motivations, values, and moral dilemmas has been proposed as a crucial ingredient for the adequate treatment of narrative in legal contexts [5].

Narratives produced in terms of the simulation aspect then need to be collected or abstracted from the log of the collective behaviour of such a system into a narrative discourse.

3.4 The Causal Aspect

Efforts focusing on *causality* as main feature of narratives have lead to the application of planning approaches to narrative generation. In these, a story is represented as a graph or network of causal links that connect the description of its initial state to the description of its final state, and the representation of the story is built by the application of planning algorithms.

Reliance on some kind of planning algorithm is a feature of many existing story generation algorithms. TALESPIN [29], a system which told stories about the lives of simple woodland creatures, was based on planning: to create a story, a character is given a goal, and then the plan is developed to solve the goal. The operation of the UNIVERSE system [24] was similar to decompositional planning. MINSTREL [45] used building units consisting of goals and plans to satisfy them. Fabulist [38] used a planning approach to narrative generation. Since then, many more systems have used planning approaches as underlying technologies [3, 11, 36, 10, 35, 30, 32].

3.5 The Intentional Aspect

The planning approach focuses basically on the causal set of inferences. Inferences about motivation and the intention's of characters are not contemplated in a traditional plan, which focuses on actions, their preconditions and effects. As a refinement on the planning approach, the work of Riedl [38] extends this representation with additional information concerning intentionality, which is assumed to take a main role in character believability. Following this, Riedl's FABULIST performs story generation by applying a planning algorithm on partial stories in which characters' objectives and the plausibility of their intentions, along with author goals, drive the creation. The Intent-Driven Partial Order Causal Link (IPOCL) planning algorithm simultaneously reasoned about causality and character intentionality and motivation in order to produce narrative sequences that are causally coherent (in the sense that they drive towards a conclusion) and have elements of character believability.

3.6 The Theme Aspect

Theme is the central topic a text treats, the central meaning of a narrative. Theme has been identified as an important inference carried out by readers in understanding a story. Cognitive theories of narrative consider it very relevant. Graesser et al [18] consider theme among their set of inferences relevant to the understanding of narrative. The concept of theme also seems very close to what Sharples defines as primary generators, which he reckons have a fundamental role in the process of writing.

In spite of this, very few story generation systems have considered it. The MINSTREL [45] system was started on a moral that was used as seed to build the story. This moral was explicitly added at the end of the story. The BRUTUS [8] system included a specific process of instantiation of a thematic frame.

3.7 The Emotional Aspect

One particular aspect that deserves special attention is emotion. Emotion is a fundamental aspect of narrative that has surprisingly received little attention in terms of computational representation, possibly due to the difficulties inherent in representing such elusive concepts. A pioneer in this sense is the Mexica system [34] which includes explicit representation of emotional links between characters and drives the story generation process based on how these emotional links and the resulting emotional tensions rise and fall throughout the story.

3.8 The Authorial Aspect

The intentions of authors are fundamental in the construction of narrative. Many story generation systems have recognised this truth and built in representations of these intentions into their operation.

Dehn's AUTHOR [14] was a program intended to simulate the author's mind as she makes up a story. According to Dehn, an author may have particular goals in mind when he sets out to write a story. But even if she does not, it is accepted that a number of metalevel goals drive or constrain the storytelling process. These concern issues such as ensuring the story is consistent, that it is plausible, that characters be believable, that the attention of the reader is retained throughout the story etc. These may translate at a lower level into subgoals concerning situations into which the author wants to lead particular characters, or the role that particular characters should play in the story. A story is understood as "the achievement of a complex web of author goals". These goals contribute to give the story its structure, guiding the construction process, but they are not visible in the final story. Some example high level author goals are given: make the story plausible, make the story dramatic, and illustrate key facts. UNIVERSE [24] relied on a procedure similar to decompositional planning, but considered a set of goals that were not character goals, but author goals. This was intended to allow the system to lead characters into undertaking actions that they would not have chosen to do as independent agents (to make the story interesting, usually by giving rise to melodramatic conflicts). The MINSTREL [45] system relied on a planning system that operated at two different levels: in terms of author goals and in terms of character goals. Mexica [34] was a computer model designed to study the creative process in writing in terms of the cycle of engagement and reflection as capture in the cognitive model built by Sharples [41]. During the reflection phase, the system checks whether the story so far satisfies criteria of coherence and novelty. These may be considered author goals.

