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Modeling and Representing Dramatic Situations as Paradoxical Structures

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Abstract

The concept of dramatic situation is important in dramaturgy and narratology. In the domain of story generation and interactive digital storytelling, this concept is particularly powerful in creating meaningful story variations from a single core model. Nevertheless, dramatic situations and the related notion of deep narrative structures have been overlooked in the domain of computational models of narrative. This article presents a computational model of dramatic situations. Designed with creative authors in mind, the model consists of a small set of building blocks that, when assembled with specific relations, create narrative structures. Some structures that are described are of particular interest from a dramatic point of view, for they embed a fundamental paradox. These structures are generalized and formalized to allow an exhaustive search and to establish an initial list of dramatic situations that share this property.

1 Dramatic situations and deep narrative structures

There is a multitude of computational models of narrative. Depending on the goal (understanding narrative, analyzing texts, generating reports on human activities, generating stories, building interactive fictions, etc.), these models focus on different aspects of narrative. In particular, these models offer a variable degree of complexity (how many narrative features are modeled) and abstraction (how distant the model is from the concrete experience of a narrative). In the context of story generation for interactive narrative (Aylett, 1999; Mateas and Stern, 2003; Miller *et al.*, 2011; Pizzi *et al.*, 2007; Szilas, 1999; Weyhrauch, 1997; Young *et al.*, 2004), a model's complexity and abstraction seems particularly elevated. This observation is explained by one of the specific goals of the domain: to create a large number of story variants from an author-defined storyworld. In terms of complexity, interactive storytelling systems consist of an elaborate architecture that includes several subcomponents which manage the various aspects of narrative (Aylett *et al.*, 2005; Dias *et al.*, 2011; Mateas and Stern, 2003; Szilas, 2007; Young *et al.*, 2004). These subcomponents include event generation, event selection, and user modeling, among others. In terms of abstraction, the more abstract the narrative model, the larger the number of possible variations within a single storyworld (Szilas *et al.*, 2012). Because the authoring work tends to exponentially escalate with the amount of variation, abstraction becomes a necessary feature as soon as choice and variations are targeted.

Among the various computational approaches that satisfy the criteria of complexity and abstraction, the modeling of dramatic situations offers certain advantages, as will be described below. Initially,

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however, we must define the concept of dramatic situation and how it relates to the scope of this research. We consider a dramatic situation not as a description of the temporality of narrative, but as a 'state' in the fictional world that is embedded with certain 'properties'. Generally speaking, a dramatic situation generates a certain interest for the audience. More precisely, it is a state of uncertainty where the story could evolve in several divergent ways, some of them leading to a major shift in plot. Therefore, a dramatic situation illustrates a core issue in the narrative which is usually described in terms of a subset of characters and their personality traits, goals, and inter-relations, in addition to environmental elements. This type of situation can be defined by 'generic' tropes such as the love triangle (two characters who are both in love with a third) or the ethical dilemma (a character who is forced to transgress his/her ethical values). Examples of Dramatic situations are also seen in 'specific' terms, such as when star-crossed lovers Romeo and Juliet are kept apart by their feuding families (Shakespeare's *Romeo and Juliet*), or when financially ruined Dorante wishes to marry the wealthy Araminte but fears she could never love a pauper (Marivaux' *Les Fausses Confidences*).

Dramatic situations provide four advantages for computational modeling. First of all, they provide an abstract representation of the story. Even in their specific formulation (such as with *Romeo and Juliet* and *Les Fausses Confidences*), they could potentially yield a large number of narrative outcomes. Second, reasoning at the level of dramatic situation allows to identify and isolate a sub-problem, without having to describe a whole 'narrative engine' (story generation or interactive digital storytelling system). While the article will refer to the narrative engine that may embed these dramatic situations, the underlying mechanisms of this narrative engine—that is, the necessary algorithms to transform a given dramatic situation into a story—will not be tackled in this article. Dramatic situations are therefore compatible with various Artificial Intelligence (AI) techniques such as planning.

Third, the concept of dramatic situations speaks to persons outside academia such as authors. Since the interactive digital storytelling domain is generally dependent on authors who enter narrative content into systems, and because authoring is recognized as an issue in this domain (Louchart *et al.*, 2008; Spierling and Szilas, 2009; Szilas *et al.*, 2003), using dramatic situations is an approach that encourages authors to use such systems. Dramatic situations are already widely known by screenwriters through the work of Georges Polti (1903).[1] Although Polti's approach is questionable from a scientific point of view (Souriau, 1950), our point is to illustrate that dramatic situations are meaningful for authors.

In addition, we believe that modeling dramatic situations is also relevant from a narratological point of view. Dramatic situations have been seldom studied so far (Jansen, 1973; Polti, 1903; Souriau, 1950), and this research may contribute to an expansion of these theories.

As it will be detailed below, focussing on narrative situations departs from the majority of research in Interactive Storytelling mostly concerned with the sequencing of action.

2 Related work

Dramatic situations in theatre have been studied extensively by E. Souriau (1950), who defines them as a system of 'forces' that are in tension. These forces cause the various characters to act and thus generate the action of the play. Souriau outlines six fundamental actants that are involved in situations later reused and renamed by A. Greimas (1966). Souriau's approach is related to the principle proposed by C. Levis-Strauss in his study of myths (Levi-Strauss, 1958). Levi-Strauss asserts that unique deep structures exist behind many different myths across communities and cultures, and that these structures are able to produce a diversity of myth when they unfold. The key feature of such structures is their atemporal nature (Levi-Strauss, 1958). This is important to highlight since the term 'structure' shares different and, at times, contradictory meanings (Szilas *et al.*, 2012). Such deep structures contain various interconnected narrative elements that do not wholly specify a definitive temporal relation between elements. For example, stating that two characters are in conflict or that the narrative revolves around two thematic elements is considered atemporal specification. These specifications later produce temporally ordered events.

The concept of dramatic situation is rarely directly tackled in interactive storytelling and story generation research, but related concepts have been developed in several research projects.

One of the main approaches for generating stories is the character-based approach (Aylett, 1999; Brom *et al.*, 2009; Cavazza *et al.*, 2001). It consists in simulating intelligent characters, with low-level and high-level cognition as well as emotional behaviors. The interaction of these characters may potentially produce a story. The concept of dramatic situation is, by definition, outside the realm of characters themselves: characters behave according to their own goals in an autonomous manner. This approach relies on the concept of narrative emergence (Aylett, 1999) which states that from the local and autonomous behavior of agents, a global narrative may emerge. Unfortunately, in practice, narrative emergence is hard to design and observe, since it mainly depends on the content that is provided to the system (Louchart, 2007). In particular, one of the key factors for narrative emergence is how goals and personalities are distributed among characters so that a potential conflict arises, as seen in 'conflict-based role-playing games' (Louchart and Aylett, 2006). Dramatic situations intervene at this level as a precise characterization of the potentially interesting global configuration of characters. In the character-based approach, the formalization effort mostly concerns the characters themselves. A formalization of dramatic situations may therefore complement the character-based approach in a relevant way.

