

Generation of Humorous Situations in Cartoons through Plan-based Formalisations

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

Introduction

Digital Storytelling aims at developing techniques for the automatic generation of narratives by computers, in the form of computer animations. In evaluating the quality of the stories produced, there has been some work dedicated to modelling suspense [Young, 1999] or the emotions of characters [Gratch and Mrasella, 2001]. However, virtually no work has addressed the characterisation of comic situations within these narratives and how they can be generated.

The principal AI technique for digital storytelling is planning [Badler et al., 1996], as it describes the high-level behaviour of characters through action selection, and as a story can be described as a sequence of causally related actions.

In this work, we attempt to characterise comic situations in digital storytelling through the planning formalisms used to generate the story. This formalisation also has the potential to gain a better understanding of some mechanisms of comedy in specific genres. In this research we use cartoons as an investigation field.

Planning in Cartoons

It is reasonable to think that formalisation would be initially easier to carry out in those narrative genres in which the plot itself makes explicit the plans constructed by the story's characters to achieve their goals, and to some extent is actually based on these plans. This appears to be actually the case in several cartoons, for instance the Roadrunner™ series, and the popular Pink Panther™, which serves as a test application in this research.

The description of stories as plans has been proposed in computational linguistics for story understanding [Schank and Ableson, 1977]. However, the analysis cartoons would reveal that many of them resort to dramatisation of problem solving, or the pursuit of a single goal (e.g., catching the “roadrunner”) as a main narrative mechanism.

This is why, to support these experiments, we have opted for such a cartoon application, in the form of a short episode of the popular “Pink Panther” character. It appears that a typical Pink Panther cartoon involves problem-solving and goal-oriented activities, which tend to be contrasted by external factors (e.g. preventing a cake from being stolen, a room to be painted new, returning a cat to its owner, etc.). Many actual Pink Panther episodes can be analysed in terms of such planning aspects, i.e. achieving or preserving a given state.

We have designed a simple scenario as a context, in which a single goal would provide a narrative drive but the intervening situations and their ordering are left open. This contrasts significantly from our previous work in interactive storytelling [Cavazza et al., 2002], in which the story would progress through pre-defined stages, story variability taking place within each stage. The scenario consists for the Pink Panther to get a quiet night's sleep (the “sweet dreams” scenario). Many things can get in the way, and getting rid of these constitutes various planning sub-problems: in addition, there is much room for long-range dependencies between sub-tasks that are likely to generate action failure and comic situations. For instance, in our example, if we assume that the Pink Panther's sleep goal can be contrasted by noise. The Pink Panther will have to identify various strategies for getting rid of noise, such as

preventing the transmission of noise or suppressing the noise source. These strategies can be represented by (high-level) operators, while the actions constituting each strategy (closing a window, wearing ear plugs, fixing a leaking tap, calling phoning the noisy neighbours, etc.) will be embedded in ground operators executed in the agent's environment.

HSP Planning for character behaviour

As our hypothesis states that comic situations arise from plan failure, we need a planning technology that can support character behaviour in a dynamic environment, and whose representation not only makes explicit the conditions for action success, but allows actions which might fail to be attempted. The former condition can be met by using a STRIPS-like formalism, while the latter is satisfied by distinguishing between executability conditions and standard pre-conditions, as introduced by Geib [1992]. Executability conditions can be seen as conditions for action success but not for action selection: their "cognitive" interpretation is that the agent might take these for granted. For instance, the availability of water is an executability condition of taking a shower. Attempting at taking a shower when the water supply has been cut (Figure 1 G) results in a comic situation. Without the distinction between executability conditions and pre-conditions, such action will never be attempted by the planner powering the virtual character, and many comic situations would never be produced.

The planner which animates the agent should be able to generate plans that fail for both external and internal reasons. External failure results from interference by another character or environmental conditions, as demonstrated for instance in [Cavazza et al., 2002]. However, a key mechanism to generate comic situations is that the plan itself fails to take into account the long-term consequences of some actions taken. We thus need a planning formalism that is centered on action descriptions and shows significant generative power.

Heuristic Search Planning techniques as introduced described by Bonet and Geffner [2001] as comprising three main aspects, which can be described as: i) a domain model and its formalisation, ii) a heuristic search algorithm and iii) a heuristic function, together with an efficient calculation method.