The intentions of the author are a fundamental aspect of narrative in as much as they provide the background against which all the other aspects need to be considered. Depending on the purpose that the author has in mind, some aspects will be more relevant than others for the final narrative. Different authors may decide to focus more on emotions, or the style of the discourse, or the narrative structure.

3.9 The Narrative Structure Aspect

Efforts focusing on the *underlying structure* of a narrative as the main feature of narratives envisage the representation of a narrative in terms of a skeleton that gives shape to it, and consider procedures for selecting or constructing such a skeleton and then progressively enriching it to a full narrative. Existing efforts rely either on Case-Based Reasoning (CBR) technologies [45, 16] or on grammars [12, 39, 43, 33, 26, 8] to achieve this. In some cases, this is achieved by reusing the structure of previously existing narratives, either by adopting a particular one wholesale, gutting it and then refilling it with new material, or by first combining the structure of several narratives to build a new skeleton, and then populating that with new material. In the spirit of making the most of available materials, these approaches tend to consider the task of refilling narrative skeletons in terms of reusing constituent elements from the set of prior narratives gathered as reference for narrative structures.

The MINSTREL [45] system applied a CBR procedure based on the application of Transform Recall Adapt Methods (TRAMs). Basic TRAMs just pass the query as it stands to episodic memory and returns any matching schemas found. However, in cases of failure, more complex TRAMs operate by applying a basic modification to the input query, querying episodic memory with the resulting new query, and returning an adaptation of any results obtained by reversing the modification applied to the original query.

A different fundamental aspect of narrative is the fact that it can be analyzed in terms of recurring structures that articulate its main ingredients into abstractions that allow its description at a higher level than simple enumerations of events. This fact has been observed by narratologists from very early studies [1, 15] with some efforts made to formalize these intuitions into stricter frameworks [37]. A number of computational implementations of story generation explicitly model narrative structure. These systems propose a top-down design implemented as attribute-grammars in which the details of the structure of a story is iteratively refined from a general definition (setting, conflict, climax and resolution, for instance) to basic events [39, 22]. These structural abstractions have been employed in the past both as means of summarization and categorization, as possible metrics of quality for narratives, and as possibly driving mechanisms for generation. Within the BRUTUS [8] system, the process of converting the resulting plot into the final output is carried out by the application of a hierarchy of grammars (story grammars, paragraph grammars, sentence grammars) that define how the story is constructed as a sequence of paragraphs which are themselves sequences of sentences.

3.10 Relating Representational Aspect with Existing Taxonomies

The different aspects that are being considered in this paper have a relation to the criteria used in the past when designing taxonomies of story generation systems. Some of the types used in these taxonomies have a correspondence with the aspects of narrative chosen as focus for computational representation. In terms of Bailey's classification, the systems he describes as based on story models map onto systems that focus on the narrative structure aspect. These would include the set of systems that Gervás et al [17] consider based on production grammars, and also the system that O'Neil [32] describes as adaptation based approaches. The systems that Bailey describes as being based on world models map well into system that focus on the simulation aspect. Niehaus' simulations or emergent systems also map onto this type of system. The systems that Gervás et al describe as based on planning/problem solving map onto systems that focus on the causal aspect [17]. Some of the examples given by O'Neil for what he describes as search-based approaches would also map onto this set. However, O'Neil's description of search-based approaches – in particular where he describes them as exploring the set of possible sequences of actions – could also refer to systems that focus on the discourse sequence aspect.

