Minimal Structures for Stories

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ABSTRACT
Our research on Interactive Drama aims at conciliating interaction and story at the deepest level, the level of action. From a given story representation formalism, a set of elementary narrative structures is derived in order to capture the minimal requirements for providing a narrative and interactive experience to a user.

Some of these structures are implemented and simulated, to illustrate the quality and limitations of each structure.

Categories and Subject Descriptors
I.2 [**Artificial Intelligence**]: Natural language processing – *discourse, language generation*; Applications and Expert Systems – *games.* J.5 [**Arts and Humanities**]: *Literature, Performing arts.*

General Terms
Algorithms, Design, Human Factors.

Keywords
Human Computer Interaction, Narrative Intelligence, Interactive Narrative, Interactive Drama, Narrative Structures.

1 INTRODUCTION
We have been involved for several years in a project aimed at building an Interactive Drama system named IDtension [15, 16, 17, 18, 19]. This project challenges the idea that narrative and interactivity should be considered mutually exclusive, and proposes an original computational view of stories and narrative that allows for interactivity.

Interactive Drama and Interactive Narrative have emerged into an autonomous research domain. Several research teams are conducting research programs in this direction [4, 5, 8, 9, 13, 21, 22]. Beyond the fact that these works mainly focus on the entertainment or artistic framework, Interactive Drama could provide us with interesting new ways for representing stories in an interactive context.

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More than 15 years ago, Brenda Laurel proposed, in her book entitled "Computer as Theatre" that theories of narrative and drama should be applied to Human Computer Interaction (HCI) [7]. Such an application would not consist in an interface *with* narrative, but in an interface *as* narrative. Stories seem to be a fundamental, universal way to organize and communicate complex knowledge. It appears natural that HCI moves toward narrative, especially whenever complex knowledge is to be handled.

Given the fact that the notion of action is the core of drama – which is confirmed by the etymology of the term "drama" – a straightforward choice is to match the actions of a user on the interface and the reactions of the computer system with dramatic actions. The subsequent and fundamental questions are then:

- How could a sequence of actions between a user and a computer constitute a narrative?
- How to assess the degree to which a sequence of action is narrative?

It may seem that this question was answered yet by existing narrative theories, but it is not. The sequence of actions experienced by the user is not just given to her. The user builds up this sequence for some part. Fully developed interactive narrative theories are missing here to capture the process of co-responsibility in a story unfolding. On the other hand, we think that good insights are to be found in current prototypes of Interactive Drama in order to help the design of new kinds of narrative oriented interfaces.

Our aim in this paper is to capture a set of minimal narrative structures. We study several elementary narrative structures and discuss their "degree of storiness" and "degree of interactivity". We do not start with an existing linear story that we would want to turn interactive, neither do we try to directly obtain a complete, convincing interactive story. Rather, our approach here is to study a set of elementary structures that we evaluate from both the

"storiness" and interactivity perspective. We call these structures *minimal* in the sense that we search for the smallest structure that has a given property (deep interactivity, causality, etc.). Thanks to our constructive approach, which consists in starting small, it is guaranteed that the proposed structures are minimal.

Section 2 overviews the IDtension model. This model will be used to represent the elementary narrative structures we study and discuss in section 3.

2 SKETCH OF IDTENSION

The IDtension narrative engine has been described earlier [15, 18]. This sections aims at providing the reader with a quick understanding of the model. IDtension has the following four main distinctive features:

- The story model is a fine grain model, in the sense that it manipulates elementary actions rather than larger units like for instance scenes [21, 8, 14], beats [9], or fragments. With respect to this point, IDtension is closer to character based approaches of Interactive Drama or story generation [4, 5, 10]. One can expect more interactivity with a fine grain model, but on the other hand the narrative quality is harder to maintain: with a large grain model, fragments can be crafted with care.

- IDtension includes a user model aimed at estimating the impact of each possible action on the user according to various narrative criteria [16]. Some of these criteria focus for instance on realism (assuming that realism is relative to a genre); such criteria could be relevant to a character based approach. Other criteria like *characterization* or *conflict* are only guided by narrative issues. Let us notice that a user model has also been used in [21].