The domain formulation is generally based on a set of STRIPS operators corresponding to the various actions an agent can take. Each operator has a set of pre-conditions, an add-list and a delete-list. For instance, figure 1 shows some typical operators in our system. In HSP systems, these operators are defined using atomic propositions only. States on the other hand, are represented as conjunctions of atomic propositions. In the case of virtual characters, ground operators correspond to actions that the agent can carry out in its virtual environment and have a direct translation in the graphic world of the agent.

The search algorithm explores the state space using heuristic search. Each node is expanded by considering the operators whose pre-conditions are satisfied by the current state (Figure 1) and the resulting states are evaluated using a heuristic function (described below). Several search algorithms have been described for early HSP systems, including weighted A* and IDA*. However, planning for character animation requires interleaving planning and execution, as the environment is a dynamic one, and some actions taken by the agent might fail as a consequence of dynamic processes. This is why we have opted for the RTA* algorithm [Korf, 1990], which supports interleaving planning and execution at each step, by selecting the best candidate operator and applying it.

As a heuristic function, we are using the additive heuristic as described in the HSP2 system [Bonet and Geffner, 2001]. This heuristic function is automatically derived from the problem description as a set of STRIPS operators, so that exploratory authoring can be based on actions descriptions alone. The heuristic function evaluates each node by solving a relaxed version of the planning problem. More precisely, it approximates the cost of achieving each goal proposition individually from the state considered and then combines the estimates to obtain the heuristic value of the given state [Liu et al., 2002], hence the name "additive heuristic". We are using the standard value iteration method to compute the heuristic [Liu et

al., 2002], which in our context offers a good compromise between speed of calculation and complexity of implementation.

Early Results

While this work is still in progress, a first system has been implemented using the Unreal Tournament game engine, which supports graphic rendering and real-time 3D character animation, with the HSP planner being implemented in Allegro Common Lisp and communicating with the graphic engine via UDP sockets. Figure 1 shows a short sequence generated by the system, which leads to a comic situation.

The single goal of the Pink Panther, acting as a narrative drive, is to go to bed and fall asleep. The PP has prepared for bed (A), however when trying to sleep, she hears noise from a leaking tap (B). This noise prevents her from falling asleep (in the planner, “quiet” is an executability condition for falling asleep). She walks to the tap, trying to tighten it (C), but this fails (D). She would then go down to the basement (E) in order to cut off the main water supply (F). However, getting to the basement results in her being dusty on return (G), which is a side effect of going to the basement, a pre-requisite for cutting off the main water supply. Being clean is a pre-condition for going to bed, so the planner tries to restore this (still following the main get-asleep goal), by taking a shower (G). However, this fails because the executability condition is not met, the main water supply having been cut off, etc.