Another widely used approach in interactive storytelling consists of using planning algorithms to dynamically build a path leading to an author-defined story goal (Cavazza *et al.*, 2001; Ciarlini *et al.*, 2008; Porteous *et al.*, 2010; Riedl and Stern, 2006; Riedl and Young, 2003). This approach does not include the concept of dramatic situations because operators (elementary events) are usually defined according to the logical constraints of the storyworld. Similar to the character-based approach, authors are in charge of creating interesting dramatic situations with a proper organization of operators, but the system does not reason on situations themselves. However, some variants are more relevant to dramatic situations than others. First, the planning algorithm may be modulated according to perceptive constraints such as the maximization of suspense or conflict. Suspense is related to dramatic situation, since it is a crucial element to highlight tension in dramatic situations. Closer to the concept of dramatic situation, the concept of conflict has also been assessed in relation to the planning approach. CPOCL is a planner that creates plots using conflicts, in terms of antagonistic goals between characters (Ware and Young, 2011). Barber and Kudenko (2007) have used planning algorithms where the planning goal itself is to create a dilemma. For example, the planner will build a plan so that the preconditions create a betrayal (a positive outcome occurs for one character but simultaneously a negative outcome occurs for the character's friend). Four other types of dilemma are similarly implemented: the sacrifice, the greater good, the take down, and the favor. These approaches are relevant to the present research. While they focus on the mechanisms for building a dramatic story, our approach is more focused on the preceding design phase, namely how an author may choose to arrange narrative elements so that dramatic situations potentially occur.

Narrative theories belonging to structuralism have inspired various projects in story generation (Bogh Andersen and Bogh, 2002; Cavazza *et al.*, 2001; Grasbon and Braun, 2001; Machado and Paiva, 2001; Szilas, 2002). However, few of them have focused on the notion of structures as described above. V. Propp's model has been largely used to generate stories. However, its succession of thirty-one functions is temporal, and thus does not reflect the same structures described by Levis-Strauss's atemporal approach. An interesting concept from structuralist narratology is the concept of roles which are incorporated in both V. Propp's (1928) theory and the Souriau/Greimas model. Roles have motivated various theoretical and practical approaches in the domain of Interactive

Storytelling (Chen *et al.*, 2010; Endrass *et al.*, 2009; Klesen *et al.*, 2000; Osborne, 2011). In Black Sheep for example (Klesen *et al.*, 2000), Greimas' (1966) six-actants model was implemented, but the model remained limited to the simple opposition between a protagonist and an antagonist. Therefore, the benefit this model provided to variations could not be observed. The IDtension system has developed a structural approach to Interactive Drama which enables it to build dramatic situations where characters have goals (quests), obstacles (antagonists), and ethical values (Szilas, 1999, 2002, 2007). Conflict is modeled as an opposition between the goals of the characters and the values that are violated in attempting to achieve this goal. Actions that exhibit such conflict are promoted during the story generation. However, these structural elements are often used in a non-structural way. For example, they might follow a more classical conditional approach (Habonneau *et al.*, 2012).

There are several other approaches which are worth mentioning. Façade, a research-based interactive drama, is based on the idea that dramatic tension increases throughout the course of the narrative. But this tension occurs within prewritten (yet interruptible) scenes and it is not modeled computationally. Conversely, the older approach adopted in DEFACTO (Sgouros, 1999) uses a sophisticated model of dramatic action and incorporates an algorithm to generate dramatic tension on the fly. For example, the system is able to trigger an action for creating a *Reversal of fortune*, a sequence in which 'a favorable intervention is followed by an unfavorable intervention'. However, this approach does not offer any guidance as to how to build a storyworld that potentially offers such dramatic sequences.

This overview of related research may be summarized as follows: despite the significant amount of research on Interactive Drama, only a few approaches have computationally modeled elements of dramatic situations. In most cases, the responsibility for creating such situations (either in a scripted manner or in an emergent way) is left to the authors. Computational formalisms based on Artificial Intelligence techniques do not incorporate such dramatic concepts. Therefore, authors lack guidance on creating relevant dramatic structures. In some cases, dramatic tension is effectively modeled as a variable that the system attempts to maximize during the simulation. But even in these cases, there is no instruction on how to organize relevant story elements to create these tense situations. Furthermore, the definition of a dramatic situation remains hard-coded in the system (such as betrayal in GADIN, ethical conflict in IDtension or antagonistic goals in CPOCL), leaving limited creative space for the author.

We are proposing a different approach to a computational model that both visually describes dramatic situations and enables computations based on the dramatic structure of these situations. In previous models (including our previous research), the focus was on the sequencing of action, based on approaches such as planning, character's simulation, or forward simulation based on narrative-perceptive evaluation. While the sequencing of action remains a main topic in the field, this article will explore a slightly different avenue, focussing on how the dramatic situations can be represented. This model is an extension of a model that has been employed within a fully implemented system for interactive drama (Habonneau *et al.*, 2012; Szilas, 2007). Beyond the computational characteristics of this model (such as expressivity and algorithmic complexity), it is particularly suitable to authors in charge of creating a specific interactive narrative application. Therefore, structures will be described visually in order to facilitate their appropriation by authors as well as to communicate between contributors of a specific work. This visual representation is also relevant from a computational point of view, as it helps to keep computational models as simple as possible.

3 The core components of the structural model

As explained above, we have adopted an atemporal structuralist approach. Various critiques of Structuralism have been formulated in the past decades, regarding the prevalence of computation and syntax, the exclusion of the pragmatics of narrative (the context of narration) and the rigidity of structures in regard to emergent and systemic phenomena. Nevertheless, our approach involves applying structuralist principles only where they are relevant. As explained above, the computational model of situations that this article proposes is not a full model of narrative generation. A complete model would involve additional components that are not based on structuralism (e.g. a model of the audience).

The basis of the structural model is informed by previous research (Szilas, 2007), though alternative representations may also be explored (Cataldi *et al.*, 2012). Six simple elements—goals, tasks, obstacles, side effects, characters and families, and denoted ‘nodes’, along with their interrelations (described below) will constitute the building blocks of the structure, with possible extension in the future. Formally, they constitute a labeled directed graph.

3.1 Goals

A ‘goal’ is a desired result that a character wishes to achieve. This concept is ubiquitous in dramaturgy and screenwriting (Lavandier, 1997; McKee, 1997; Vale, 1973). It also appears in some recent definitions of narrative (Ryan, 2004), since it corresponds to the fundamental notions of characters’ actions and intentions. A large number of narrative computational models implement goals (in particular agent-based models) since goals are a fundamental concept in Artificial Intelligence (Aylett *et al.*, 2005; Sgouros, 1999; Szilas, 2007). In the discrete, binary case (default), the goal is either reached or not reached. In the continuous case, the achievement of a goal is a continuous value that is managed by the narrative engine.

3.2 Tasks

A ‘task’ is a concrete action that a character can perform to reach a goal. It corresponds to the notion of action or operator in several AI or robotic frameworks. Note, however, that in a whole system, actions may be different from tasks, in the sense that actions may consist of more complex units that involve one or more tasks, such as the action of encouraging someone to perform a given task.

When performed, a task either leads to a success (the goal is partially or totally reached) or to a failure (the goal is not reached). In the continuous case, a task leads to the full or partial achievement of a goal. This is quantified by an ‘achievement increment’, a value between 0 and 1 that modulates the degree of achievement of the target goal (the detailed mechanism is part of the narrative engine). By default, the performance of a task is successful. However, obstacles related to the task may lead to a failure.

3.3 Obstacles

An ‘obstacle’ is an event related to a task that may hinder the reaching of a goal when that task is attempted by a character. This is where the model departs from classical AI representations, due to the nature of narrative. While the focus in robotics is to reach a goal as efficiently as possible, the focus of narrative is on the difficulties met by the characters as they try to reach their goals. An obstacle is a classical way of representing these difficulties, and is borrowed from dramaturgy and screenwriting (Lavandier, 1997; McKee, 1997). Obstacles implement the important concept of failure that is central in the narrative theory of C. Bremond (1973). Obstacles are also implicitly mentioned in U. Eco’s (1985) characterization of narrative action: ‘the actions are difficult and the agent does not have an obvious choice regarding what to do’ . While few interactive digital storytelling systems have implemented the notion of obstacles (Cavazza *et al.*, 2003; Szilas, 2002), the field of Interactive Fiction uses puzzles extensively, which are obstacles that must be solved by the reader (Montfort, 2011).