- Articulation of actions is twofold. IDtension considers generic actions and tasks. Generic actions stem from narratology [3, 20]. They are for instance: inform, encourage/dissuade, accept/refuse, perform, felicitate/condemn. Tasks are specific to a story. They are specific actions that characters can perform within the story: kiss, hug or slap in a romance story, threaten, torture or kill in a *roman noir*… This makes it possible to handle complex actions like "John tells Mary that Bill has robbed her jewels" without requiring from the author to explicitly enter them into the system. In the previous example, the narrative engine would be able to manipulate by itself the following expression: Inform(John, Mary, have_finished(Bill, rob , [jewels,Mary]). The author only specifies the task (to rob), the characters (Mary, John) and the objects (the jewels) in the story. *Inform* and *have_finished* are generic actions managed by the system.

- IDtension explicitly processes the notion of (ethical) values. Values are thematic axes according to which each task is evaluated, for instance: honesty, friendship, family, fraternity, etc. This mechanism adds, beyond the pure performative dimension, a further dimension to the story, namely the axiological dimension. The User Model uses those values to evaluate some narrative criteria, *conflict* in particular.

Next action selection is divided into two main processes. The first one generates the set of all possible actions at a given time in the narrative with applying narrative rules to elements in the story world. The second filters these actions according to the User Model evaluations. Then, the system alternates actions chosen by the engine and actions chosen by the user.

A module called the Theatre is responsible for the interface. It displays the actions and manages the interaction with the user. Currently, this is a text-based interface.

The World of the Story is the place where narrative elements (among which are the characters and the tasks) are defined by the author. Those elements are:

- Goals: States in the world of the story that characters want to reach.
- Tasks: Concrete activities. Goals are reached by characters with performing tasks.
- Obstacles: elements in the World of the Story which can hinder the tasks. Performing a task can result into a failure if there is an obstacle hindering it.
- Characters: entities that have goals and perform actions.
- Values: (ethical) axes used to evaluate the tasks and actions with respect to the user model.

Obstacles play an important role in the unfolding of a narrative. Some obstacles are associated with a guard: a set of conditions that triggers the obstacle when validated. Reaching goals may produce consequences that may consist in adding or withdrawing some guards. This generates a powerful subgoaling mechanism (see [18] for details).

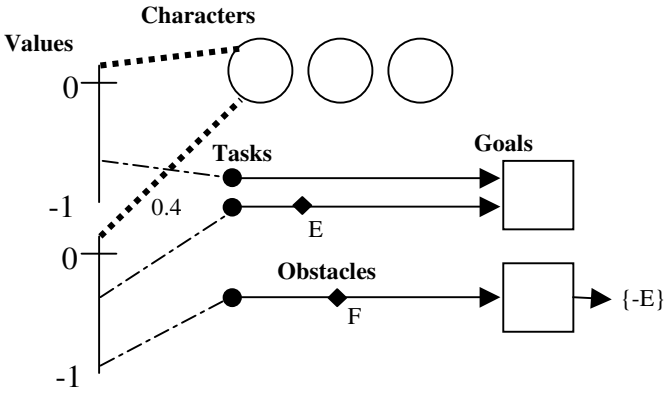

Figure 1. Narrative structure. Characters (circles) wish to reach some goals (squares). Each goal can be reached through tasks (arrows) that are more or less negatively evaluated according to each value of the narrative (dashed lines). The characters are more or less linked to the values (bold and dashed lines). Obstacles allow the triggering of a sub-goal (through the condition "E").

The World of the Story is organized into a narrative structure. A narrative structure is composed of several "goal-tasks structures". The graphical representation shown in figure 1 constitutes a meaningful level of authoring [19].

Such structures are not a kind of story tree or graph-based representation of the story unfolding. Rather, they are abstract

representations of the logical relationships between the elements of the story. Execution of those structures in the IDtension engine departs from the mere execution of the tasks:

- Many actions are derived from one single task: information transmissions, influences, performances, sanctions, etc.
- Goals, tasks and obstacles can be parameterized. For instance, the goal "possess an object" may generate various dramatic situations, depending on the character who wishes to reach the goal and on the object to be obtained.

3 EXERCICES OF STRUCTURE

We consider in this section several elementary narrative examples and discuss how these small stories can be implemented into the IDtension model. This implementation is compared, whenever possible, with graph-based representations.

