

Problem Formulation for Accommodation Support in Plan-Based Interactive Narratives*

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Branching story games have gained popularity for adapting to user actions within a story world. An active area of Interactive Narrative (IN) research uses automated planning to generate story plans as it can lighten the authorial burden of writing a branching story. Rather than hand-crafting each branch, automated planning generates them from a declarative representation. A goal of an Experience Manager (EM) is to guide a user through an IN's space of desirable narrative trajectories (Riedl and Bulitko 2012), or story branches.

However, in the cases when an EM must accommodate user actions and mediate them from a desired narrative trajectory to a new narrative trajectory, automated planning's authorial advantage becomes a liability as the available narrative trajectories are not known a priori. This limitation can lead to the EM choosing a new narrative trajectory that is not coherent with the previous one and may result in a negative user experience. The goal of my research is to develop a problem formulation methodology for story planning problems that elicits the available narrative trajectories enabling an EM to execute more coherent accommodations. This goal is captured by the following thesis:

Thesis - *A model of the causal and motivation dependencies between character goals in the storyworlds represented in a story planning problem can allow an interactive narrative experience manager to accommodate exceptional user actions by selecting a storyworld that preserves author goals, user agency, and coherence between narrative trajectories.*

This thesis will answer the following research questions:

RQ 1 - *How can a problem formulation methodology for a story planning problem be used to measure the coherence between narrative trajectories?*

RQ 2 - *What factors affect the relationship of the coherence between two narrative trajectories and a user's experience of agency and fun when accommodating user actions?*

The primary technical contribution is a character-goal model of storyworlds and algorithms to generate them in a

story planning problem. This enables human subject contributions that lead to a more fundamental understanding of the effects of accommodation coherence on agency and fun.

Answering the research questions consists of three distinct stages. The first stage requires developing a problem formulation methodology for story planning problems. Problem formulation research has focused on problem validity (McCluskey and Porteous 1997) and solution efficiency (Ware and Young 2014), however the desired output of this methodology is a set of partial narrative trajectories capturing the storyworlds that could solve the story planning problem. The first challenge is to define a plan-based storyworld model that includes essential character-goal dependencies and excludes precise syntactic details of a plan (e.g. exact movements). Addressing this challenge enables narrative-theoretic comparisons, rather than using comparisons that are influenced by syntactic necessities of story plans. A second challenge is to define a process to generate the possible storyworlds that when refined into a story plan could reach a story plan's goal state. The output from step 1 in Figure 1 represents two storyworlds from Red Riding Hood. The first is the classic tale, Red's goal is to get to Grandma's house with food, the Wolf desires to eat Red, and the woodsmen protects her. A second storyworld has Red and the Wolf's goals staying the same, but differs by Grandma feeding herself and protecting Red. A complete view of the possible storyworlds informs the EM of the available accommodations and allows the EM to make strategic choices among the options, which addresses the EM plan generation design challenge (Roberts 2011). Finally, an EM needs to translate a storyworld into a story plan used in an accommodation strategy. This requires defining a process to translate abstract character-goals of a storyworld into Planning Domain Definition Language (PDDL) details of a partial narrative trajectory (step 2, Figure 1). This stage is represented in the top of Figure 1.

The second stage will address the first research question by integrating the problem formulation methodology from the first stage into an accommodation strategy in the General Mediation Engine (GME) (Robertson and Young 2014). The first step in this integration stage is to develop a storyworld comparison framework to rank accessible story worlds in terms of their coherence with the current storyworld (step 3, Figure 1). There are several domain-independent and

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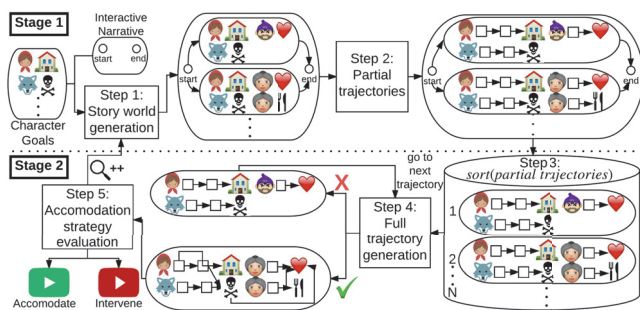


Figure 1: Dissertation stages one(top) and two(bottom)

domain-specific (Amos-Binks, Roberts, and Young 2016) metrics available to compare plans. Developing a comparison framework ensures that the formulation of coherence measures can adapt to reflect experimental results. The second step is to generate the full narrative trajectories from the partial trajectories output from stage one (step 4, Figure 1). This step fills in the trajectory details to validate the soundness of a storyworld as an operationalized narrative trajectory in the form of a story plan to address the tactical action/plan refinement design issue identified by Roberts 2011. The final step in the integration stage is to determine the effectiveness of the accommodation options (step 5, Figure 1). Should an appropriate trajectory be found, then the underlying world representation is set to the new trajectory. However, when it is not possible to obtain a complete narrative trajectory with sufficient coherence to the previous narrative trajectory, the search space can be incrementally expanded to include potential solutions that are increasingly non-optimal but may be more coherent. Alternatively, an EM could apply another mediation strategy such as intervention (Riedl and Bulitko 2012). This stage is represented in the bottom of Figure 1 and in conjunction with the first stage, addresses RQ 1.

Finally, a third stage will consist of human subject research to evaluate the effect of independent variables for accommodation coherence and subject gaming skill on dependent variables of affectance (agency) and enjoyment (fun). This evaluation involves human subjects performing actions in a text-based IN that are incompatible with the desired narrative trajectory. These actions will engage the accommodation strategy from stages one and two in GME to mediate participants to new narrative trajectories. After the subject completes the IN, we will collect user responses to an established assessment instrument for agency and fun used by Ramirez et al. 2013. To assess the variables, we will perform hypothesis testing using a parametric ANOVA test.

We wish to evaluate accommodation coherence as a first independent variable, as it is assumed that accommodation should preserve coherence between trajectories (Robertson and Young 2014). However, measures of coherence have not been formally defined nor has the assumption been empirically validated. Using character-goal measures of coherence, participants will be mediated to narrative trajectories that vary in character-goal changes to the original trajectory. Our expectation is that with an increase in an accommoda-

tion's character-goal changes, fun and agency will decrease. We surmise that when new character-goals are introduced, a subject will make backward-inferences to establish coherence (Van den Broek 1985). These inferences are made more difficult by the absence of causal connections to previous events, which occurs when introducing new character-goals.

Secondly, we are interested in gaming skill as an independent variable to investigate anecdotal references to the 'pull-back' effect (Ramirez, Bulitko, and Spetch 2013), where participants report being consistently pulled-back to the same narrative trajectory. We intuit from subject comments in the aforementioned work that higher gaming skill increases their ability to foresee the effects of their actions and alters their control heuristic (Thompson, Armstrong, and Thomas 1998) thought to be used by participants to judge their agency. To capture a gaming skill variable, the IN will present a short survey gathering the number of hours a subject plays games, type of games, interest in narrative, and the number of years playing. We expect that with high gaming skill, participants' fun and agency will not decrease as significantly as those with lower skill when presented with an accommodation that is low in character-goal coherence.

In summary, maintaining the balance between control and coherence is central to IN research. Completing this dissertation contributes to this goal by supporting the formulation of branching INs with accommodations that maintain coherence. The primary technical contribution is a character-goal model of storyworlds and algorithms to generate them within a story planning problem. This enables human subject research leading to a more fundamental understanding of accommodation coherence on affectance and enjoyment.

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