Narrative Representations and Causality in Character-Based Interactive Storytelling

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Abstract

In this paper we describe a fully implemented prototype for interactive storytelling using the Unreal™ engine. Using a sit-com like scenario as an example of how the dynamic interactions between characters and/or the user dramatise the emerging story. We present how all possible narrative variations are formalised using Hierarchical Task Networks. However, within interactive narrative representation, matters arise from the conjunction of different sorts of causality: physical, psychological and narrative.

Keywords:
Interactive storytelling, Emergent stories, Virtual characters, Agent behaviour, AI-planning algorithms.

1. Introduction

Recent developments in interactive storytelling have resulted in many different approaches, sometimes taking opposite views on key concepts, such as the relations between character and plot. These approaches include emergent storytelling [1], user-centred plot resolution [2], character-based approaches [3] [4], anytime interaction [5], and narrative formalisations [6].

In this paper, we describe the first results obtained with a character-centred [3] interactive storytelling system. The final applications we are addressing consist in being able to alter the ending of stories that have an otherwise well-defined narrative structure. In other words, we start with a generic storyline representation, which defines the characters' roles: their dynamic interaction, together with potential user interference, will determine the actual instantiation of the plot.

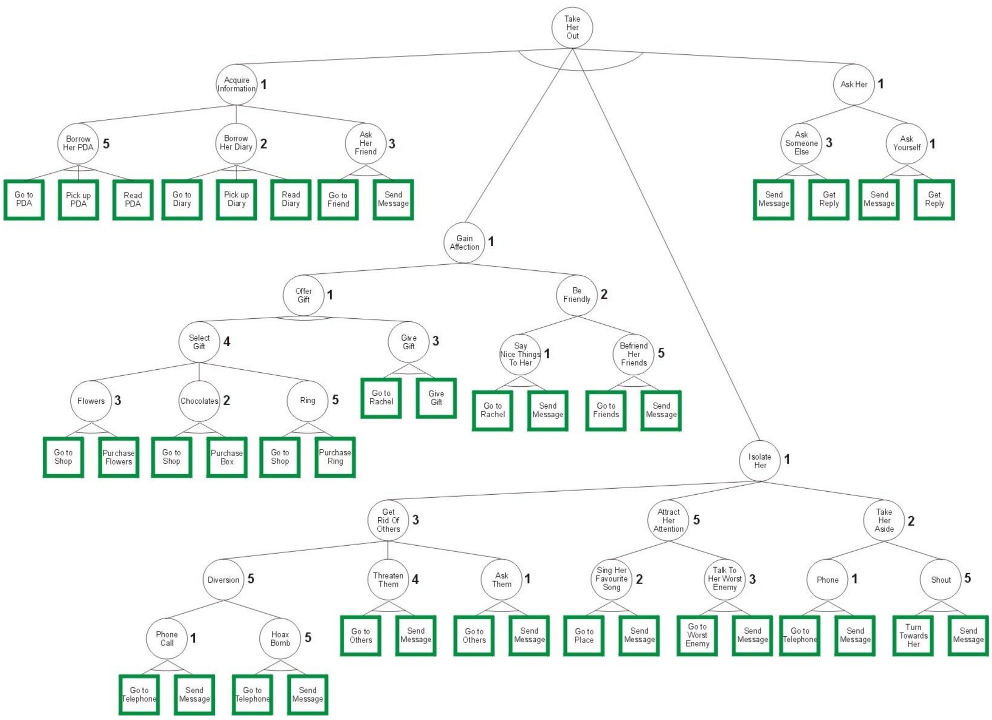

Figure 1: Ross' Plan

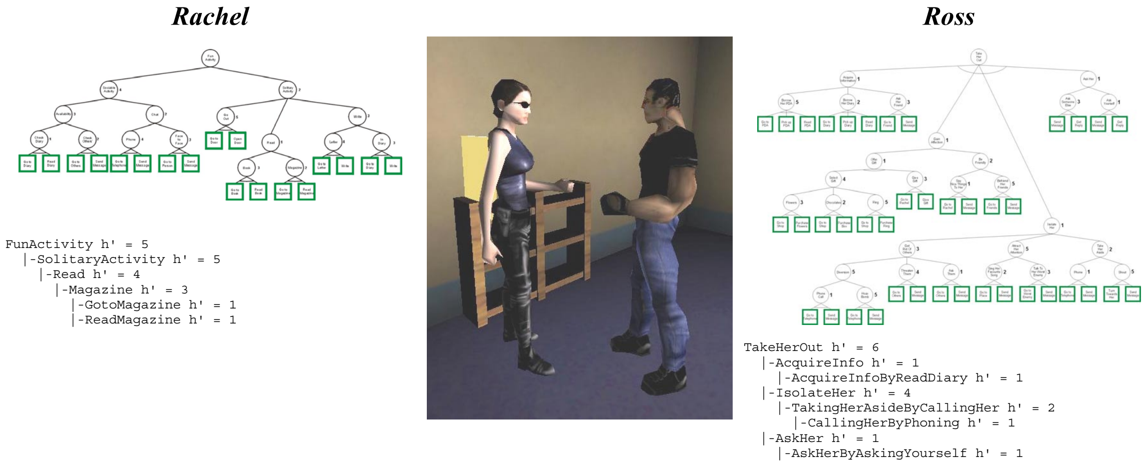

Figure 2: Ross' "active" plan and Rachel's generic pattern of behaviours

Previous work has identified essential concepts and techniques in interactive storytelling, such as the relation between character and plot, or the balance between storytelling and interaction [3] [7]. However, there is still often a gap between the AI techniques supporting character behaviour and their use to represent narrative knowledge. Now that practical solutions have been proposed for some basic problems, such as the use of planning for characters' behaviour, there is a need for some more fundamental analysis to take place before attempting to scale-up interactive storytelling systems.

We hereby try to identify, on the basis of the first results of our prototype, essential problems in narrative knowledge representation, analysing them through the notion of narrative causality [8] [9].

2. Authoring and Storytelling