3.1 Quasi-linear interactive narratives

Let us first consider the following narrative:

"Character A needs money. He decides to steal money from somebody passing by. Unfortunately, A is not a strong person ; the attack ends up into a miserable defeat. So, A decides to become stronger, and learns karate. Later on, A attacks another passer-by, with success, and gets money."

The IDtension interactive modeling of this narrative is given by a logical narrative structure, the goal-tasks structure shown in figure 2, together with an instantiation of these abstract notions of goal and task (table 1). The logical relationship between the fact that character A is strong or not, and the success or failure of the attack, is explicit. This relationship is actually a first level object in the IDtension model that the author of the interactive story can handle by setting consequences of reaching goals and guards conditions for obstacles. Such relationships are first level components of narratives. In a graph-based representation however, they cannot directly be represented.

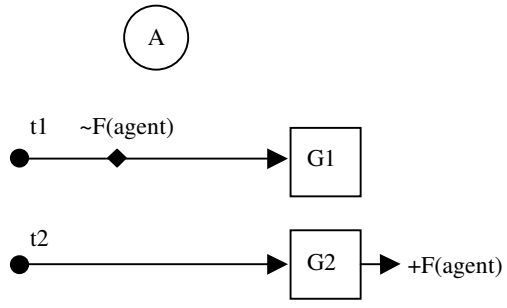

Figure 2. A simple narrative structure. G1 and G2 are two goals, reached by tasks t1 and t2 respectively . The obstacle (diamond) on task t1 can be overcome by reaching goal G2.

In an interactive setting, even if the user plays the role of character A and tries to launch several attacks before learning karate, the story unfolds in a quasi-linear way. This unfolding can be represented with a hypertext as shown in figure 3. Let us notice that the narrative event where A launches an attack has to be split into two nodes of the graph – *A performs t1 (failure)* and *A performs t1 (success)* – in order to capture the two possible results of the attack: success or failure.

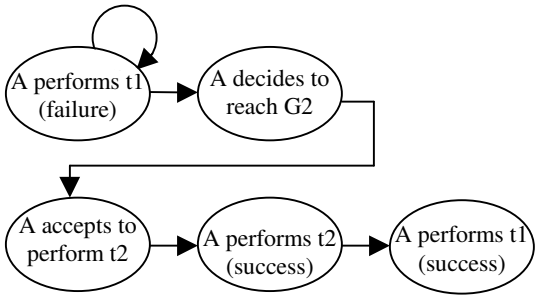

Figure 3. Hypertextual story corresponding to the structure in Fig. 2. This story is linear, except the loop on the first node.

Table 1. Example of story instantiation, from the structure in Fig. 2

Instantiations
G1 ← have money; G2 ← be strong(agent) t1 ← steal money to a passer by; t2 ← learn karate F ← strong(agent)
Initial conditions
A is the protagonist WISH(A , have money)

Let us now start turning this narrative more complex.

Let us consider a friend of A, named character B. B is reluctant in letting his old friend committing crimes, and interacts in the scene by trying to influence A. The IDtension model allows to do so in a very simple way by just adding a character and specifying that, for instance, he loves honesty.

Representing this narrative in terms of a graph is difficult because many interactions can occur between the two characters. Here is an example: "A needs money. He decides to steal money from somebody passing by. Then A meets B, and tells him that he wants to steal money. B strongly dissuades A to do so. Despite this, A tries to attack a passer-by but ends up defeated. A learns karate, and then succeed in stealing money. A tells B about this success, and B condemn A for having committed a crime".

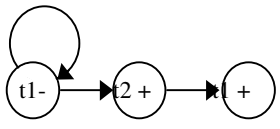

Figure 4. Performative graph, representing only the performances in the interactive narrative.

Instead of giving account of the whole narrative, we can restrict the graph to represent the performative actions only (Fig. 4). t1- (resp. t1+) denotes the failure (resp. success) of character A in stealing a passer-by. Performative actions in this story still unfold in a quasi-linear way, but yet the narrative appears very interactive

to the user due to the possible interactions between the two characters.