Other types included in the taxonomies reviewed concentrate not so much on the representation being used but on the particular processes being modelled. Niehaus' category of deliberative systems is broad, and it can be seen to encompass systems that focus on either discourse sequence, causality, or narrative structure, depending on what representation the deliberation processes are applied to. In contrast with systems based on simulation, which correspond to simulations or emergent systems. Bailey's author models may also have broad application over systems that represent different aspects of narrative, as long as the systems somehow attempt to reflect processes attributed to humans. Obviously, any system that addresses the authorial aspect would fall into this category. Bailey's proposed reader models, of which none existed at the time he was writing have flourished since [3, 11, 32]

4 Discussion

Three basic issues are worthy of discussion: how existing systems show evidence of the usefulness of representing multiple aspects, what the analysis of these aspects tells us about the nature of narrative, and the relation between these aspects and the models of cognition outlined in Section 2.1.

4.1 Evidence in Support of Multi-Aspectual Representation from Existing Systems

The review presented in Section 3 has underlined the fact that many of the existing systems already attempt to model more than one narrative aspect. In fact, as more refined systems are developed, they tend to progressively extend the set of aspects of narrative that they cover.

Systems that generate a linear sequence apply different methods for selecting what action to consider next in the sequence, but they are generally chosen so that they include an implicit understanding that the statements included in the story constitute a coherent whole (with causality hopefully arising during interpretation) and lead to an interesting conclusion. Approaches that rely on representing the causal nature of narrative assume the existence of a final rendering process in which the content they produced can be exposed as an ordered set of facts, even if an intermediate representation in terms of a plan has been used to drive the construction of the plot. Systems based on planning, which are inherently causal in nature, may consider as additional information data on intentionality, or author goals. Specific modules can address thematic instantiation, or grammar based generation. Systems explicitly addressing the underlying structure of stories need to take into account a number of relations between facts, and *causality*, as a key property of narrative information, is commonly present. Inversely, causality between events builds an implicit graph that can partially define the structure of the narrative. While this bidirectional implicit influence usually exists, systems that do not explicitly employ the two aspects usually do not take advantage of the corresponding properties of both, namely the strong planning properties that explicit causality offers and the complete world construction that story structures permit.

All this is taken as evidence that consideration of more than one aspect of narrative in a generation system is considered a positive value.

4.2 The Nature of the Various Aspects in Terms of Representation

Every system models narrative creation through a certain set of data structures that help to instantiate the approach taken.

The same information may be stored in different data structures without significant loss, or a data structure can be enriched to be capable of representing additional types of information. An important conclusion of this paper is that narrative has different aspects, each of which has a different natural structure. This can be illustrated by the following examples of natural associations between aspects and data structures: the set of causal links between elements of a story is best represented as a graph, the sequence of discourse fits better into a list, and many of the narratological refinements of the three-act structure of classic tradition are best expressed as a syntactic tree.

These differences in nature can be bridged in many ways. First, more than one representation may be used, with explicit processes of mapping from one to the other added to the system. For instance, a causal account of a story is produced first and then it is linearized as discourse. Second, the way in which such data structures are actually implemented and loaded with information may lead to implicit data topologies. Many systems focusing on the narrative structure aspect often make use of attribute grammars in which attributes convey information between levels and branches of the grammar. The information contained in these attributes is used to *link* properties between characters, events or partial stories, thus connecting elements across different branches of the grammatical trees in ways more similar to how they might have been represented as a graph. Simulation-based system may employ additional models of narrative, whether at system or at character level, that may be based on some of the other aspects (planners, emotions, target plot structure...).

4.3 An Integrated Multi-Aspectual Representation Allowing Redescription

Each of the aspects of narrative described in Section 3 can be understood as a different dimension of a narrative. The review presented in Section 3 has identified existing AI technologies that provide a good model of the corresponding features. Each of these combinations of a particular representation and a particular technology can claim successful modelling of some aspect of narrative directly related to the feature that they have focused on. Constraints on the process of constructing a narrative in the sense described by Sharples can be formulated in terms of each of these dimensions.