The storyline for our experiments is based on a simple sitcom-like scenario, where the main character ("Ross") wants to invite the female character ("Rachel") out on a date. This scenario tests a narrative element (i.e. "will he succeed?") as well as situational elements (the actual episodes of this overall plan that can have dramatic significance, e.g., how he will manage to talk to her in private if she is busy, etc.). Our system is driven by characters' behaviours. These actually "compile" narrative content into characters' behaviours, by defining a superset of all possible behaviours, represented by a plan for each character. Dynamic choice of an actual course of action within this superset is the basis for plot instantiation [3]. In that sense, this addresses the causality/choice duality described by Raskin [9] in storytelling, though this choice takes place within the limits of the formalism used to represent possible behaviours, which is a plan-based formalism [3] [10]. This can be illustrated by considering the overall plan for the Ross character (Figure 1).

In order to invite Rachel, he must for instance acquire information on her preferences, find a way to talk to her, and finally formulate his request (or having someone acting on his behalf, etc.). These goals can be broken into many different sub-goals, corresponding to potential courses of action, each having a specific narrative significance.

The initial storyline should actually determine not only the main character plan, but those of other characters as well. The problem of dependencies between characters' roles has actually been described within modern narratology, though not to a formal level. Narrative functions can be refined into bipolar relations between couple of actors, emphasising the asymmetry in their roles [8]. We have adopted this framework to define the respective behaviours of our two leading characters (Figure 2). We started with the overall narrative properties imposed by the story genre (sitcoms). In terms of behaviour definition, this amounts to defining an "active" plan for the Ross character (oriented towards inviting Rachel) and a generic pattern of behaviour for Rachel (her day-to-day activities).

3. System Description

A first version of the prototype has been fully implemented and runs the scenario in a real-time interactive 3D environment [10]. Graphic rendering, character animation and user interaction in the system are based on the Unreal™ game engine. The engine provides high-quality display at a constant frame rate, while also serving as a software development environment [3]. Besides embedding its own scripting language (UnrealScript™), it can accept C++ modules and can communicate via sockets with external software. This first prototype has been developed mostly in C++ to implement the AI planning techniques at the heart of the system and UnrealScript™ to describe low-level animations and interactions of characters.