All obstacles are associated with a task. If an obstacle is triggered by an attempt to perform a task, then the goal may not be reached and could impact the storyworld (see relations below). Obstacles do not all systematically trigger. Therefore, we introduce the ‘chance’ associated with each obstacle, that denotes the probability of triggering the obstacle. It ranges between 0 and 1 (1 by default). This value is author-defined, according to the frequency with which the author wants the obstacle to occur. For example, if the author wants an obstacle to trigger half the time, then s/he chooses a chance of 0.5; If s/he wants the obstacle to trigger more often, say eight times out of ten, a value of 0.8 is chosen. This numerical value can be advantageously replaced by a qualitative value such as 'rarely', 'sometimes', or 'often'. In some cases, the chance of triggering obstacles remains undetermined. The decision to trigger them is at the discretion of the narrative engine. These obstacles are called 'free obstacles'.

3.4 Side effects

A 'side effect' is an event associated with a task that may be triggered when the task is performed by a character. Yet, unlike an obstacle, a side effect does not prevent a goal from being reached. A side effect thus enables a variant of a task. Side effects are not a prominent concept in narrative theory or dramaturgy. However, we have included them in the model because this concept was lacking in previous systems that implemented obstacles but not side effects. With obstacles, plenty of variants of a task can be written and may occur unpredictably when a character starts to perform a task, but they all lead to failure. Side effects enable us to write variants of tasks that occur unpredictably even when the task succeeds. When a character has no prior knowledge of a side effect, it corresponds to an involuntary action as described by C. Bremond (1973, p. 237): an agent undertakes a task but at the same time performs an 'involuntary action'. Like obstacles, side effects are associated with chance (1 by default).

Characters: Characters are an obvious constituent of a story. Note, however, that structures without characters are possible (see Section 7), where the characters are in fact embedded in goals. Characters are necessary in a structure to represent a conflict between two goals or between two characters.

Families: A family represents a set of characters who are more or less bound (e.g. all animals, a group of friends). It enables the representation of inter-characters conflicts.

AI-oriented narrative models use world states to express the consequences and preconditions of action execution (Barber and Kudenko, 2007; Cavazza *et al.*, 2001; Young *et al.*, 2004). For computer scientists, this is simply a natural way of representing actions, but for authors it does not align with the traditional approach of linear writing and requires much more time to learn (Mixon, L. J. unpublished; Szilas *et al.*, 2003). We are proposing an alternative way to represent knowledge for narrative where the dynamics of goals, tasks, obstacles, characters and side effects are described as 'relations' (or links) between these nodes. We have identified the following relations:

Reaching: A 'reaching relation' connects a task to its desired goal. In the continuous case, it contains the achievement increment (see goals).

Attachment: An 'attachment relation' connects an obstacle or side effect to the task which triggers it. When the task is connected to an obstacle, it is called a 'hindering' relation (oriented from the obstacle to the task). When the task is connected to a side effect, it is called a 'collateral' relation (oriented from the task to the side effect).

Sub-goaling: A 'sub-goaling relation' connects an obstacle to a goal. It indicates that the obstacle (called the 'triggering obstacle') activates the goal (called the 'sub-goal') when triggered. The task remains blocked by the obstacle until the sub-goal is reached (the blocking is only partial, in case the obstacle's chance is lower than 1).

Inhibiting: An 'inhibiting relation' connects a goal to an obstacle or a side effect. It prevents the target obstacle or side effect from being triggered. If the source goal is reached, the obstacle or side effect is not triggered. In the continuous case, instead of an all or nothing binary, the triggering is modulated according to a parameter called the 'inhibiting factor', which ranges from 0 (no modulation) to 1 (maximum modulation). Symmetrically, an 'exciting relation' also connects a goal to an obstacle or side effect, but favors its triggering.

Needing: A 'needing relation' connects a side effect to a goal. When a side effect is triggered, it means that the target goal becomes or remains 'unreached'. In the continuous case, the achievement of the goal is modulated according to a parameter called the 'achievement decrement' (value between 0 and 1).

Satisfying: A ‘satisfying’ (or ‘unsatisfying’) relation links a goal to a character who benefits from (or is hindered by) the achievement of the goal.
Belonging: A belonging relation connects a character to a family.

However counter-intuitive the directions of the relations in some cases may be, they have been carefully chosen to enable the structural calculations described in sections 6 and 7.

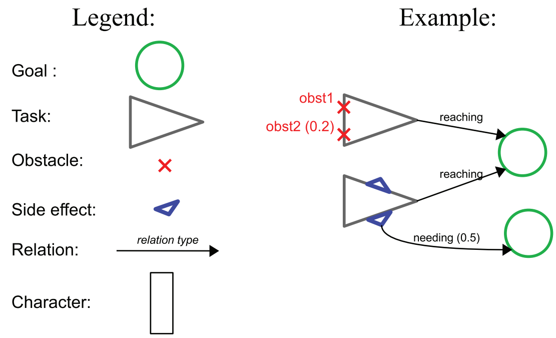

Fig. 1 A Graphical representation of the elements of a structure. When the relation is associated with a value, this value is represented after the relation name, in parentheses. To improve readability, the attachment relations are not depicted explicitly, but they are represented by positioning the obstacle or side effect over top of the task it is attached to. The number in parentheses after the obstacle or side-effect name is the associated chance. If the letter *F* is written instead, it indicates a free obstacle (see text)

4 Different types of structures and their visual representation

An abstract structure is a graph containing nodes and relations. It corresponds to what the author writes in terms of abstract narrative content (the data needed to display this content are described separately).

This abstract structure is distinct from the ‘active structure’, handled by a narrative engine during execution. The latter is specific to a narrative generation session. It monitors the achievement of the goals and handles data useful for the display of actions.

Generally, the abstract structure may contain variables that are instantiated in an ‘active structure’, according to rules that will not be detailed here. For the purposes of this article, there are no variables. Therefore, the active structure is identical to the abstract structure. During the execution, the active structure’s internal values are modified, such as the ‘achievement values’ for goals. The precise dynamics of these values depends on the specified narrative engine that makes use of the structures, which falls outside the scope of this article.

Note that even without these variables, a system based on dramatic situations is able to produce a variety of story events because structural writing and genericity (the use of variables) are two distinct writing principles (Szilas *et al.*, 2012).

Nodes and relations can be represented visually. This is essential for the authoring process. Fig. 1 depicts an example of an abstract structure containing various types of nodes and relations introduced above. Fig. 2 depicts an active structure.