We Introduce now non linearity. The structure can be enriched by some alternative task t1' with a new obstacle, and some alternative sub-goal G3 (figure 5). t'1 instantiates into "fool somebody passing by". The passer-by, being an intelligent person, can eventually fool A (obstacle H). G3 instantiates into "be clever(agent)". Thus, there exist two ways for character A to reach the main goal G1: via G2 or via G3.

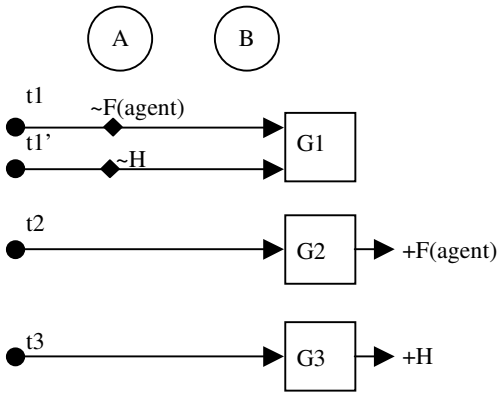

Figure 5. Structure with alternative tasks. Goal G1 can be reached via t1 (sub-goal G2) or t1' (sub-goal G3).

Describing this kind of structure with a hypertext or even a graph-based representation of the actions is difficult because the user can switch at any time between the two parallel storylines: (t1,t2) and (t1',t3). Figure 6 gives a representation of this structure with parallel finite state machines:

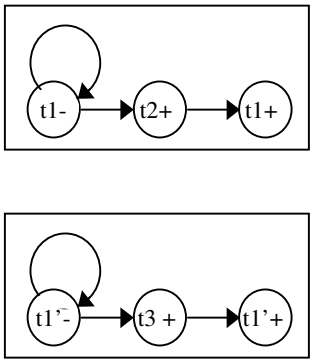

Figure 6. Parallel finite state machine representation of a story with two alternative tasks (Fig. 5): two state are active, one in each rectangular box.

All the structures we presented so far are actually fairly simple. The user intervention is almost limited to the ornamentation of a pre-written graph of performances.

We want to go further and find structures where the size of possibilities of performances (excluding other acts) does not grow proportionally but exponentially (or polynomially) with the size of the structures themselves.

3.2 Interactive Drama as *Ars Combinatoria*

We believe that the combinatorial effect is a key to Interactive Drama. It allows the author to design small size narrative materials, and produce, through user's intervention, a very rich set of dramatic situations. The combinatorial effect is the answer to two of the main challenges of Interactive Drama:

- providing the user with "the satisfaction power to take meaningful action and see the result of [his/her] decisions and choices" [11, p. 126];
- not considering the user as a (co-)author, maintaining the authority on the author's side [1, 11, 12].

This is a key effect in many games too: chess, card games, computer "god games" or sim games", etc. Some of the rules in these games are rules of combination.

Consider the structure given in Figure 7.

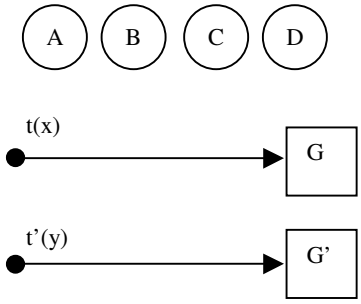

Figure 7. Structure with tasks' parameters (no obstacle)

From the structure above, which contains four characters, two goals and two tasks, one can derive 3×3×2=18 different possible unfoldings, as depicted in Figure 8.

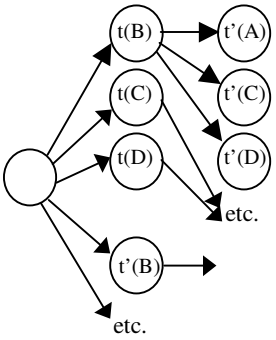

Figure 8. Performative graph of the structure depicted on Fig. 7

With p characters, q goals and q tasks, we obtain $(p-1)^q \times (!q)$ possible unfoldings, which is exponential.

Let us notice however that all these possible sequences of events are not stories: execution of *t* and *t'* can occur in any order, whatever the causality lying in the semantics of these tasks. For these sequences to become stories, the formal IDtension structure must include some causal relationships between story events.