Individual agent behaviours are produced by solving the plans discussed in the preceding section, which are represented by Hierarchical Task Networks (HTN) such as the one of Figure 1. Using formal properties of these plans, it is possible to generate solution plans by searching directly the AND/OR graph of the HTN with an algorithm such as AO* [12] [13]. In our system, this is done with a "real-time" variant of AO*, which interleaves planning and execution and supports re-planning that is required when a character's plan is altered through interaction with another virtual actor or the user. The terminal actions (e.g. reaching a location, using an object, interacting with other actors) forming the plan are actually played in the graphic environment through their corresponding animations. The dramatisation of these actions constitutes the story as seen by the user.

4. Example

While the conditions for interaction between characters lie in the on-stage spatio-temporal instantiation of the storyline, additional mechanisms are required to recognise these interactions and propagate their consequences. Figure 3 illustrates an entire story instantiation.

Let us now give a more technical description of these events, by detailing the associated steps in plan generation or terminal actions. Each of the main characters has its own planning system: they are synchronised through Unreal™ low-level mechanisms. Firstly, Ross' plan. The first sub-goal for Ross' plan is to acquire information about Rachel. There are various ways to satisfy this goal in Ross' behaviour representation, and the first one selected is to read her diary. The corresponding script involves going to the diary location and reading it (reading it always succeeds in providing the information). The first part of the script is executed and played on stage. In the meantime, Rachel's plan that governs her spontaneous activity, determines her to write something in her diary. She reaches the diary and starts using it through a durative action (a scripted action which is associated a clock based on the internal Unreal™ clock). When Ross arrives in sight of the diary, the pre-conditions of the action of "reading it" are checked: the diary is in place and that no one else is using it. This pre-condition is not satisfied, hence the second terminal action ("ReadDiary") fails, which in turn causes the whole sub-plan to fail. The re-planning produces a new partial solution, which consists in asking Phoebe. Ross then goes to Phoebe's location and starts talking to her. As Phoebe is a reactive actor, she responds directly to Ross' request, in this case positively. In the meantime, Rachel's next occupation is to talk to Phoebe. When she reaches Phoebe, the internal mechanisms will make Rachel aware of the situation where Ross is talking to Phoebe. The pre-conditions for a terminal action involving conversation with another actor is to check whether this actor is free. The jealousy rule is added on top of this check and concerns subjects with which there is a relationship. Internally, the mood state is altered accordingly: all heuristics are revised, and of course, the activity "Chat with Phoebe" fails.

Rachel leaves the room. In the same way, Ross' low-level mechanisms will provide situational information that will modify his internal states and influence his sub-plans. Ross will stop talking to Phoebe (terminal action fails) when he realises Rachel is upset, and will then run after her.

In order to get the information he needs, Ross goes to read Rachel's diary (a). When he approaches the room, he realises that Rachel is actually writing in her diary. Unnoticed by Rachel, he goes to meet Phoebe to ask her about Rachel (b). In the meantime, Rachel has finished writing and decides to have a chat with Phoebe (c).

As she arrives to meet Phoebe, she sees her in a joyful conversation with Ross (d). She gets jealous and ostensibly leaves the room (e). Ross sees her leaving and follows her to ask her out, which she refuses (f).

Figure 3: Storyboard of the "jealousy" scenario.

To summarise, this example illustrates the two main character's plans as a representation of narrative instantiation. Though these plans are run independently , they are designed from global narrative principles (considering the story genre).

5. Causality and Interactivity in Storytelling

The creation of an interactive narrative can be analysed through the notion of causality in storytelling as described by Raskin [9]. Raskin introduces three different sorts of causality: physical causality, psychological causality and narrative causality. Causality, which can be tracked back to Aristotle's Poetics, is mostly instrumental to the understanding of stories and their formalisation for narrative analysis. It is however common in interactive storytelling to assume that narrative formalisms, originally introduced for narrative analysis, can serve as a basis for computer implementations. This is largely similar to the role of descriptive linguistics in computational linguistics, and we should consider in that case that interactive storytelling can be based on computational narratology, supported by narrative knowledge[1].