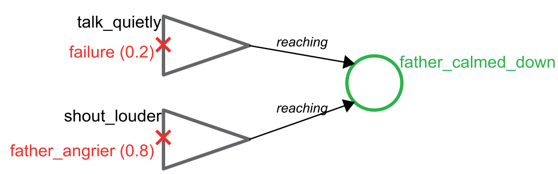

Fig. 2 An example of structure. Inspired by the Interactive Drama, Nothing For Dinner (Szilas *et al.*, 2014), this structure consists of a goal (*father_calmed_down*) that may be reached by two tasks (either *talk_quietly* or *shout_louder*). Both tasks have two obstacles respectively: *failure* and *father_angrier*

Compared with other formalisms used in interactive narrative systems, the proposed approach shares notable elements such as goals, tasks (similar to the notion of operators or action), and characters. Therefore, a story such as the one represented in Fig. 2 may be converted into existing formalisms, which may prove useful when the question of sequencing actions arises. However, existing formalisms oriented toward the sequencing problem fall short when it comes to representing the narrative more globally, as seen in atemporal structures with dramatic potential. The following sections will enhance these central characteristics by (1) extending the model with some hierarchy (Section 5), (2) proposing a criteria to differentiate dramatic structures from non-dramatic ones (Section 6), and (3) formally defining this criteria and performing an exhaustive search of all dramatic structures within a given formalism (Section 7).

5 Hierarchical structures

When modeling a narrative at the higher level, it is important to keep the structure simple to prevent the graph from becoming indecipherable. At the same time, a simple structure that captures the essence of a story (e.g. a quest of justice, a love conquest) does not contain enough content to express variety and richness. To solve this dilemma, one modeling technique should be added: 'modularity'. It consists of grouping subsets of elements into modules, and reasoning at the level of these modules rather than at the level of the elements themselves. This creates a 'hierarchy' between the lower level (simple elements inside a module) and the upper level (modules). This approach is traditional in Artificial Intelligence and has proven useful, both for computational and ergonomical reasons; see for example Hierarchical Finite State Machines (Gebhard *et al.*, 2011), Hierarchical Petri Nets (Balas *et al.*, 2008), and Hierarchical Neural Networks (Jordan and Jacobs, 1994). Two levels of hierarchy are taken into consideration for the purpose of this article.

A 'task module' is a subset of tasks, goals, obstacles, and side effects. This task module connects to other nodes with the same relations that are specified above. However, the way the elements connect to each other as well as the associated mechanisms differ slightly, due to the presence of internal elements. These are specified below and illustrated in Fig. 3.

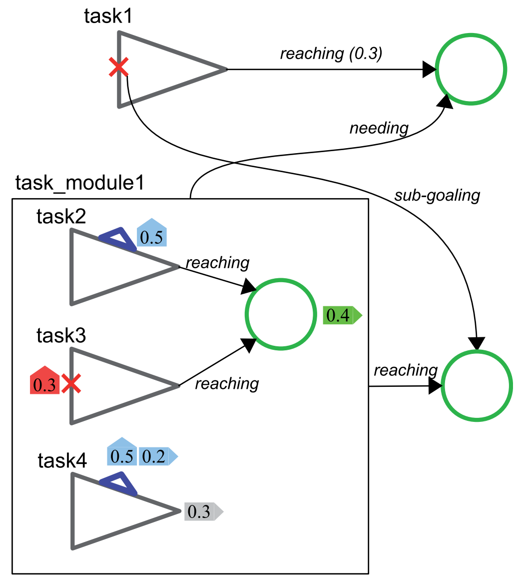

Fig. 3 A Graphical representation of the hierarchical and modular model for structures. Small arrows pointing up denote the decrement associated with the needing relation from the task module to *goal1*. Small arrows pointing to the right denote the achievement increment associated with the external reaching link from the task module to *goal2*. Note that if there are several relations leaving the task module, they should be numbered and the corresponding number noted along with the above-mentioned arrows

Reaching: A reaching relation connects a task module to a goal. The reaching relation is fired and the target goal is reached when some of the internal goals are reached or when internal tasks succeed. If an internal task with no attached goal is finished, it fires the reaching link and therefore other internal tasks do not need to succeed. In the continuous case, the increment of the reaching link is specified for each internal task and goal. Finally, an internal side effect or obstacle can also fire the reaching link of the enclosing task module.

Sub-goaling: A sub-goaling relation connects a task module to a goal. It is fired and the sub-goal is activated when certain internal obstacles are triggered.

Inhibiting: An inhibiting relation connects a goal to a task module. When it is fired (that is, when the source goal is reached), some internal obstacles or side effects are triggered or in the continuous case, their chances are modulated. The same applies for exciting relations.

Needing: A needing relation connects a task module to a goal. It is fired and the target goal is activated (in the continuous case, the target goal's achievement value is decreased by an increment) when some internal obstacles or side effects are triggered.

Visual representations of hierarchical structures are illustrated by Fig. 3. New notations have been introduced to describe the mechanisms detailed above. The example in Fig. 3 shows that the core structure is still clearly visible while the story has gained in complexity. Without hierarchy, the same structure would consist of a confusing network of nodes and links.

Sometimes a relation needs to connect a specific internal element in one task module to a specific element in another task module. In this case, the target element's name is mentioned at the source element's level. In the graphical representation, the gray arrows are supplemented with the name of the target element (or with a space-saving tag that is associated with the target element).

6 Dramatic situations as structures in tension

Our approach thus far has consisted in modeling dramatic situations in terms of narrative structure. However, an abstract structure in this model (with its set of nodes and relations) could conceivably be created in such a way that it would present no dramatic interest. For example, an author could choose ten tasks connected to ten goals, respectively. The resulting execution of this structure would consist of a random triggering of unconnected actions. This scenario does not fit with what is usually considered as an interesting dramatic situation; it lacks any consequential action. Thus far, the model is underspecified. The key question is: which properties does a structure need to represent a relevant dramatic situation?

We previously postulated that a good structure is one that contains tension, and that such a structure also contains some circularity (Szilas *et al.*, 2012). This circularity echoes the characterization of a dramatic situation as a 'system of forces in internal tension' (Souriau 1950). In this section, we will use an example to illustrate the circular nature of dramatic structures. The following section will formalize and generalize this example to provide a sound model of dramatic situations.

The following example is based on B. Nichols' (1981) approach to narrative as a fundamental paradox. Although not well known, this approach offers an interesting way to model tension in drama (Szilas and Richle, 2013). According to B. Nichols, all narratives are based on a paradox (a logical impossibility), as illustrated by the classical paradox of Epimenides: 'Epimenides was a Cretan who said, "Cretans always lie"'. The narrative paradox is the juxtaposition of two contradictory terms that successive narrative actions attempt to resolve. Trying to 'resolve the unresolvable' along the major part of a story inevitably creates tension, which is a major criteria for good situations. A typical structure implementing such a paradox can be described as containing two goals (see Fig. 4). The first goal has a task attached to it, and an associated obstacle with an inhibiting relation from the second goal. The second goal also has a task attached to it, and an associated side effect with a needing relation from this side effect to the first goal. If the character manages to reach the first goal, he or she fails (due to the obstacle) which triggers the second goal and a task that, when executed, invalidates the first one.

The proposed model of paradoxes in dramatic situations has been applied to twenty Aesop's fables (Aesop, 1994). In this corpus, one can identify

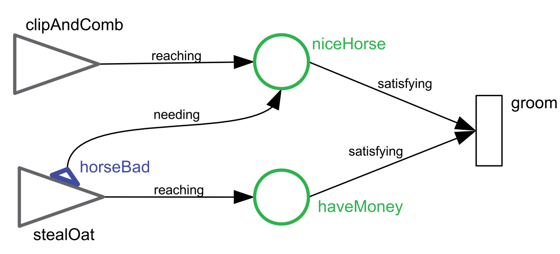

Fig. 4 The dramatic situations model as applied to Aesop's fables, here *The Horse & the Groom*. The dramatic cycle can be perceived by observing the two different paths that go from the node 'stealOat' to the node 'groom'

simple stories that perfectly match this model, for example, The Horse & the Groom, as illustrated in Fig. 4. In this story, figuring a groom spending hours to comb his horse but at the same time stealing his oats and causing the horse's decline, the paradox is represented by the fact that the task 'stealOats' satisfies the groom through the goal 'haveMoney', but on the other hand this same task dissatisfies the groom, through the goal 'niceHorse'.

