Sex, Lies, and Video Games: an Interactive Storytelling Prototype

Marc Cavazza, Fred Charles and Steven J. Mead

School of Computing and Mathematics, University of Teesside
TS1 3BA, Middlesbrough, United Kingdom
{m.o.cavazza, f.charles, steven.j.mead}@tees.ac.uk

Abstract

We describe a first prototype of an Interactive Storytelling system, whose objective is to allow user intervention within a pre-defined storyline. The system is character-based rather than plot-based, each character's role being dynamically computed using HTN planning. The interaction between characters creates various instantiations of the baseline narrative, with which the user can interfere at any time. After introducing the basic AI techniques used in the prototype, we discuss the modalities of user intervention and present an example story produced by the system.

Introduction

Interactive Storytelling promises to be an important evolution of computer entertainment, re-introducing better narrative content and extending the user experience. Several paradigms have been described for interactive storytelling (Mateas, 2000) (Young, 2000) (Szilas, 1999) (Sgouros et al., 1996), which differ on various dimensions such as user involvement and relations between character and plot. Our approach is a character-based approach, which essentially follows proposals by Young (2000; 2001), in which the story is generated by the dynamic interaction of autonomous actors whose roles are implemented using real-time planning systems. Within the many possible implementations of interactive storytelling, we are targeting a specific kind of application, which consists in enabling the users to interfere with the progression of a pre-defined storyline. User intervention should be allowed at anytime, and the consequences of this intervention (stealing an object on-stage, giving advice to a character) affect the characters behaviour to alter the course of action, creating new dramatic situations and eventually leading to different story endings. In the next sections, we give an overview of the various AI techniques we implemented in our first prototype.

System Overview and Architecture

A wide range of AI techniques has been used to support interactive storytelling systems: logic programming (Grasbon and Braun, 2001), Augmented Truth-Maintenance Systems (Sgouros et al., 1996), Blackboard Systems (Hayes Roth et al., 1997) and planning systems (Young, 2001) (Swartout et al., 2001) (Mateas, 1999) (Cavazza et al., 2001b). Their use depends on the interactive storytelling paradigm implemented.

However, there is no direct correspondence between a given AI technique and a storytelling paradigm. For instance Young (1999) has described the use of planning to control the narrative itself, rather than just the behaviour of individual autonomous characters; the ICT's "Holodeck" project (Swartout et al., 2001) has reported the use of planning for its autonomous characters but also relies on causal narrative representations (Swartout et al., 2001) (Douglas and Gratch, 2001).

As we are mainly interested in the emergence of story variants from the interaction of autonomous actors, our emphasis has been on the actors' behaviour rather than on explicit plot representation or narrative control. However, we still needed our formalism to be able to accommodate the authoring aspects of the baseline narrative. These requirements led us to investigate planning techniques that could be used in knowledge-intensive domains, and we eventually opted for HTN planning (Nau et al., 1998). We originally considered using HTNs planning for interactive storytelling as it is generally considered appropriate for knowledge-rich domains, which can provide domain-specific knowledge to assist the planning process (Kambhapati and Hendler, 1992). It also appeared that characters' roles, which serve as a basis for our narrative descriptions, could be naturally represented as tasks decompositions in the HTN planning framework.

A single HTN corresponds to several possible decompositions for the main task: in other words, HTNs can be seen as an implicit representation for the set of possible solutions (Erol et al., 1995). In the present context, each ordered decomposition constitutes the basis for a character's plan, and each HTN associated to an artificial character contains the set of all possible roles for that character across story instantiations. Though this set can be large enough, the set of stories instantiations is at least an order of magnitude larger, as the story is composed of situations that are the "cross-product" product of the actors' roles.

Interactive storytelling requires interleaving planning and execution (Young, 1999). We have thus devised a search algorithm to produce a suitable plan from the HTN. Taking advantage from our total ordering assumption and sub-task independence, it searches the HTN depth-first and left-to-right and executes any primitive action it encounters in the process. Backtracking is allowed when primitive actions fail (e.g. following competition for action resources by other agents, or user intervention) This search strategy is thus similar to the one described by Smith et al. (1998). In addition, heuristic values are attached to the various sub-tasks, so forward search can make use of these values for selecting a sub-task decomposition (this is similar to the use of heuristics described by Weyhrauch (1997) to "bias" a story instantiation). An essential aspect of HTN planning is that it is based on forward search while being goal-directed at the same time, as the top-level task is the main goal (other recent forward-search planning systems, such as HSP (Bonet and Geffner, 1999) or MinMin (Pemberton and Korf, 1994) search forward from the initial state to the goal). An important consequence is that, since the system is planning forward from the initial state and expands the sub-tasks left-to-right, the current state of the world is always known, in this case the current stage reached by the plot.