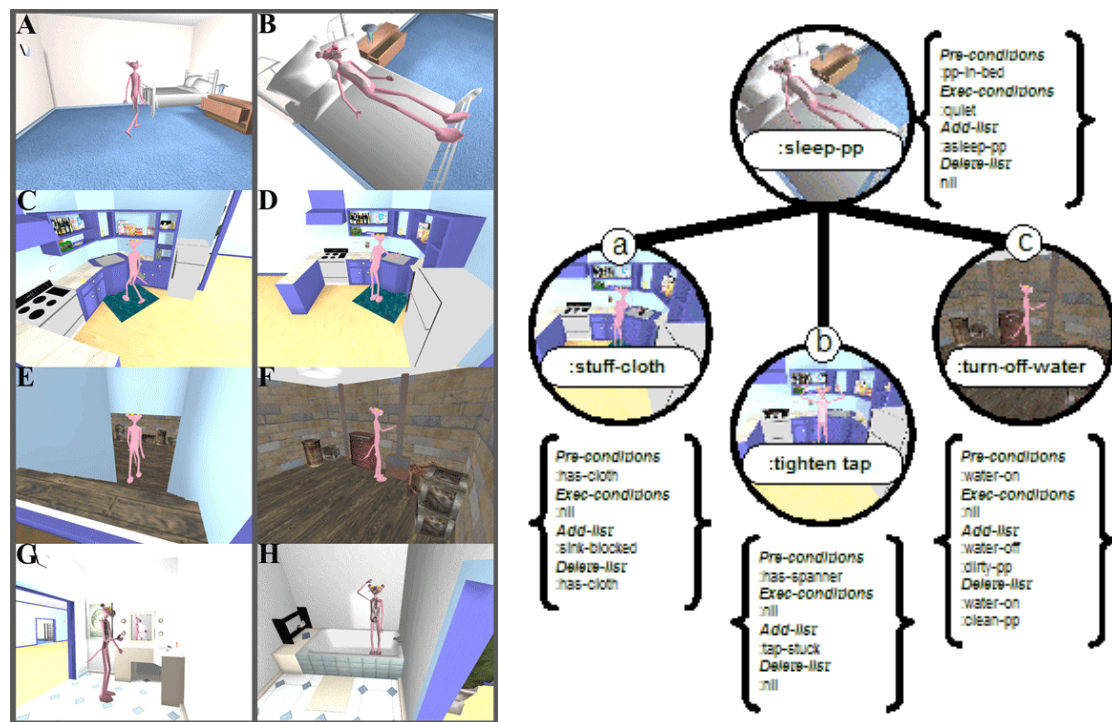


Figure 1: Example results (left) and action selection (right)

Conclusions: Towards a formalisation of comic situations

This work suggests that, at least in specific narrative genres, humour can be modelled using plan-based behaviours. At this stage it is probably too early to attempt anything but a very partial classification of the mechanisms by which humour can be generated within plan-based courses of action. These mechanisms include: the visible complexity of the plan elaborated, failure of the plan due to external events (e.g., environmental ones), failure of the plan due to oversight of conditions, failure of the

plan due to long-term consequences of some actions (in particular the delete-lists of some operators), failure of the plan due to the incorrect ordering of operators, etc.

Acknowledgements

We thank Eric Jacopin for many discussions and Hector Geffner for his advice on the use of HSP techniques

References

Badler, N., Webber, B., Becket, W., Geib, C., Moore, M., Pelachaud, C., Reich, B., and Stone, M. Planning for animation. In N. Magnenat-Thalmann and D. Thalmann (eds), *Interactive Computer Animation*, Prentice-Hall, pp. 235-262, 1996.

Bonet, B. and Geffner, H. Planning as Heuristic Search. *Artificial Intelligence Special Issue on Heuristic Search*, 129(1), pp. 5-33, 2001.

Cavazza, M., Charles, F. and Mead, S.J. Interacting with Virtual Characters in Interactive Storytelling. *ACM Joint Conference on Autonomous Agents and Multi-Agent Systems*, Bologna, Italy, pp. 318-325, 2002.

Geib, C. Intentions in means-end planning, Technical Report MC-CIS-92-73, University of Pennsylvania, 1992.

Gratch, J. and Marsella, S. Tears and Fears: Modeling emotions and emotional behaviors in synthetic agents, in *Proceedings of the 5th International Conference on Autonomous Agents*, Montreal, Canada, June 2001.

Korf, R.E. Real-time heuristic search. *Artificial Intelligence*, 42:2-3, pp. 189-211, 1990.

Liu, Y., Koenig, S. and Furey, D. Speeding Up the Calculation of Heuristics for Heuristic Search-Based Planning. In *Proceedings of the National Conference on Artificial Intelligence*, pp. 484-491, 2002.

Schank, R.C. and Abelson, R.P. *Scripts, Plans, Goals and Understanding: an Inquiry into Human Knowledge Structures*. Hillsdale (NJ): Lawrence Erlbaum, 1977.

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., Thieboux, M., Tuch, L., Whitney, R. and Douglas, J. Toward the Holodeck: Integrating Graphics, Sound, Character and Story. in *Proceedings of the Autonomous Agents 2001 Conference*, 2001.

Young, R.M. Cognitive and computational models of suspense: Towards the automatic creation of suspense in interactive narratives, talk presented at *Interactive Frictions: The Conference Produced at the Pressure Point Between Theory and Practice: An International Conference on Interactive Narrative* Friday, June 4, 1999, University of Southern California, Los Angeles, CA, 1999.