Most fables are more complex but still include a similar form of circularity as in Nichols' paradox (see Section 7). The complete set of analyses can be viewed online (Szilas, 2015).

Stories that are more complex than fables include several intricate paradoxes at different levels, and require a hierarchical structure. This is illustrated in Fig. 5 by a story authored specifically for the interactive medium, inspired by the interactive drama *Nothing For Dinner* (Szilas *et al.*, 2014). Frank is a teenager whose father Paul has suffered a traumatic brain injury and often acts strangely because of it. Frank wants to be appreciated by Julia, who visits him to get help with Math. Whenever Frank begins helping her, he is interrupted by aggressive remarks from Paul, who distresses Julia. But when Frank tries to warn Julia about his father and explain to her why Paul acts the ways he does, she finds him boring, and Frank becomes less interesting to her.

The paradoxical situation has been presented here in its simplest forms. Thanks to the hierarchy principle (see Section 5), a task module needs to be introduced systematically, to add some material depth to the story. For example, the simple structure in Fig. 5 can be extended to produce a realistic situation for a short story, as illustrated in Fig. 6. In this extended example, inside the goal 'be appreciated by Julia' is the goal 'Julia ok with math', since Julia visits Frank to receive help from him. This latter goal can be reached by two alternative tasks, both being blocked by the obstacle 'Paul interrupts', which leads to the subgoal 'Paul satisfied'. Indeed, Paul is suffering from the consequences of a traumatic brain injury causing his unusual behavior. He will keep interrupting, even after Frank's attempts to distract him or reason with him. Only the task of rebuffing him might discourage him from interrupting, though not without side effects, such as Julia being shocked by Frank's behavior toward his father (gray arrow to the right). To hinder the triggering of these reactions from Julia (gray arrows from the bottom), Frank must 'prepare' Julia (goal 'julia_prepared'). Three tasks are available to reach this goal, having various effects on the goal (right-oriented gray arrows) and various negative effects on the first goal (top-oriented gray arrows) since these tasks tend to be either boring or slightly repulsive to her. This structure, although rich and complicated, is based on the simple dramatic cycle depicted in Fig. 5.

There are many ways this structure could be sequenced and represented in the eventual narrative text. The characters may just perform tasks to reach their goals, as in traditional character-based approaches. In this case, they would perform the task and then encounter the obstacles and side effects attached to it. Alternatively, they could be informed of the obstacles and side effects, and wish to reach other goals ('paul_satisfied', 'julia_prepared') before even attempting to satisfy Julia directly. For example, Frank's sister would warn: 'Frank, do you

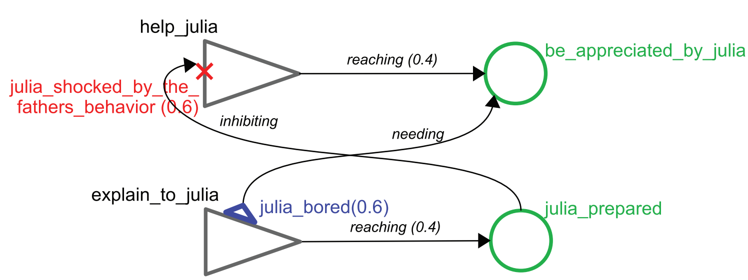

Fig. 5 A representation of the paradoxical situation (see text)

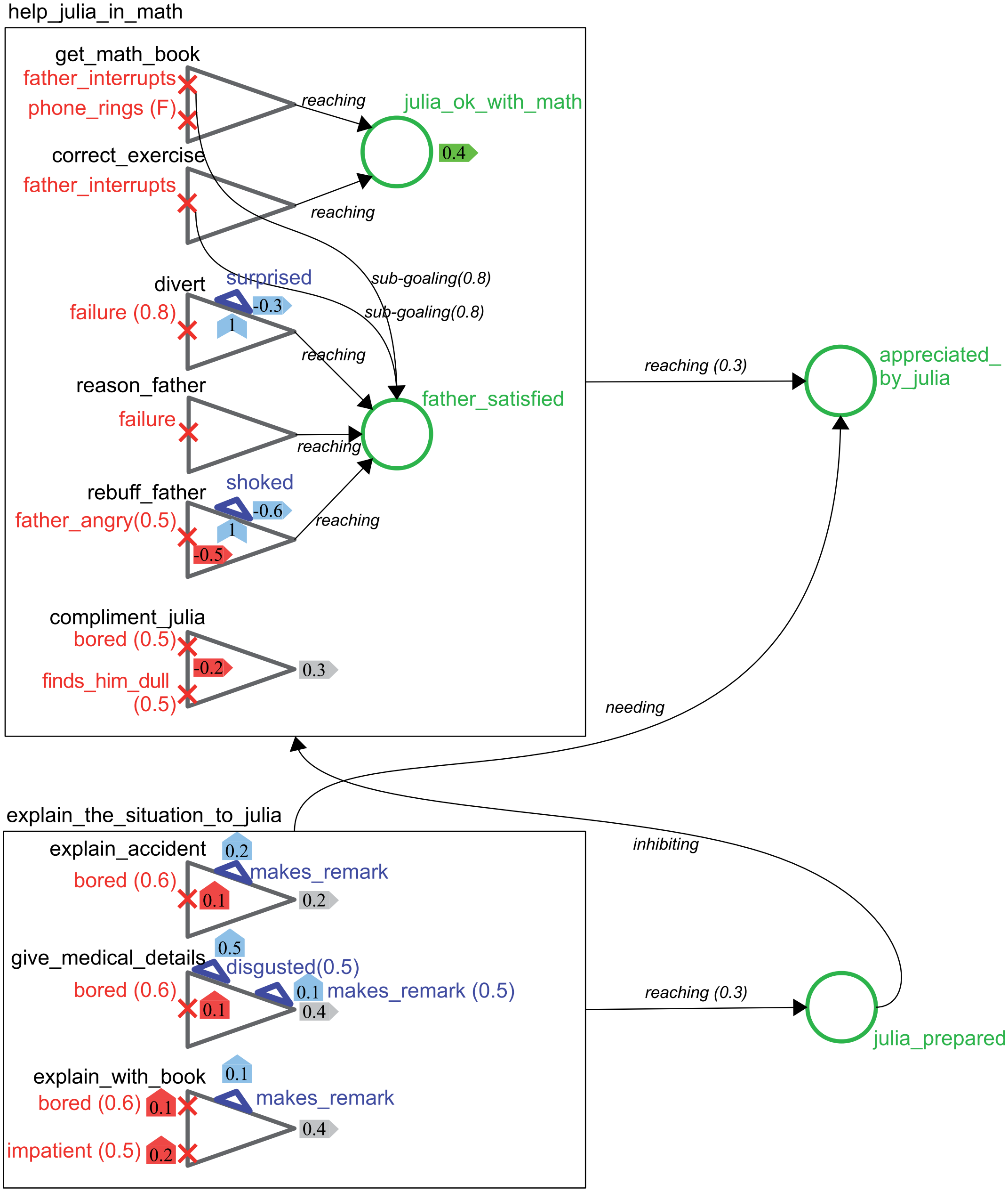

Fig. 6 A full example of a narrative structure describing a paradoxical situation. It extends the example in Fig. 5

really intend to explain anything to your friend while Dad is around?'. At the sequencing level, the engine being aware of the dramatic structure, it will make sure that the goal 'appreciated_by_julia' is not reached before the rest of the dramatic structure (i.e. the goal 'julia_prepared') has been sufficiently experienced by the user. More generally speaking, the engine will promote the circulation of the main components of the dramatic situation, and increase the tension each time a component is reconsidered again. The detailed way tension is calculated is outside the scope of this article, but the idea is that a sentence such as Julia saying, 'Frank, you know… I don't really care about your dad's accident… it's your family's private business.' creates less tension than if she were to say, 'I think it's just disgusting, Frank! I don't want to know anything about your father's damaged brain!'. Finally, some characters may be aware of the situation as a whole, and utter a dialog line such as, 'You see, Paul won't let you help Julia with Math unless you seriously rebuff him. But I can understand why Julia doesn't like seeing you act that way towards your Dad'.

