A Cognitive Approach to Narrative Planning with Believable Characters*

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Abstract

In this work, we address the question of generating understandable narratives using a cognitive approach. The requirements of cognitive plausibility are presented. Then an abduction-based cognitive model of the human deliberative reasoning ability is presented. We believe that implementing such a procedure in a narrative context to generate plans would increase the chances that the characters will be perceived as believable. Our suggestion is that the use of a deliberative reasoning procedure can be used as a basis of several strategies to generate interesting stories.

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1 Introduction

Throughout their lifetime, humans are surrounded by narratives. A large amount of time is devoted to the production of narratives [19, 13]. Many psychologists and AI researchers suggest that narratives are used to make sense of the world, to order events and assimilate them. This narrative intelligence is of major importance in the cognitive processes employed across many contexts including entertainment [10], advertising, remembering or learning [8].

The classical problem addressed in the context of narrative generation is the *fabula* generation, *i.e.* the generation of a temporally ordered sequence of events from the time the story begins to the time the story ends [1]. The process of generating a narrative meets some requirements to form acceptable narratives. One of them is to produce a sequence of events that is understandable by the audience. Events should respect the causal rules of the (possibly imaginary) world and the audience must be able to infer the characters' intentions during the course of the narration [2, 7].

In this work, we address the question of generating stories using a cognitive approach. Especially, we are interested in investigating how authors create understandable stories with believable characters. To do so, we will argue in favor of a cognitive model of deliberative reasoning to generate stories.

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2 A cognitive approach to narrative planning

Computer-based story generation has been the subject of intense study in Artificial Intelligence during the last century. The present work addresses the question of generating stories using a cognitive approach. Especially, we address the question of generating plans, *i.e.* temporally ordered sequences of actions or events.

Generating plans not only consists in choosing actions that respect the causal rules of the world but also make the characters of the story appear believable. Characters' actions should not negatively impact the audience's suspension of disbelief [2]. As Riedl and Young (2005) put it: 'one important aspect of character believability is character intentionality [*i.e.*] the way in which the choice of actions and behaviors that a character makes appears natural (and possibly rational) to external observers.'

According to classical models, someone who acts intentionally must have a desire (for an outcome) and appropriate beliefs about how her action would lead to that outcome [5]. Malle and Knobe (1997) have identified five necessary components to recognize the intentionality of an acting agent: the desire for an outcome, the beliefs that the action would lead to this outcome, the intention to perform the action, the awareness of the act while performing it, and a sufficient degree of skill to perform the action reliably. In the field of automatic narrative generation, it has been shown that the characters' behavior must be perceived as goal-oriented to make them appear as believable [17]. However, not all goal-oriented systems meet the conditions of cognitive plausibility.

In the field of automatic story generation, there have been many attempts to generate stories using script-based models [6]. These models, however, do not constitute as such a cognitive approach. Humans use scripted plans to perform a large variety of tasks in daily life, like drinking water or going to the bakery. However, a story generation system should be able to modify scripts on the fly and, in the absence of appropriate scripts, to design a new plan using knowledge about the world (*e.g.* states and rules).

It has been previously mentioned that goal-oriented systems are considered as essential to make characters appear as believable. However, from a cognitive point of view, we do not suppose that humans permanently hold in mind a (potentially unlimited) set of goals that have to be fulfilled. A cognitively plausible model of plan generation at the agent's level should rather generate plans, not from some list of pre-existing goals, but on the fly, based on conflicting elements in the characters' internal knowledge and desires.

Another requirement for a cognitive model of planning is that it should not have access to an external oracle that would provide pieces of information about the truth value of some propositions. Plans are designed by the characters, from their own point of view, using only their own internal knowledge and preferences.

Cognitive models of planning have to realize a sequential computation of the plans. Many studies in psychology suggest that humans engage in something akin to partial-order planning [15]. Especially, partial-order planning systems construct plans by manipulating partial plans and revoking (if necessary) only parts of the global plan. Humans seems to exhibit performances that are close to those of partial-order planners in terms of calculation time or number of operations.

Lastly, a cognitive model of planning is not expected to generate an optimal plan that would be best evaluated (depending on various objectives). It is expected to generate plans that are merely acceptable.

In the next section, we present an abduction-based model of deliberative reasoning: the Conflict-Abduction-Negation (CAN) procedure [3]. We show that this model may be used as a cognitively plausible model for the generation of plans at the character level. We also indicate how it can serve as basis for several strategies to elicit interest in the audience.