We have chosen to adopt total ordering of sub-tasks for our initial descriptions of roles. Total-order HTN planning precludes the possibility of interleaving sub sub-tasks from different primitive tasks, thus eliminating tasks interaction to a large extent (Nau et al., 1998). In the case of storytelling, the sub-tasks are largely independent as they represent various stages of the story. Decomposability of the problem space derives from the inherent decomposition of the story into various stages or scenes, a classical representation for stories. However, this is largely an empirical finding that we would like to challenge in further experiments.

In addition to their top-down plans, characters also react to specific events: for instance they can get upset if interrupted in an interesting activity, or become jealous of other characters. These reactions produce dynamic updating of "mood" values that impact on the remainder of the characters' plans.

A first prototype has been fully implemented on top of the Unreal Tournament™ (UT) engine. The graphic environment has been modelled using the game's level editor, modelling additional objects with 3D studio max™ and obtaining textures from several on-line resources (including one for "The Sims™"). The characters have been imported from on-line repositories[1]. The AI layer is implemented in C++ and integrated in UT as a set of dynamic link libraries (.dll). All the functions that interface with UT's events, e.g. those functions dealing with object interactions are defined in UnrealScript. Communication with the speech recognition system (EAR™ SDK from Babel Technologies) takes place through datagram sockets using the UDPlink class in UT.

[1] Credits for the characters: Brian Collins (*Ross*), "Austin" (*Rachel*), Roger Bacon (*Phoebe* and *Monica*).

A Sitcom Scenario

The test scenario we have been using is inspired from the popular "Friends™" sitcom (Cavazza et al., 2001a). The rationale for using a sitcom is that the story ending and intermediate situations are equally relevant, which constitutes a good test case for story generation and interaction. Several roles are defined as plans for each feature character. The decomposition of a plan into sub-goals reflects different stages of the action, while the lower layers correspond to various ways to achieve these goals. For instance, in order to take Rachel out, Ross needs to acquire information about her, to gain her friendship, find a way to talk to her in private, etc. He his faced with several possibilities at each stage, e.g. to gain information he can steal her diary, ask one of her friends, phone her mother, etc., each of these sub-goals being further refined until they can be described in terms of terminal actions to be played in the virtual environment.

Story Generation

Story generation is the result of the dynamic interaction between the four main characters' plans (somehow the "cross product" of these plans) (Cavazza et al., 2001a). Story generation derives from top-down and bottom-up aspects. The characters' plans naturally correspond to the top-down component. However, in the course of the action, situations might emerge that do not form part of the initial plans but cannot be ignored. One clear example is when Ross and Rachel bump into each other at an early stage of the story. Emerging situations are dealt with through situated reasoning complementing top-down planning (Geib and Webber, 1993). This provides a modular way to cope with situations, while keeping plans to a manageable size. For instance, in the above example Ross can choose to either hide from Rachel or to engage in conversation. The latter option will impact on his plan and post-conditions (such as him having gained information about Rachel) will be passed to the original plan when it resumes.

Even though the basic elements of actors' behaviours are deterministic, there are several factors that contribute to make the action non-predictable from the user's perspective these are: i) the initial positions of actors on stage, ii) the interaction between actors' plans, the various characters essentially competing for resources for action (whether narrative objects or other characters) iii) the random output of some terminal actions, iv) the "mood" status of the characters and v) user intervention. For instance, the initial positions will have a strong impact on the emerging situations. Depending on their respective initial position and activities, Ross might or not be able to acquire information from Phoebe before she leaves the flat for some shopping, etc.

As a consequence, similar conditions, even similar intervention from the user, might not always produce the same results.

User Intervention

The user watches the story as a spectator. At this stage he can follow the story from any character's perspective or navigate on the virtual set while the action is in progress. From his understanding of the current action, he can choose whether to interfere or not with the characters' goals. Characters' actions are dramatised through the timing of appropriate animations. Because the actors are playing a role rather than improvising, their actions are always narratively meaningful. Hence, if a character moves towards a given object, it is likely to bear significance for the story and can be the target for user intervention. For instance, if the user sees Ross moving towards Rachel's diary, he can choose to steal or hide that diary.