3.3 Deep vs. shallow interactivity

Let us continue these narrative structure exercises. We consider below (figure 9) a narrative and combinatorial structure inspired from the one proposed in Section 3.1:

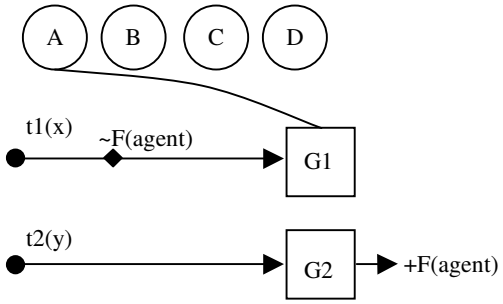

Figure 9. Narrative structure with tasks' parameters and one obstacle.

This structure is associated with the following instantiation of variables:

Table 2. Example of story instantiation, from the structure in Fig. 9

Instantiations
G1 ← have money; G2 ← be strong(agent) t1(x) ← steal money to x ; t2(y) ← learn karate from y F ← is too weak(agent)
Initial conditions
A is the protagonist WISH(A , have money)

The agent can get money by stealing any of the other characters in the story, as well as he can become strong by learning karate from any other character. The corresponding performative graph contains $(p-1)^2$ different stories, p being the number of characters in the story.

Here, each possible unfolding corresponds to a story. We have managed to obtain a combinatorial effect while maintaining "storiness". However, most of these stories are likely to sound similar to the user. They can indeed be summed up by the following "generic story": "I want to have money, so I try to steal money to someone. Unfortunately, this person is stronger than me and defeats me. So I decide to become strong. I learn karate from someone, and later, I steal again, and get money."

At his generic level, the story is linear again. We want to go further, and obtaining nonlinear stories, even at this generic level.

3.4 Causality

So far, we have obtained on the one hand a combinatorial structure lacking causality between events (Section 3.2) and on the other hand a structure with causality (via tasks triggered by obstacles) whose combinatorial effect appears to be limited (Section 3.3).

In order to combine causality with the combinatorial effect, it is now possible to reuse story material during the unfolding of the story. Consider the following story: "I want Bill to like me. So I decide to offer him a present, but I have nothing I can offer. So I ask Carl to give me his jewel, but he refuses, because I am not his friend. So I decide to offer something to Carl in order to be his friend. I ask Doug to give me his CD but he refuses, because I am not his friend either. So I ask bill whether he could give me his book, so that I could offer it to Doug, etc."

This story is not very interesting and rather repetitive but it shows how story material can be reused infinitely, until the protagonist manages to get something that s/he could offer, which maybe will never happen…

This story is implemented with the following narrative structure (Fig. 10) and instantiation (Table 3):

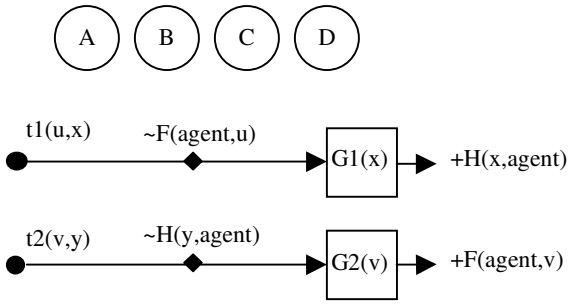

Figure 10. A circular narrative structure. G2 is a subgoal of G1 and G1 is a subgoal of G2

Table 3. Example of story instantiation, from the structure in Fig. 10. Anna stands for A, Bill for B, etc.

Instantiations
G1(x) ← be friend with x; G2(v) ← possess v t1(u,x) ← offer u to x ; t2(v,y) ← ask v to y H(x,y) ← x appreciates y; F(x,u) ← x has u Ann, Bill, Carl and Doug are characters in the story A book, a jewel and a CD are the objects in the story
Initial conditions
A (Ann) is the protagonist WISH(Ann , be friend with B) HAVE(Bill , book) HAVE(Carl , jewel) HAVE(Doug , CD)

The structure above is circular, because the goals G1 and G2 have parameters. G2 is a subgoal of G1, and reciprocally, G1 is a subgoal of G2: with the subgoaling mechanism each of this goals calls the other, in a recursive way, with different parameters.