It is worth noting that the proposed approach qualifies a situation as interesting not according to the semantics of its elements (the goal could be to conquer the world or prepare dinner) but according to the relation between these elements. This approach is in line with structuralist semiotics, in which 'the narrative syntax is not a meaningless form, […] modal and actantial organizations are really significant' (Courtès, 1991, p. 199).[2] The succession of thirty-one functions in the well known Propp's (1928) model does not carry specific semantics but more abstract characterization such as 'absence', a 'request for information', or a 'return'. These are instantiated differently according to the specific story. In fact, as noted by Todorov, there is no clear boundary between syntax and semantics. The verb 'harm' may be progressively refined semantically with 'kill', 'strangle', 'strangle with a rope', etc. (Ducrot *et al.*, 1968, p. 139). Our model favors the most abstract categories, not only because our theoretical starting point states that the interest in the story lies in the interrelation between the constituting elements, but also because it enables the author to fill the content as s/he wishes. Naturally, the author's work of 'semantisation' is critical and far from straightforward. For example, if the main goal of a character is not obviously important (e.g. 'making dinner' versus 'saving the world'), staging this goal so that it effectively appears important to the user requires specific attention.

7 Formalizing and assessing structures in terms of dramatic situation

The previous section illustrated how a dramatic situation can be designed and represented within the proposed computational model of narrative. While authors may use the paradoxical dramatic situation as a writing guideline, if they wish to explore other dramatic situations and corresponding structures, they will need a tool to help them build alternative valid structures from the point of view of dramatic tension. One option is to build algorithms able to assess the qualities of a structure, like the existence of an unresolvable paradox.

Based on the paradox example in the previous section (Fig. 4), we can establish a set of criteria that guarantee that a structure is a dramatic situation:

(1) Circularity. One circular path (cycle) exists within the structure across various relations and nodes.
(2) Opposition. This path contains two nodes X and Y, the latter being a goal, such as when taking the first route from X to Y, Y is reached and when taking the second route, Y is hindered.
(3) No shortcuts. Between two nodes in a given cycle, there is no other path outside the cycle.

We will demonstrate this concept using graphs. A structure can easily be transformed into a set of vertices and edges. A vertex can be a 'goal', a 'task', an 'obstacle', or a 'side effect', and an edge can be a 'reaching', 'hindering', 'collateral', 'inhibiting', 'needing', or 'exciting' relation. Edges are therefore directed and labeled. Furthermore, they are weighted either positively or negatively, as specified in Table 1.

In the formalization process, a simpler model than the one presented below has been adopted: (1) structures do not include hierarchy; (2) all relations are discrete rather than continuous (hence their weights being either -1 or 1); (3) the character's node, the satisfying/unsatisfying, sub-goaling, and belonging relations have not been considered,

Table 1 Types of edges in the graph-based representation of structures

Edge (short name)	Source node (short name)	Target node (short name)	Weight
reaching (r)	task (T)	goal (G)	+1
hindering (h)	Obstacle (O)	task (T)	−1
colateral (c)	task (T)	side effect (E)	+1
needing (n)	side -effect (E)	goal (G)	−1
inhibiting (i)	goal (G)	obstacle (O)	−1
exciting (x)	goal (G)	obstacle (O)	+1

since it was unnecessary in the paradoxical structures such as those illustrated in Fig. 4. Note that in these structures, characters are embedded in the goals.

Each structure is associated with an oriented graph named the 'structure's graph'. Within the structure's graph paths exist, described using a sequence of four tuples (sourceVertex, targetVertex, relationType, and weight). Let us define the 'strength' of a path as the product of all the weights of its edges. In the simple case when weights are either $+1$ or -1, the strength is either $+1$ or -1.

The above-mentioned criteria that characterize the paradox-based dramatic situation can be reformulated as follows: a structure is said to be paradoxical if and only if

– Its graph contains a cycle, regardless of the edges' directions (circularity criterion).
– This cycle contains two nodes, the source and the target. While the source's type is left unconstrained, the target is a goal. The strengths of two paths from the source to the target have opposite signs. These two paths are called the positive route and the negative route (opposition criterion).
– There are no shortcuts in the cycle, meaning that two nodes in the cycle are not connected by a path outside the cycle ('no shortcut' criterion).

These three conditions make it possible to formally assess whether a structure's graph contains a paradox or not, and whether it therefore consists of a relevant dramatic situation. Another way to make use of this formalization is to 'generate' structures that satisfy the above criteria and then analyze their narrative nature. We have developed a computer program that generates all cycles of a given length, according to the connectivity rules in Table 1 and that follow the opposition criterion (the circularity and isolation criteria being met by construction). These graphs are called 'dramatic cycles'. Dramatic cycles of a length up to 10 are reproduced in Appendix I. One of the main results of this computer-based search is that many dramatic cycles exist beyond the one that was identified in the previous section. We will analyze a few of them in what follows.

Interestingly, there is one paradoxical cycle with a length as low as 3. The corresponding visual structure is illustrated in Fig. 7. After reaching a given goal, this same goal is re-activated, leading to an endless repetition of the same task. This extremely simple situation represents the punishment of Sisyphus: he is forced to roll a boulder up a hill and when nearing the top, the boulder always rolls back down and Sisyphus must start again, creating an endless situation.

The following paradoxical situations contain five nodes. Fig. 8 represents one of them. In this case, the cycle itself is incomplete and may not be considered a valid structure, since it contains a task that does not point toward any goal (Fig. 8a). Therefore, we must introduce a goal into the structure to complete it (Fig. 8b). The resulting structure is still paradoxical, because the 'no shortcuts' condition is maintained. In this situation, an obstacle is hindering two tasks: the first one leads to a goal but the second, as a side effect, activates the goal. Let us illustrate this case with the scenario from *Nothing For Dinner*. As described above, Frank wants to tutor Julia in Math to get her appreciation. At the same time, the telephone is ringing. Another task is therefore added, that of Frank's sister Lili answering the phone. Anita is on the phone, and Julia would be upset if she learned that Anita was calling Frank. A common obstacle, the fire alarm going off, hinders Frank from helping Julia and Lili from answering Anita's call, which both helps and hinders Frank in reaching his goal (being appreciated by Julia). Should the alarm go off or not? This example illustrates that the computer-generated structure can effectively be filled with narrative content that makes a relevant dramatic situation.

One of the length 6 cycles (the first one listed in Appendix I) is the structure represented in Fig. 4, while the two others (which need to be completed) represent different situations. We have manually analyzed all cycles of lengths up to 9. They can be illustrated with variations and/or extensions of the above situations. For example, Fig. 9 illustrates the third length 9 dramatic cycle, as listed in Appendix I. It is an extension of the initial paradoxical structure in Fig. 4.