The user can intervene by either acting on physical objects on-stage that bear narrative relevance (and are often obvious, such as keys, letters, gifts, weapons, etc.). These objects being resources for actions, they will force the character into re-planning or action repair, which, being dramatised as well, will create a new course for the plot. The other mode of interaction consists in influencing actors using speech recognition. This form of influence will become the main one in further developments of the system and will include:

- providing information needed by the actors to complete their plans (e.g. Rachel's preferred gifts, see Figure 1)
- giving doctrine advice that influences the personality of an actor (i.e. recommending a friendly behaviour towards certain characters)
- trying to alter the mood of a character
- getting actors to perform certain actions that have narrative consequences, such as moving to a certain location that increases the probability of meeting other characters

Results

In its current status, the system is able to generate short complete stories up to three minutes in duration. The dramatic action appears from Ross perspective (though the user can switch viewpoints to either of the characters' or even freely explore the stage while the plot is unfolding) and progresses until he asks Rachel out in what is the final scene. The story concludes with Rachel's (positive or negative) answer.

The following story instantiation presents four characters, two main roles (Ross and Rachel) and two secondary roles (Phoebe and Monica). As presented previously, the characters are engaged in activities defined by plans represented by their own HTNs. Below is a sample story produced by the system (Figure 2).

Ross wants to use Rachel's PDA to retrieve relevant information regarding her preferences. He goes to Rachel's bedroom (a), unseen by Phoebe, who is preparing some coffee (b). As the user discovered Ross' plan, he decides to remove the object from the virtual environment (c) to alter the on-going storyline. Ross reaches the location of the PDA (d), unaware of user intervention (e). Ross makes a new decision to talk to Phoebe (f), as she may provide him with the relevant information. Ross interrupts Phoebe regardless of what she is doing (g). As Ross was rather unkind to Phoebe, she decides to lie to him concerning Rachel's preferences, telling him to offer Rachel a box of chocolates (h). In a different story instantiation, if Ross were more careful when asking Phoebe, she would have responded more positively to his request, by telling him to buy roses instead. After succeeding in gathering important information, Ross goes to purchase his gift for Rachel from the shop (i, j). After buying the box of chocolates (k), he goes back to the flat (l, m) to offer them to Rachel. As she is alone, he goes (n) and asks her out, which she inevitably refuses (o).

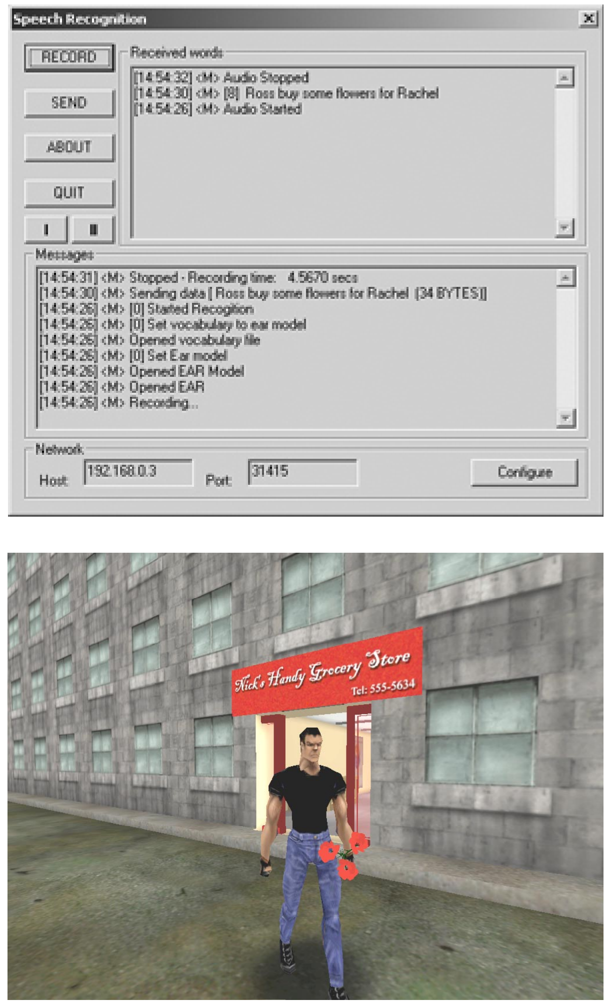

Figure 1: Giving spoken advice to characters.