We implemented this structure with the IDtension narrative engine prototype. We show below the result of an execution, where the computer is set to play automatically the role of the user, even if Story Generation is not our objective. The following result (and the other ones below) has been translated from French into English: "I decide to offer a CD to bill, but I have no CD. I decide to get a CD and ask Carl for his CD. Carl refuses... I

decide to be liked by Carl. I want to offer a jewel to Carl, but I have no jewel. I decide to possess a jewel. I ask Doug for his jewel. He refuses. I decide to be liked by Doug and want to offer him a jewel, but I have no jewel. I inform bill that I have asked his CD to Carl, etc." The story goes on, with the protagonist always trying to either offer an object or ask for it.

Let us notice that this kind of stories reminds some stories generated by Tale-spin [10], with infinite loops, as related in [1, p. 131].

This story we have produced never ends. We address this issue in the next section.

3.5 Transformation

In the previous example, there was no escape: no character would offer anything to Ann, and thus she would never reach her initial goal: becoming Bill's friend.

In classical narrative theory, the notion of transformation is central in stories: the main character should evolve from one initial state to some final state. From this point of view, the previous story is not satisfactory. For instance, the protagonist could evolve from a situation where nobody likes her to a situation where somebody does.

The story of the Section 3.4 should be adapted as follows: "I want that Bill likes me. So I decide to offer him a present, but I have no present. So I ask Carl to give me his Jewel, but he refuses, because I am not his friend. So I decide to offer Carl something in order to be his friend. I ask Doug to give me his CD but he refuses, because I am not his friend either. So I ask bill whether he could give me his book, so that I could offer it to Doug. Bill accepts. I get the book. I offer it to Doug, who becomes my friend. I ask his CD to Doug, and he gives it to me. I offer the CD to Carl, who becomes my friend. I ask him the jewel, he accepts. I offer the jewel to Bill, who becomes, at last, my friend.".

To obtain such a result, we have two solutions, within the IDtension model:

- either the initial conditions are modified so that at least one of the guard triggering the obstacle is not validated (for example, "Carl likes Ann");
- or one of the obstacle guard is associated with a probabilistic factor. This means that even when the guard is activated, the chance of triggering the obstacle is lower than 1 (see [18] for details).

We choose the latter approach, because it interestingly adds a random factor.

The narrative structure is the same as in the previous section (see Fig. 10), except that the probability of the obstacle on the task t2 to trigger whenever "~H(y,agent)" is true is set to 0.7 instead of 1.

According to the specific instantiation above (Table 3), this means that even if two characters are not friends, they sometimes accept to give an object.

Note that the higher this value, the longer the story. We found after a few trials and errors that 0.7 gave an appropriate length. The result is not very sensitive to this value.

The execution ended up with the following story: "I decide to offer a jewel to bill, but I have no jewel. I decide to get a jewel and ask Doug for his jewel. Doug refuses... I tell Bill that I did not manage to ask Doug his jewel, because Doug does not like me. Bill dissuades me to ask the jewel to Carl. I inform Doug I could not offer a jewel to Bill, because I have no jewel. Carl dissuades me to try to offer a jewel to bill. […] I ask the jewel to Carl, he accepts. I offer the jewel to bill, and I am his friend now."

This time, the story terminates (we actually manually cut the story, because the current implementation lacks a precise stopping criterion).

3.6 Axiology

We presented in Section 2 the IDtension narrative engine and emphasized the role of values in narrative. The stories presented so far do not express any ethical sense of good actions or bad actions.

We would want to produce a story like this one: "I decide to offer a jewel to Bill, but I have no jewel. I decide to get a jewel and ask Doug for his jewel. Doug refuses... I tell Carl that I did not manage to get Doug's jewel because Doug does not like me. Carl informs me that I could punch Doug's nose, and then steal the jewel from him. I accept to do so. I punch Doug, and get the Jewel. I offer the jewel to Bill, and I am his friend now. Doug tells Bill that I have punched his nose. Bill condemns me, and I am not his friend anymore".

This story is far more interesting than the previous ones, because there is an ethical message: violence is bad. The structure for such a story is depicted in Fig. 11.