The analysis of the produced structures shows that it is possible to illustrate the computer-generated dramatic cycles with concrete examples, leading to simple stories. Nevertheless, because a minimal model has been chosen for computer simulations and because only one graph per story is considered, there are still many stories that cannot be represented

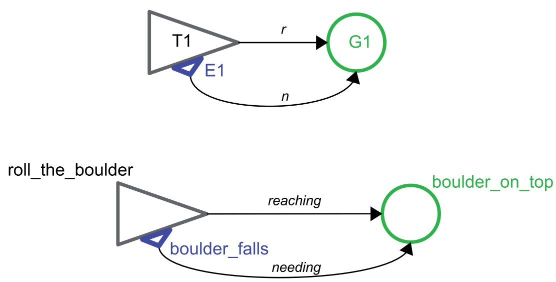

Fig. 7 A representation of the endless need situation. As soon as a given goal is reached, it is desired again. The top figure is drawn directly from the graph outputted by the computer program (T1–r1→G1←n1–E1←c1–T1). The bottom figure is the interpretation of it, in terms of the Myth of Sisyphus

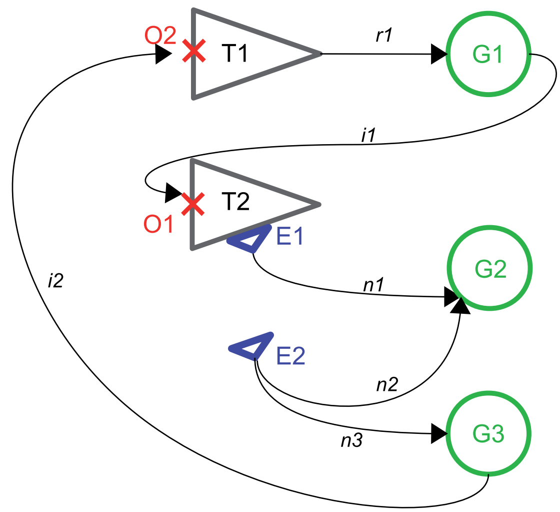

Fig. 9 A visual representation of one of the nine existing length 9 dramatic cycles

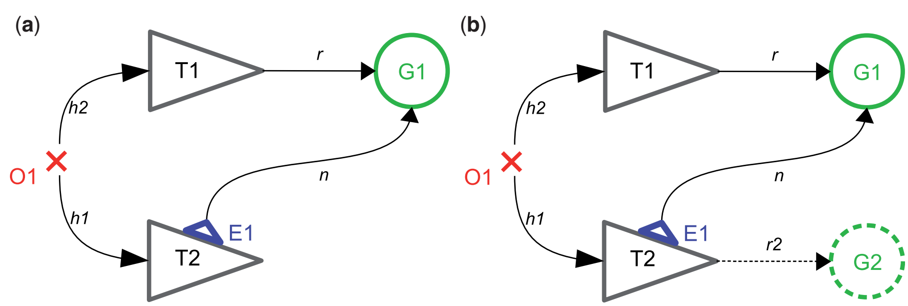

Fig. 8 A Visual representation of one of the two existing length 5 dramatic graphs. On the right, the structure has been completed (in dashed lines) to provide a valid narrative structure (see text)

by the graphs listed in Appendix 1, such as stories involving conflicting characters.

The formal characterization of a paradoxical structure may be used in various ways. First, as has just been illustrated, it can provide a complete catalogue of valid paradoxical structures, that can be used as an authoring guideline. Second, it can intervene as a form of model checking, to assist an author during the creation of a structure. Third, the algorithm for checking structures may be adapted to detect structures which are 'near paradoxical' (like when a cycle with an opposition exists but a shortcut invalidates the structure) and propose possible solutions. Finally, beyond the scope of this article, this formal characterization may also be at work in active structures during the concrete unfolding of a story. Reasoning at the level of a dramatic cycle rather than at the lower level of goal achievements enables an author to exploit the full potential of the structure and the dramatic situation it represents. At this level, a drama manager could meaningfully trigger an obstacle, instantiate a goal, or transmit knowledge about the structural elements in a way which makes the dramatic situation functional.

8 Contribution to narrative theories

Beyond the targeted applications underlying this modeling effort, this proposed model of dramatic situations is relevant for the study of narrative and drama in general. It concerns the story (fabula) rather than the discourse (syuzhet) (Genette 1972) favored by other models proposed in the past (Lehnert 1981; Trabasso *et al.*, 1989). A distinctive feature of this proposed model is its high degree of abstraction. This model outlines seven levels of increasing abstraction:

(1) The 'text': the concrete representation of the narrative within a given media.
Example: 'Mary killed the cat because she saw him eating the cheese she had made.' (Inspired by a traditional French song)
(2) The logical discourse: the logical encoding of the events in a text.
Example: [kill (Mary, cat), see (Mary, cat), eat (cat, cheese), prepare (Mary, cheese)]
(3) The logical story: the reconstruction of the story events in their chronological order.
Example: [prepare (Mary, cheese), eat (cat, cheese), see (Mary, cat), kill (Mary, cat)]
(4) The narratively decomposed logical story: the coding of story events in terms of generic narrative acts and elements of the narrative structure.
Example: [perceives (Mary, eat (cat, cheese)), perform (kill (Mary, cat))]
(5) The active narrative structure.
Example: instantiated goals such as *(cat, hungerSatisfied)*, tasks such as *(cat, eat)* or *(Mary, kill, cat)*.
(6) The abstract narrative structure.
Example: generic goals such as *hungerSatisfied*, generic tasks such as 'eat' or 'kill'.
(7) The properties of the narrative structure, particularly in terms of the paradoxical path.

In this article, levels 5–7 are described. The underlying assumption is that these levels enable us to understand several essential properties of narratives and their deeper meanings, independent of the story itself, its discourse, and its representation in a medium. From a cognitive point of view, these structures correspond to a deep encoding of narrative, deeper than the grammar-like representation of events (Mandler and Johnson, 1977), the causal networks between events (Trabasso *et al.*, 1989), or the plot units (Lehnert, 1981). The atemporal nature of deep narrative structures has been described by early structuralists (Greimas, 1966; Levi-Strauss, 1958), but no computational model has been proposed to give a full account of this fundamental property. Structuralist writings tackle the question of deep narrative structures with discussions and pseudo-formalisms, which often makes it hard to understand the clear nature of these structures and how they may concretely produce a given narrative. In contrast, the proposed model of dramatic situation, although not a straightforward modeling of earlier theories, is clearly defined, and from it concrete actions (such as text, still images, or animated three-dimensional worlds) may be generated.

Nevertheless, the limitations which may compromise this approach as a general theory of narrative must be addressed. First, the more abstract the model, the less subtle it is and the more it looses the interesting elements of stories (style, perception, pace, montage, etc). Therefore, it must be stressed again that our proposed model is partial, and that levels 1–4 in the above list must be concurrently described to provide a full narrative model. Second, by excluding the discourse level (level 2), some essential narrative effects have been omitted. Let us consider for example the dramatic situation of adultery. It occurs when character A loves character B, but character B has intercourse with character C which disrupts character A's loving status (love being exclusive in this case). Within this deep structure, we can distinguish four different cases: either A knows that B is cheating or A does not and either the audience knows that B is cheating or it does not. These four cases are quite different in terms of dramatic tension, because tension is often created only at the discourse level (Baroni, 2002). Our proposed model of situation is not able to take into account this kind of tension. Third and more generally, it is hard to evaluate the scope of narrative that may be covered by the model. An initial experiment with game design students showed that some stories would fit with the model while for others it seemed more difficult to find the proper narrative structure. This led us to modify the model slightly. Therefore, the proposed model is meant to evolve, according to an iterative design approach.