Under this light, each of the approaches for the construction of narrative that has been attempted based on one of these dimensions is indeed a valuable model of a human ability to construct narrative, or at least a valuable model of a particular ingredient of human ability to construct narrative. Yet a complete model of the process as described by Sharples would require not just models of the construction process based on one of these dimensions, but a set of such models together with a procedure for switching across dimensions and integrating into a single draft of the narrative results from each of the models.

According to this view, each of the dimensions would correspond to a different subset of what Sharples describes as “vocabulary to describe mental processes”, which beginners do not have and experts have developed over years of expertise. If one considers this point of view, the human ability to construct narratives should be considered not as a solid block of functionality, but rather as a set of posible progressive stages of development, with beginners at one end – relying on simple problem solving techniques applied to a representation based on a reduced vocabulary – and experts at the other end – possibly relying on narrative-specific techniques defined over a much broader representation vocabulary that includes many more dimensions. In that sense, systems developed along a single dimension might constitute acceptable models of beginners ability. Systems based on a restricted number of the dimensions of narrative that may be contemplated would constitute models of human ability at some point in the scale of development between beginners and experts. Sharples’s description of the reflection phase could then be envisaged as progressive refinement of the initial set of constraints on the desired text. Successive constraints would be incrementally developed at the various levels: some on discourse sequence, some on character behaviour, some on emotion, some on causality. If this were true, plausible models of human expert ability are unlikely to be achieved without representation and operation along a fair number of these dimensions of narrative. Although an intuitive step is required, such richer models may have a better chance of success at emulating the performance of human experts in terms of narrative ability.

This argument can be further explored with reference to the levels of expertise described by Karmiloff-Smith with respect to cognitive representation. Initial representations of narratives within a computational system – of the type that each system considers as output representation of a story, usually in terms of discourse sequences – would correspond to what Karmiloff-Smith calls implicit or explicit level one representations. Computational systems that model narrative at this level can be considered as static snapshots of expertise during the first phase of learning. They may evidence a basic kind of behavioural mastery – in terms of producing stories of acceptable quality. Each of the richer representations that successive systems propose as internal representation of the narrative, usually involving explicit representation of additional aspects of narrative, would correspond to explicit level two. At this level, some particular structure observable within or inferable from the previous level has been redescribed as a schema at this second level. Systems showing this type of representation can be seen as static snap shots of expertise achieved during the second phase of learning. But real expertise only comes when explicit level three is reached. In this level, a wide pool of such schemas – possibly different ones for different aspects or dimensions – are available, and they have been integrated into "a more general cognitive system". Systems at his stage would achieve the second kind of behavioural mastery, allowing representational flexibility and control that may lead to creativity.

5 Conclusions

Different aspects of narrative all have a role to play in modelling the human ability of constructing narrative. Each particular aspect is better served by a different computational technology, relying on a specific type of data structure for representation. Although technologies particular to one aspect may be extended to cope with information usually addressed by another aspect, theoretical models of cognitive process applied by humans do suggest that explicit transformations of the underlying representation – Sharples' constraints – do take place, and that these transformations known as representational redescription allow richer creative process that carry out optimal exploration of the conceptual spaces involved in a creative process. In fact, when observed in humans, this particular ability is associated with expertise in the particular task, and its absence usually observed in beginners. This suggests that efforts to model human ability to construct narrative may benefit from the exploration of models that consider a multi-aspectual representation of narrative, with explicit procedures for representational redescription across aspects, and different process – possibly of the engagement and reflection type – operating on each of these specific representations.

The set of existing systems reviewed evidences a positive trend towards an increase in the number of aspects explicitly covered by each successive system, but improvement is still possible along the lines described in the paper.