Conclusion

Character-based approaches in interactive storytelling have a good potential for story generation. Despite the deterministic nature of their underlying techniques, many different factors contribute to the non-predictability of the unfolding plot. An extension of our current prototype will develop more complex storylines, and scale up using multiple plans for each character to increase characters' interactions.

References

Bonet, B. and Geffner, H, 1999. Planning as Heuristic Search: New Results. *Proceedings of ECP'99*, pp. 360-372.

Cavazza, M. Charles, F. and Mead, S.J. 2001a. Characters in Search of an Author: AI-based Virtual Storytelling. *Proceedings of the First International Conference on Virtual Storytelling (ICVS 2001)*, Avignon, France, Lecture Notes in Computer Science, n. 2197, Springer Verlag, pp. 145-154.

Cavazza, M. Charles, F. and Mead, S.J. 2001b. AI-based Animation for Interactive Storytelling. *Proceedings of IEEE Computer Animation*, Seoul, Korea.

Douglas, J. and Gratch, J., 2001. Adaptive Narrative: How Autonomous Agents, Hollywood and Multiprocessing Operating Systems Can Live Happily Ever After. *Proceedings of the First International Conference on Virtual Storytelling (ICVS 2001)*, Avignon, France, Lecture Notes in Computer Science, n. 2197, Springer Verlag, pp. 100-112.

Hayes-Roth, B., van Gent, R. and Huber, D. 1997. Acting in character. In R. Trappl and P. Petta (Eds.), *Creating Personalities for Synthetic Actors.* Berlin, New York: Springer.

Erol K., Hendler J., Nau D.S. and Tsuneto, R., 1995. A Critical Look at Critics in HTN Planning. *Proceedings of IJCAI-95*.

Kambhampati, S. and Hendler, J.A., 1992. A Validation Structure Based Theory of Plan Modification and Reuse, *Artificial Intelligence*, 55(2-3):193-258.

Geib, C. and Webber, B., 1993 A consequence of incorporating intentions in means-end planning. Working Notes – *AAAI Spring Symposium Series: Foundations of Automatic Planning: The Classical Approach and Beyond.* AAAI Press.

Grasbon, D. and Braun, N. 2001. A Morphological Approach to Interactive Storytelling. *Proceedings of Cast'01, Living in Mixed Realities*, Sankt Augustin, Germany.

Mateas, M. 1999. An Oz-Centric Review of Interactive Drama and Believable Agents. In M. Wooldridge and M. Veloso, (Eds.), *AI Today: Recent Trends and Developments. Lecture Notes in AI 1600*. Berlin, New York: Springer.

Mateas, M., 2000. A Neo-Aristotelian Theory of Interactive Drama. *AAAI Spring Symposium in Artificial Intelligence and Interactive Entertainment 2000*, AAAI Press.

Nau, D.S., Smith, S.J.J., and Erol, K., 1998. Control Strategies in HTN Planning: Thoery versus Practice. *Proceedings of AAAI/IAAI-98*, pp. 1127-1133.

Pemberton, J.C. and Korf, R.E., 1994. Incremental Search Algorithms for Real-Time Decision Making. *Proceedings of the 2nd Artificial Intelligence Planning Systems Conference (AIPS-94)*.

Sgouros, N.M., Papakonstantinou, G. and Tsanakas, P., 1996. A Framework for Plot Control in Interactive Story Systems, *Proceedings AAAI'96*, Portland, AAAI Press, 1996.

Smith, S.J.J., Nau, D.S., and Throop, T., 1998. Computer Bridge: A Big Win for AI Planning. *AI Magazine*, 19(2):93-105.

Swartout, W., Hill, R., Gratch, J., Johnson, W.L., Kyriakakis, C., LaBore, C., Lindheim, R., Marsella, S., Miraglia, D., Moore, B., Morie, J., Rickel, J., Thiebaux, M., Tuch, L., Whitney, R. and Douglas, J., 2001. Toward the Holodeck: Integrating Graphics, Sound, Character and Story. *Proceedings of the Autonomous Agents 2001* Conference, Montreal, Canada.

Szilas, N.: Interactive Drama on Computer: Beyond Linear Narrative. *AAAI Fall Symposium on Narrative Intelligence*, Technical Report FS-99-01, AAAI Press (1999).

Weyhrauch, P., 1997. *Guiding Interactive Drama*. PhD Thesis, School of Computer Science, Carnegie Mellon University, Technical Report, CMU-CS-97-109, Pittsburgh, PA.

Young, R.M., 1999. Notes on the Use of Plan Structures in the Creation of Interactive Plot. *AAAI Fall Symposium on Narrative Intelligence*, AAAI Press, 1999.