9 Conclusion

'In this article we have provided a computational model of dramatic situations, by examining a few core elements that can be assembled to create deep atemporal narrative structures. A formal characterization of these structures as dramatic situations has been proposed, based on the concept of paradox. This enabled an exhaustive search of all suitable structures of a given size. The resulting structures can consequently be drawn and narratively interpreted.

Inserting this model into a larger system, with the long-term goal of producing dynamic narratives according to user interaction is a large effort that has already been initiated (Szilas and Richle, 2013). The difficulty is not only to implement the model, but to implement all the other layers, including event generation, event sequencing, discourse generation, surface text realization and, if applicable, graphical user interfaces for entering the action, as well as 3D real-time animation and staging. It is difficult to effectively assess the benefits of the approach for Interactive Drama if these components are not all implemented. Our plan is to assess the quality of the narrative experience via a partially implemented system, with the non-implemented parts being either paper-prototyped or replaced by human-controlled components, according to a Wizard of Oz protocol. In this spirit, the model has been tested on a paper-based game design task, with fifteen game design students. Students managed to write meaningful and creative narrative structure with the model, and yet, they sometimes reported that the approach is difficult to grasp, compared to traditional video game design.

An alternative use of the model would involve generating textual descriptions of a given situation. This kind of usage is far simpler than generating a story derived from the structure, and yet, it remains a challenging natural language processing task. It may open the way to an indirect evaluation of the quality of dramatic situations.

Out of the many models related to the modeling of dramatic situations, our approach is distinctive in that it attempts to incorporate the concept of dramatic situation early on within the first-class elements that are handled both by the author and the program, in order to describe a story at a certain level. In contrast, the traditional approach involves starting from a well-known framework in Artificial Intelligence (such as planning or intelligent virtual agents) and in progressively adding some narrative constraints to it. On the one hand, we expect our approach to be well suited for creative authors and for the model's expressivity to be higher since it is 'natively narrative'. On the other hand, it generates more complex intelligent computation because the initial data structures are more complex. In the long run, the goal of this research is to establish the basis of a genuine 'Narrative Intelligence', understood as a research agenda in which various psychological, social, and cultural phenomena are primarily described and modeled in terms of narrative, rather than knowledge or intelligence.

Appendices

Appendix I

List of generated dramatic cycles with length of up to 10, as outputted by the computer program. Each capital letter followed by a number represents a node (T for task, G for goal, O for obstacle, and E for side effect) while each small letter followed by a number represents a relation (r for reaching, n for needing, c for collateral, h for hindering, i for inhibiting, x for exciting). The direction of the relation is represented by arrows (depicted with ‘–’, ‘<‘, and ‘>‘). Each line represents a cyclic structure, the first node being identical to the last node (T1 in the first example). It also contains a ‘target’ node upon which each of the two sub-paths converge (G1 in the first example).

```
One unique valid path of length 3:
T1-r1->G1<-n1-E1<-c1-T1

Two unique valid paths of length 5:
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1-h2->T1
T1-r1->G1<-n1-E1-n2->G2-x1->O1-h1->T1

Three unique valid paths of length 6:
T1-r1->G1-i1->O1-h1->T2-r2->G2<-n1-E1<-c1-T1
T1-c1->E1-n1->G1<-r1-T2-r2->G2-i1->O1-h1->T1
T1-c1->E1-n1->G1<-n2-E2-n3->G2-i1->O1-h1->T1

Three unique valid paths of length 7:
T1-r1->G1-x1->O1-h1->T2-c1->E1-n1->G2<-n2-E2<-c2-T1
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1<-i1-G2-i2->O2-h2->T1
T1-r1->G1<-n1-E1<-c1-T2-c2->E2-n2->G2-x1->O1-h1->T1

Four unique valid paths of length 8:
T1-r1->G1-i1->O1-h1->T2-r2->G2<-n1-E1<-c1-T3<-h2-O2-h3->T1
T1-r1->G1-i1->O1-h1->T2-r2->G2<-n1-E1-n2->G3-x1->O2-h2->T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2<-r2-T3<-h2-O2-h3->T1
T1-c1->E1-n1->G1-i1->O1-h1->T2-c2->E2-n2->G2<-n3-E3<-c3-T1

Nine unique valid paths of length 9:
T1-r1->G1-i1->O1-h1->T2-r2->G2-i2->O2-h2->T3-r3->G3<-n1-E1<-c1-T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2<-r2-T3-r3->G3-i2->O2-h2->T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2<-n2-E2-n3->G3-i2->O2-h2->T1
T1-r1->G1-x1->O1-h1->T2-c1->E1-n1->G2<-n2-E2<-c2-T3<-h2-O2-h3->T1
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1<-i1-G2<-r2-T3-r3->G3-i2->O2-h2->T1
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1<-i1-G2<-n2-E2-n3->G3-i2->O2-h2->T1
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1<-x1-G2<-n2-E2<-c2-T3<-h2-O2-h3->T1
T1-r1->G1<-n1-E1<-c1-T2<-h1-O1-h2->T3-c2->E2-n2->G2-x1->O2-h3->T1
T1-r1->G1<-n1-E1-n2->G2-i1->O1-h1->T2-c1->E2-n3->G3-i2->O2-h2->T1

Eleven unique valid paths of length 10:
T1-r1->G1-i1->O1-h1->T2-r2->G2-x1->O2-h2->T3-c1->E1-n1->G3<-n2-E2<-c2-T1
T1-r1->G1-i1->O1-h1->T2-r2->G2<-n1-E1<-c1-T3<-h2-O2<-i2-G3-i3->O3-h3->T1
T1-r1->G1-i1->O1-h1->T2-r2->G2<-n1-E1<-c1-T3-c2->E2-n2->G3-x1->O2-h2->T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2-x1->O2-h2->T3-r2->G3<-n2-E2<-c2-T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2<-r2-T3<-h2-O2<-i2-G3-i3->O3-h3->T1
T1-r1->G1-i1->O1-h1->T2-c1->E1-n1->G2<-r2-T3-c2->E2-n2->G3-x1->O2-h2->T1
T1-c1->E1-n1->G1-i1->O1-h1->T2-c2->E2-n2->G2<-r1-T3-r2->G3-x1->O2-h2->T1
T1-c1->E1-n1->G1-i1->O1-h1->T2-c2->E2-n2->G2<-n3-E3<-c3-T3<-h2-O2-h3->T1
T1-c1->E1-n1->G1-i1->O1-h1->T2-c2->E2-n2->G2<-n3-E3-n4->G3-x1->O2-h2->T1
T1-c1->E1-n1->G1<-n2-E2<-c2-T2<-h1-O1<-i1-G2<-r1-T3-r2->G3-x1->O2-h2->T1
T1-c1->E1-n1->G1<-n2-E2<-c2-T2<-h1-O1<-i1-G2<-n3-E3-n4->G3-x1->O2-h2->T1
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Note

1 See the multitude of writing/storytelling Web sites and blogs that make mentions of the thirty-six situations, for example: http://writeworld.org/post/44959188412/the-36-dramatic-situations, http://www.wordplayer.com/columns/wp12.Been.Done.html, https://gideons-way.wordpress.com/2009/10/31/screenwriting-tip-15-%E2%80%93-the-36-dramatic-situations/, http://www.scenario-buzz.com/2011/01/26/lecons-de-scenario-les-36-situations-dramatiques/, etc.

2 Our translation.