References

1 Aristotle. *Poética*, volume 8. Colección Biblioteca Románica Hispánica IV, 1974.

2 R. S. Aylett, S. Louchart, J. Dias, A. Paiva, and M. Vala. Lecture notes in computer science. chapter Fearnot!: An Experiment in Emergent Narrative, pages 305–316. Springer-Verlag, London, UK, UK, 2005.

3 Byung-Chull Bae and R.Michael Young. A use of flashback and foreshadowing for surprise arousal in narrative using a plan-based approach. In Ulrike Spierling and Nicolas Szilas,

editors, *Interactive Storytelling*, volume 5334 of *Lecture Notes in Computer Science*, pages 156–167. Springer Berlin Heidelberg, 2008.

4 Paul Bailey. Searching for storiness: Story-generation from a reader's perspective. In *Proceedings of the AAAI Fall 99 Symposium on Narrative Intelligence*, 1999.

5 Floris Jurriaan Bex and Trevor J. M. Bench-Capon. Persuasive stories for multi-agent argumentation. In *AAAI Fall Symposium: Computational Models of Narrative*, volume FS-10-04 of *AAAI Technical Report*. AAAI, 2010.

6 M. Boden. *The creative mind*. Weidenfeld and Nicholson, London, 1990.

7 Gordon H. Bower, John B. Black, and Terrence J. Turner. Scripts in memory for text. *Cognitive Psychology*, 11:177–220, 1979.

8 Selmer Bringsjord and David A. Ferrucci. *Artificial Intelligence and Literary Creativity: Inside the Mind of BRUTUS, a Storytelling Machine*. Lawrence Erlbaum Associates, 1999.

9 J. Campbell, P. Cousineau, and S.L. Brown. *The Hero's Journey: Joseph Campbell on His Life and Work*. Collected Works of Joseph Campbell. New World Library, 2003.

10 Marc Cavazza, Fred Charles, and Steven J. Mead. Planning characters' behaviour in interactive storytelling. *Journal of Visualization and Computer Animation*, 13:121–131, 2002.

11 Yun-Gyung Cheong and R.Michael Young. Narrative generation for suspense: Modeling and evaluation. In Ulrike Spierling and Nicolas Szilas, editors, *Interactive Storytelling*, volume 5334 of *Lecture Notes in Computer Science*, pages 144–155. Springer Berlin Heidelberg, 2008.

12 B. N. Colby. A partial grammar of eskimo folktales. *American Anthropologist*, 75:645–662, 1973.

13 N. J. Dehn. *Computer Story- Writing: The Role of Reconstructive and Dynamic Memory*. PhD thesis, University of Yale, New Haven, CT, USA., 1989.

14 Natalie Dehn. Story generation after tale-spin. In *In Proceedings of the International Joint Conference on Artificial Intelligence*, pages 16–18, 1981.

15 G. Freytag. *Die Technik des Dramas*. S. Hirzel, 1863.

16 P. Gervás, B. Díaz-Agudo, F. Peinado, and R. Hervás. Story Plot Generation Based on CBR. *Knowledge-Based Systems. Special Issue: AI-2004*, 18:235–242, 2005.

17 Pablo Gervás, Birte Lönneker-Rodman, Jan Christoph Meister, and Federico Peinado. Narrative models: Narratology meets artificial intelligence. In Roberto Basili and Alessandro Lenci, editors, *International Conference on Language Resources and Evaluation. Satellite Workshop: Toward Computational Models of Literary Analysis*, pages 44–51, Genova, Italy, 2006.

18 A. C. Graesser, M. Singer, and T. Trabasso. Constructing inferences during narrative text comprehension. *Psychological Review*, 101:371–395, 1994.

19 Randall W. Hill, Jr., All W. Hill, Jonathan Gratch, Stacy Marsella, Jeff Rickel, William Swartout, and David Traum. Virtual humans in the mission rehearsal exercise system. *In KI Embodied Conversational Agents*, 17:32–38, 2003.

20 A. Karmiloff-Smith. *Beyond Modularity: A Developmental Perspective on Cognitive Science*. A Bradford book. A Bradford Book, 1995.