Young, R.M., 2000. Creating Interactive Narrative Structures: The Potential for AI Approacches. *AAAI Spring Symposium in Artificial Intelligence and Entertainment*, AAAI Press, 2000.

Young, R.M., 2001. An Overview of the Mimesis Architecture: Integrating Intelligent Narrative Control into an Existing Gaming Environment. *AAAI Spring Symposium on Artificial Intelligence and Interactive Entertainment*, AAAI Press.

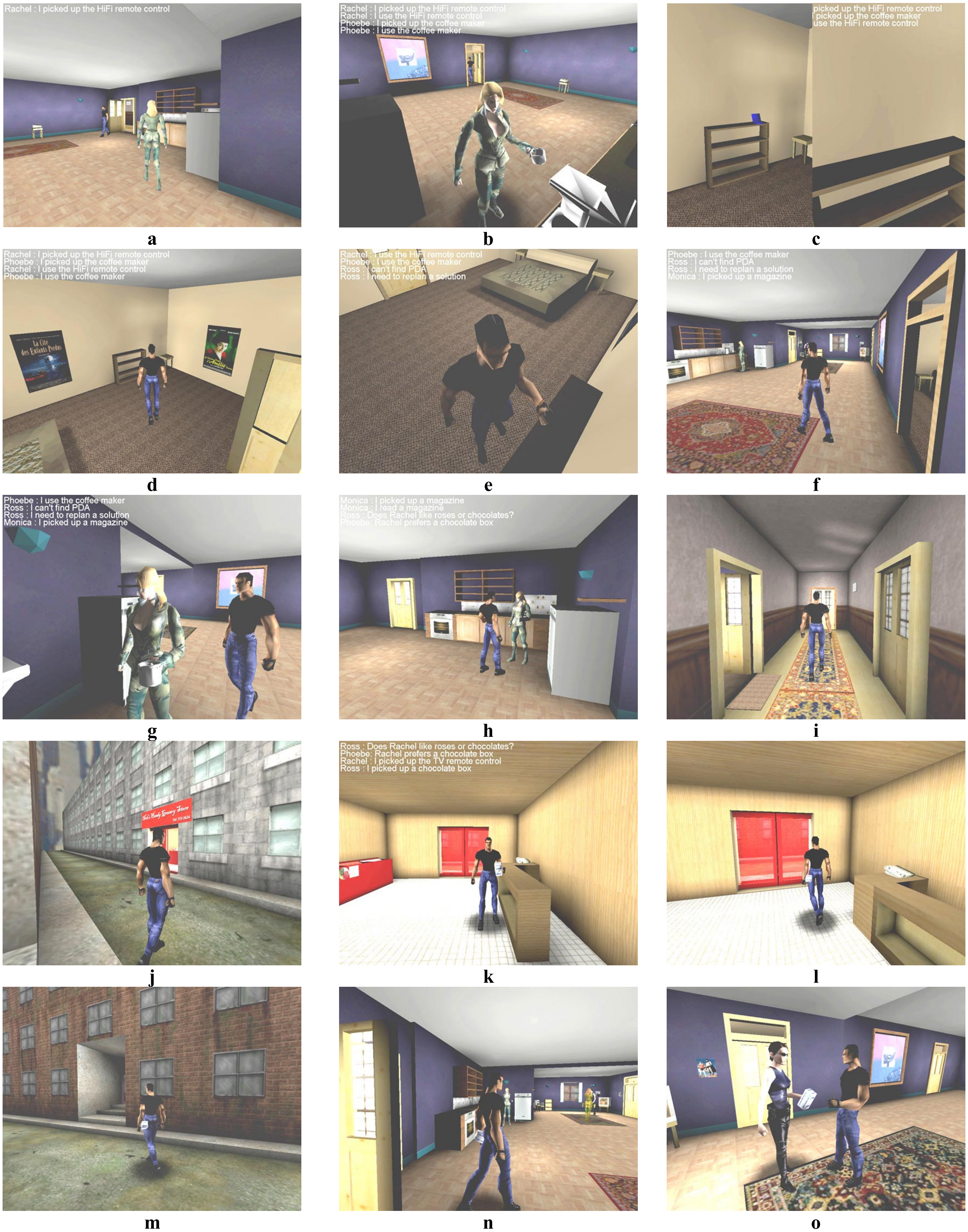

Figure 2: An Example Story Produced by the System.