3 The CAN-procedure, an argumentative model for narrative generation

The CAN-procedure [3] is based on the conflict resolution via abduction. It has been shown that abduction is central to human intelligence [9], especially in problem solving and diagnosis reasoning contexts [11]. In the sense close to Peirce's definition, abduction consists in generating an hypothesis that explains an observation. Abduction also plays a major role in narratives, both for characters and audience [4]. Oatley and Johnson-Laird (1987) explain how readers of a narrative feel emotions as abductions. Abduction is also a way to avoid emotional or narrative inconsistencies, and it is useful to avoid characters' goals that would appear as unmotivated.

The CAN-procedure is not goal-oriented, but problem-oriented: goals are generated on the fly from cognitive conflicts when these conflicts are detected. The output of the CAN-procedure, as it can be observed in actions and justifications, may lead observers to perceive behaviour as goal-oriented, ignoring how "goals" have been generated. To understand the notion of cognitive conflict, we have to introduce the notion of 'evaluation' of a situation.

In real life, as in the storyworld, situations are not true or false but believed or not believed. Some situations are desired and some others are not desired. We found that for plan generation purposes, it is useful to merge beliefs and desires in a single evaluation. Situations that one wants to avoid or that one does not believe will receive a negative evaluation. Situations that are desired or believed will receive a positive evaluation. The intensity of these evaluations depends on the level of desire or confidence. A situation may receive several evaluations, it may be both believed and desired at the same time. Such a case is considered as not conflicting. If the situation is believed but not desired, then the situation is 'not comfortable' and there is a cognitive conflict.

A cognitive conflict is detected whenever a given proposition is assigned two opposite evaluations. For example, imagine that John, an adventurer, is looking for a treasure. Owning the treasure is positively evaluated. However, the same fact is negatively evaluated as well, since he knows the fact is false. The role of the deliberative reasoning procedure is to diminish the intensity of evaluation conflicts. The procedure is described below:

Algorithm 1 The Conflict-Abduction-Negation Procedure

Step 1) A conflict has been detected, i.e. a situation s receives two opposite evaluations $v_1 < 0 < v_2$. The conflict-solving procedure is launched.

Step 2) The procedure performs abduction from s, looking for a "weak" cause that would make the conflict less intense. If the evaluation of the cause is smaller than $-v_1$, the conflict is moved to the cause.

Step 3) If the abduction phase fails, v_2 is replaced by $-v_1$. Then the whole procedure starts anew from the negation of s (which is conflicting as well).

Step 4) If no solution to the conflict has been found, either one evaluation is revised or the system exits without solution.

This procedure meets the conditions of cognitive plausibility previously described. Goals are generated on the fly when undesired facts are negated. Plans are calculated using the internal evaluations of the planning individual. Moreover, the CAN-procedure is something akin partial-order planning systems. Plans are only partially re-computed when inconsistencies are detected. Consider the following example:

John wants the treasure, but didn't get it (conflict). John needs to go in the castle (abduction). The castle can be reach by going over the bridge (abduction) . . .

1) . . . *[The bridge is not broken] John decides to go over the bridge to reach the castle and then get the treasure (plan).*

2) . . . *[The bridge is broken] John cannot change it (abduction, negation). John cannot use the bridge (failure). The castle can be reached through a longer path (abduction). John decides to use the longer path to reach the castle and then get the treasure (plan).*

The Conflict-Abduction-Negation procedure can be used recursively. It means that, if the plan calculated by a character does not terminate as anticipated for whatever reason, the character may launch the procedure anew to solve the remaining conflicts. Plans may fail for a variety of reasons. At some point during the execution, a character may realize that her knowledge about the world is erroneous, which means that one ore more propositions have received a wrong evaluation. An action which was previously considered possible can no longer be performed. A character may also realize that one or more consequences of her actions were not correctly anticipated. Either her knowledge about the world is incomplete or the consequences were just probable. Yet another possibility is the intervention of other agents that may thwart the plan (including the storyworld considered as an "agent" controlled by the author). The recursivity of the CAN procedure offers simple strategies to create situations that are surprising from a character's point of view. One strategy may be the following one: the audience is informed about a character's plan but this plan is thwarted by the occurrence of some event and both the character and the audience may be surprised.

4 Conclusion

In this paper, we have built an argument for the use of a model of deliberative reasoning in the context of story generation. Our suggestion is that it may serve as basis for a minimalist model of narrative generation.

In this article, the CAN-procedure is mainly used at the character level. With a model of the audience, we believe that it can also be used at the audience level. At the character level, the CAN-procedure may be used to compute plans characters intend to achieve. It may also be used to anticipate what an audience will imagine, depending on the information provided.

The model needs to be associated with a formal model of narrative interest. In previous works, we addressed this question and we introduced a model of narrative interest: Simplicity Theory [18]. We intend to use this model based on the notion of unexpectedness in the CAN-procedure to evaluate the situations in the storyworld and locally control the level of interest during the course of the story.

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