21 Sheldon Klein, John F. Aeschliman, DavidF. Balsiger, Steven L. Converse, Claudine Court, Mark Foster, Robin Lao, John D. Oakley, and Joel Smith. Automatic novel writing: A status report. Technical Report 186, Computer Science Department, The University of Wisconsin, Madison, Wisconsin, December 1973.

22 R. Raymond Lang. A declarative model for simple narratives. In *Proceedings of the AAAI Fall Symposium on Narrative Intelligence*, pages 134–141. AAAI Press, 1999.

23 M. Lebowitz. Storytelling as planning and learning. In *nternational Joint Conference on Artificial Intelligence*, 1983.

24 M Lebowitz. Storytelling as Planning and Learning. *Poetics*, 14:483–502, 1985.

25 M. Lebowitz. Storytelling and generalization. In *In Annual Conference of the Cognitive Science Society*, pages 100–109, Berkeley, California, 1987.

26 Lee, M. A Model for Story Generation. Master's thesis, University of Manchester, 1994.

27 M. Mateas and A. Stern. Structuring content in the Façade interactive drama architecture. In *Proceedings of AIIDE*, pages 93–98, 2005.

28 J. Meehan. *The Metanovel: Writing Stories by Computer*. PhD thesis, Yale University, 1976.

29 James R. Meehan. Tale-spin, an interactive program that writes stories. In *In Proceedings of the Fifth International Joint Conference on Artificial Intelligence*, pages 91–98, 1977.

30 J. Niehaus. *Cognitive Models of Discourse Comprehension for Narrative Generation*. BiblioBazaar, 2011.

31 N. Okada and T. Endo. Story generation based on dynamics of the mind. *Computational Intelligence*, 8:123–160, 1992.

32 B. O'Neil. *A Computational Model of Suspense for the Augmentation of Intelligent Story Generation*. PhD thesis, Georgia Institute of Technology, Atlanta, Georgia, USA., 2013.

33 L. Pemberton. A modular approach to story generation. In *4th Conference of the European Chapter of the Association for Computational Linguistics*, pages 217–224, 1989.

34 R. Pérez y Pérez. *MEXICA: A Computer Model of Creativity in Writing*. PhD thesis, The University of Sussex, 1999.

35 D. (David) Pizzi, M. O. (Marc) Cavazza, and J-L. (Jean-Luc) Lugrin. Extending character-based storytelling with awareness and feelings. ACM.

36 J. Porteus and M. Cavazza. Controlling narrative generation with planning trajectories. In *Proceedings of the 2nd International Conference on Interactive Digital Storytelling*, pages 234–245, 2009.

37 Vladimir Propp. *Morphology of the Folk Tale*. Akademija, Leningrad, 1928.

38 M. Riedl. *Narrative Planning: Balancing Plot and Character*. PhD thesis, Department of Computer Science, North Carolina State University, 2004.

39 D. E. Rumelhart. Notes on a schema for stories. *Representation and Understanding: Studies in Cognitive Science*, pages 211–236, 1975.

40 M. Sharples. An account of writing as creative design. *The Science of Writing*, 1996.

41 M Sharples. *How We Write*. Routledge, 1999.

42 M. Theune, E. Faas, A. Nijholt, and D. Heylen. The virtual storyteller: Story creation by intelligent agents. In *Proceedings of the Technologies for Interactive Digital Storytelling and Entertainment*, pages 204–215, 2003.

43 P. W. Thorndyke. Cognitive structures in comprehension and memory of narrative discourse. *Cognitive Psychology*, 9(1):77–110, 1977.

44 T. Trabasso, P. vand den Broek, and S.Y. Suh. Logical necessity and transitivity of causal relations in stories. *Discourse Processes*, 12:1–25, 1989.

45 Scott Turner. *MINSTREL: A Computer Model of Creativity and Storytelling*. PhD thesis, University of California at Los Angeles, Los Angeles, CA, USA, 1992.