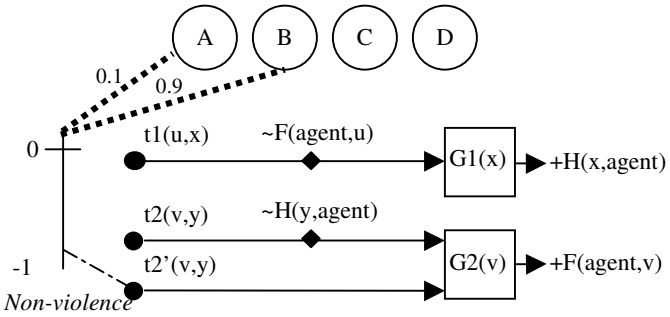

Figure 11. A structure with a value: the task t2' is very badly evaluated according to the "non-violence" value.

The proper simulation of this structure is more difficult. It requires an effective user model, able to shape the story events in a meaningful way. Here is what we could obtain with the current prototype implementation: "I decide to offer a jewel to Bill, but I have no jewel. I decide to get a jewel and ask Doug for his jewel. Doug refuses... I tell Bill that I failed in asking Doug to give me his jewel, because Doug does not like me. Bill dissuades me to ask the Jewel to Doug. I tell Doug that I did not manage to offer a Jewel to Bill, because I don't have any jewel. Doug encourages me to offer a jewel to Bill. I tell Carl that I did not manage to ask Doug his jewel, because Doug does not like me. Carl dissuades me to ask the Jewel to Doug. Carl informs me that I could hit Doug to get the jewel. I accept this idea and hit Doug. I have the jewel. I offer the jewel to Bill, who thanks me. I am his friend

now. I inform Bill that I have hit Doug to get the jewel. Bill condemns me for having hit Doug for the jewel."

This generated story shares with the "ideal" story described above, the fact that it expresses the values of the narrative, with an interesting end. Obviously, the story is still imperfect (e.g. why would I tell bill that I punched Doug?). The User Model is responsible of these weaknesses, and will be improved.

4 CONCLUSION

Starting from elementary narrative structures, which were more or less easily represented by graph models, we have progressively added new features, to make these structures more interesting from a narrative and interactive point of view. The structure in Section 3.1 produces sequences that are narrative but not enough interactive. The structure in Section 3.2 produces very interactive sequences that are not narrative. From Section 3.4 to Section 3.6, we have added narrative features, without compromising interactivity, which seems to be a promising approach.

It is interesting to relate this progression to the definition of narrative given by J.M. Adam, in terms of six criteria [2]:

- Succession of actions
- Thematic unity
- Transformation
- Process (unity of action)
- Causality
- Evaluation

Three of these criteria, transformation, causality and evaluation are addressed in Sections 3.5, 3.4 and 3.6 respectively. The other can be satisfied in the model. The structure in Section 3.6 passes the "test of storiness", according to Adam.

The emphasis of this paper is on a constructive and formal approach for finding interesting structures for interactive narratives. This approach is complementary with the artistic approach, which consists in building real size interactive narratives with the system [19]. From an artistic point of view, the stories present in this paper are poor. They can be improved by two means:

- Improving the User Model, which constraints the story into narrative tracks, especially from an emotional point of view.
- Writing better semantic content to be applied on the structure.

From the author point of view, it is quite difficult to start from an abstract structure and then instantiate it. Even starting from instantiated structure is a difficult task, as discussed in [19]. The approach we proposed here is not an authoring method. Rather, it helps understanding which structures are narrative and why.

The next step consists in formalizing our empirical findings in order to be able to automatically analyze a given structure and provide various quality indicators. This analyzer could be used by the author in order to provide him/her some guidelines to write interesting structures. Note that a structure poorly analyzed would for sure produce a bad interactive narrative, but this is not reciprocal: a good structure is not enough for a good story. The quality of the final story also depends on a good User Model, an interesting instantiation, the quality of the surface forms and the design of the interaction.

We hope that this approach could be generalized in two ways.

First, beyond the IDtension model we used for representing stories, we believe that this approach could apply to other representations, in particular, character based approaches.

Second, as stated in the Introduction, we think this work on minimal narrative structures could be applied to a context where stories are not explicit, like for instance educational systems or web design.

5 ACKNOWLEDGMENTS

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