Physical causality corresponds to common sense physics, i.e. our understanding of the physical consequences of actions in the everyday world. The point to be considered here is the level of detail of the simulation. While in traditional simulation or some computer games, physical causality plays a major role, this needs not be the case in interactive storytelling. This again is consistent with the fact that the virtual characters are not improvising, but acting along the lines of a variable, yet initially defined, storyline. Not every low-level detail needs to be generated and, more specifically, not every physical detail. In our system, we have only dealt with physical causality at the object level, i.e. the availability of objects as resources for actions (a diary, a telephone, a gift, etc.), illustrated in Figure 4.

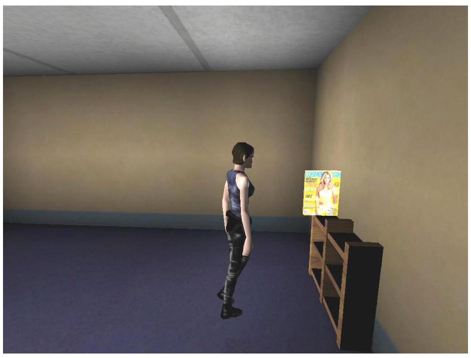

Figure 4: Rachel goes to read a magazine

[1] We shall discuss the fact that causality is just as relevant to character-based approaches than it is to explicit plot representations [2], though its analysis might be more complex in the former case.

Psychological causality is what determines an agent's actions from its internal mental states. Personality determines the choice of a character's actions from the set of narratively meaningful ones. In our system, agents' behaviours are not determined by an explicit intentional representation in the cognitive sense, and psychological causality is implemented through the notion of personality profiles. For instance, when trying to find a way to talk to Rachel in private, a "shy" Ross would not interrupt Rachel when she is with her friends, while an overconfident Ross would ask them to leave (Figure 5). Hence, internal sub-goals are categorised according to personality-related narrative dimensions and the heuristic values that are used by the planning algorithm will determine the course of action accordingly. This also results in a consistent set of decisions that should make the personality visible to the user, through the specific actions taken by the character.

Figure 5: Ross asks Phoebe to leave

Narrative causality is certainly the most relevant concept in this context. This difficult notion is discussed in narrative theories such as Barthes', through the notion of dispatcher [8]. A dispatcher is essentially an element that signals the possibility of alternative course of action. That causality of events can crystallise around a single intervention triggering dramatic change also evokes the Althusserian concept of clinamen. Causality is of course strongly related to choice [9], which in our system is supported by the alternative sub-goals that an agent can follow. In our system, dispatchers are represented through objects that are resources for actions. There is also a strong relation between dramatisation and the recognition of dispatcher. Because in our framework the characters are acting rather than improvising, nothing in their behaviour is accidental: the actions they are undertaking have a narrative meaning, which facilitates the dramatisation of actions. For instance, the fact that Ross tries to get Rachel's diary suggests to the user that this diary has narrative significance (without of course always signifying which meaning it has), which can prompt user interference, such as the user "stealing" the diary from the set (Figure 6). In that sense, the equivalent of dispatchers are associated with interactivity as well. However, the main source of narrative causality remains the sequential ordering of sub-goals in a character's plan.

Figure 6: Dramatisation of user interference

6. Conclusions

The description of character's behaviour from narrative principles is a difficult task and still a field for investigation. The main challenge is to turn concepts defined for narrative analysis into knowledge supporting automatic narrative generation. Taking the example of causality, we adopt a pragmatic view, namely that causality can underlie interactivity by i) supporting user understanding on ongoing actions and ii) providing mechanisms to propagate the effect of agents' or user's intervention. However, causality, with its associated determinism, should not imply the unfolding of predictable events at the user level. Several factors actually contribute to this non-predictability, essentially the dynamic interaction between various characters' plans. The random allocation of initial conditions to various characters, together with the duration of the actions they carry out, creates conditions for variability, such as characters competing for objects, meeting or missing each other, depending on their on-going activities, etc. At this stage, this has already been confirmed in our experiments. We are now working at scaling-up the system both in terms of episode complexity and in terms of number of feature characters.

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