Interactive Narrative Planning in *The Best Laid Plans*

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Abstract

The Best Laid Plans is an interactive narrative video game that uses cognitive-inspired fast planning techniques to generate stories with conflict during play. Players alternate between acting out a plan and seeing that plan thwarted by non-player characters. The Glaive narrative planner combines causal-link-based computational models of narrative with the speed of fast heuristic search techniques to adapt the story each time the player attempts a new plan.

About *The Best Laid Plans*

The Best Laid Plans is an interactive narrative point-and-click adventure game. Players take on the role of a hapless goblin minion in service to the skeletal Dark Overlord. The goblin is tasked with visiting the local village to retrieve a bottle of hair tonic and return with it to the Overlord's tower.

Play alternates between two modes. In *Make Your Plan* mode, the player acts out a sequence of actions to obtain the hair tonic and return to the tower. Non-player characters (NPCs) do not act in this mode, allowing the player to explore many possible ways of completing the mission.

Once the player has acted out a complete plan to fetch the hair tonic, play changes to *Watch Your Story Unfold* mode. Now the player watches the goblin execute the plan, but in this mode the non-player characters will act to thwart the goblin. When the player's plan is thwarted, play returns to *Make Your Plan* mode and prompts the player for a new plan. The game alternates between these modes until the goblin successfully reaches the tower with the hair tonic in hand.

For example, in *Make Your Plan* mode the player acts out a simple plan to walk to the village, purchase the hair tonic from the potion shop, and walk home. Then, during *Watch Your Story Unfold* mode as the goblin is walking home, a bandit blocks his path, kills the goblin, and takes the hair tonic. Play returns to *Make Your Plan* mode at the moment before the goblin's death, and the player must now find a way around the bandit. The player decides to return to the village, steal a weapon from the weapons merchant, and use it to fight his way past the bandit. But as the player is watching this new plan unfold, after stealing the weapon, the angry

town guard attacks the goblin for robbing the weapons merchant. Play returns to *Make Your Plan* mode, and the goblin must now find a way around the town guard. And so on.

The Best Laid Plans is a small but non-trivial virtual environment containing 9 characters, 15 locations, and 17 items. Agents can take 10 different kinds of actions and cast four kinds of spells. The scope of this environment was designed to allow players to complete a game in about 15 minutes.

Architecture

The game has a simple client/server architecture which decouples the virtual environment from the interactive narrative controller. The client is the 3D virtual world and interface, which was created with the Unity 3D game engine. The client prompts the player for plans and visualizes them as they unfold. The server generates and adapts the game's story during play. It was created with Java 1.7 and communicates with the client via a TCP socket.

When *Make Your Plan* mode ends, the client sends the player's intended plan for the goblin to the server using the syntax of the Planning Domain Definition Language, or PDDL. The server responds with the story that should actually be visualized, which can include actions by other characters. Every time some agent completes an action in *Watch Your Story Unfold* mode, the client notifies the server so that it can update its model of the game's current state.

The Best Laid Plans is freely available to play and modify:

http://liquidnarrative.csc.ncsu.edu/blp/

The client/server architecture makes it easy to test a variety of different interactive narrative control techniques. The next section describes how the Glaive planner is used in the default version of the game.

Narrative Planning

Narrative planning is a branch of classical planning which imposes additional constraints on its solutions to meet a standard of narrativity (Young et al. 2014). The Glaive narrative planner (Ware and Young 2014) leverages two computational models of narrative which are inspired by narrative theory and cognitive science and based on causal reasoning.

Riedl and Young (2010) describe agent intentionality as an extension of partial-order causal-link (POCL) planning (Weld 1994). Each action in an intentional planning domain

Figure 1: A screenshot of *The Best Laid Plans* (left) and the list of available actions (right). The screenshot shows the goblin in the village along with the weapons merchant and town guard. The Dark Overlord watches and telepathically provides feedback from the top left of the screen. To the left is a description of the player's current plan. On the bottom is the goblin's inventory, number of actions remaining, and score.

is annotated with a list of 0 to many agents who much consent to take that action. A valid plan must achieve the author's goal, and each step must be explained in terms of the individual motivations and goals of the agents who take them. Ware and Young (2014) further extended this model to include the essential narrative phenomenon of conflict. By marking certain steps as *intended but not executed*, a plan can include an explanation of what each agent intended to do, even if their plans failed due to conflicts with other agents or the environment.

The Glaive narrative planner combines the rich knowledge representation of causal link plan models with fast forward-chaining state-space heuristic planning techniques. Glaive is based on Hoffmann and Nebel's Fast-Forward algorithm (2001), but in addition to tracking which propositions are true and false in the current state it also tracks the causal history of which earlier steps made those propositions true or false. Glaive uses these causal links to calculate a more accurate heuristic and prune large branches of a problem's search space which can never produce valid intentional plans. Glaive also supports a model of conflict by treating the problem's search space graph as a model of possible worlds. The explanation of an action in one branch of the search space that does not actually occur (one possible world) can be treated as an *intended but not executed* action and used to explain that action in the solution plan (the actual world).

In short, Glaive treats the narrative planning problem as one of multi-agent coordination where agents can both cooperate and conflict with one another. Glaive constructs a plan which achieves the author's goal out of steps which are clearly motivated by and in service of the goals of the individual agents who take them. In other words, agents appear

to follow their own goals but are being shepherded toward the author's goal (that the goblin fail to reach the tower with the hair tonic) by an invisible puppet master.

Each time the player acts out a plan, Glaive searches the first 5000 nodes in the problem's search space to find a plan in which the NPCs thwart the goblin. Glaive typically finds dozens of solutions if any exist, and planning takes about 2 seconds depending on the speed of the computer on which it is running.

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